EC NEVADA

Southern Nevada Health District

New BSL-3 Laboratory Building

Las Vegas | Nevada

GC Bidding Specifications

EWINGCOLE PROJECT NUMBER: 20230523

November 8, 2024

401 West A Street, Suite 320, San Diego, CA 92101 **TEL** 949.417.7550

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SECTION 00 01 15 - DRAWING LIST

Drawings consist of the Contract Drawings and other drawings listed on the Table of Contents page of the separately bound drawing set included on Drawing: CS, G.1, LS2.1, LS2.2, C-001, C-101, C-201, C-301, C-401, C-501, AG.2, AG.3, AG.4, AD2.1.A, A0.1, A1.1, A1.2, A1.6, A2.1.1A, A2.1.1B, A2.1.1B.2, A2.1.2A, A2.1.2B, A2.1.2B.2, A2.2.1A, A2.2.1A.2, A2.2.1B, A2.2.1B.2, A2.2.2A, A2.2.2A.2, A2.2.2B, ACP2.1.0, ACP2.1.A, ACP2.1.A.2, ACP2.1.B, ACP2.1.B.2, ACP2.2.0, ACP2.2.A, ACP2.2.A.2, ACP2.2.B, ACP2.2.B.2, ACP2.2.0, ACP2.2.A, ACP2.2.A.2, ACP2.2.B, ACP2.2.B.2, A3.1.1, A3.1.2, A3.3.1, A3.5.1, A4.1.1, A4.2.1, A4.2.2, A4.3.1, A4.3.2, A4.3.3, A4.5.1, A4.6.1, A4.6.2, A4.7.1, A4.7.2, A4.8.1, A4.8.2, A4.8.3, A5.1.1, A6.1.1, A6.1.2, A6.1.3, A8.1.1, A8.2.1, A8.4.1, A8.4.2, DG.1, DG.2, DSG.1, DS.1, DS.2, DS.3, DS.4, SG.1, SG.2, SG.3, S2.0, S2.1, S2.2, S2.3, S2.4, S3.1, S3.2, S3.3, S3.4, S4.1, S5.1, S5.2, S5.3, S5.4, S5.5, S5.6, S6.1, HG.1, H1.1, H1.2, H2.1.1A, H2.1.1B, H2.2.1A, H2.2.1B, H2.3.1A, H2.1.1A.2, H2.1.1B.2, H2.2.1A.2, H2.2.1B.2, H2.3.1A.2, HP1.1, HP1.2, HP2.1.1A, HP2.1.1B, HP2.2.1A, HP2.2.1B, HP2.3.1A, HP2.1.1A.2, HP2.1.1B.2, HP2.2.1A.2, HP2.2.1B.2, HP2.3.1A.2, H3.3.1, H4.1.1, H4.1.2, H4.1.3, H4.1.4, H5.1, H5.1.2, H5.2, H5.2.2, H5.3, H5.4, H6.1, H6.2, H7.1, H7.2, H7.3, H7.4, H7.5, PG.1, PD1.0, PD1.1, PD1.2, PD2.0.1A, PD2.0.1B, PD2.1.1A, PD2.1.1B, PD2.1.1B.2, PD2.2.1A, PD2.2.1A.2, PD2.2.1B, PD2.2.1B.2, PD2.3.1, PD2.3.2, PS1.0, PS1.1, PS1.2, PS2.0.1A, PS2.1.1A, PS2.1.1A.2, PS2.1.1B, PS2.1.1B.2, PS2.2.1A, PS2.2.1A.2, PS2.2.1B, PS2.2.1B.2, PS2.3.1, PS2.3.2, P3.1.1, P3.1.2, P3.1.3, P3.1.4, P3.1.5, P3.1.6, P3.1.7, P3.1.8, P3.1.9, P3.1.10, P3.1.11, P4.1.1, P4.2.1, EG.1, EDS1.0, ES1.1, EP2.1, EP2.2, EP2.3, EP2.4, EP2.5, EP2.6, EP2.7, EP2.8, EP2.9, EP2.10, EL2.1, EL2.2, E3.1.1, E3.1.2, E3.2.1, E4.1.1, E4.2.1, E4.2.2, E4.2.3, EP5.1, E6.1, E6.2, E6.3, E6.4, TG.1, T0.1, TT2.1.1, TT2.2.1, TT2.1.2, TT2.2.2, TT2.3, TS2.1.1, TS2.2.1, TS2.1.2, TS2.2.2, TS2.3, TT5.1, T6.1, T6.2, T6.3, T6.4, TT7.1, TS7.1, TS7.2, FS0.00, FS2.20, FS2.21, FA0.00, FA2.20, FA2.21 dated October 11, 2024, as modified by subsequent Addenda and Contract modifications, form a part of the contract documents.

END OF SECTION 00 01 15

SECTION 00 71 23 - GENERAL CONDITIONS (AIA Form A 201; 2017 As Modified)

PART 1 - GENERAL (See Attached)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 00 71 23

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Project information.
2. Work covered by the Contract Documents
3. Assigned Subcontractors.
4. Owner-furnished products, Contractor-installed products.
5. Access to site.
6. Owner occupancy requirements.
7. Work restrictions.
8. Specification formats and drawing conventions.
9. Seismic Requirement.
10. Infection Control Risk Assessment (ICRA)
11. Substrate for Floor Materials.
12. Miscellaneous Provisions.

a. Project Identification and Temporary Signs
b. Compliance with industry standards
c. Electrical ratings
d. References

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: New Laboratory Building Project No. 20230523
Project Location: 700 South M. L. K. Blvd., Las Vegas, NV 89106

B. Owner: Southern Nevada Health District (SNHD)
280 S. Decatur Blvd., Las Vegas, NV 89107

1. Owner's Representative: Sean Beckham

C. Architect: EwingCole
Architects.Engineers.Interior Designers.Planners
401 West A Street
Suite 320
San Diego, CA 92101
949.417.7550

D. Civil Engineer: Latitude33
10731 Treena Street
San Diego, CA 92131

E. Fire & Life Safety Engineer: TERP Consulting
1604 S. Maryland Parkway
Las Vegas, NV 89104

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

The work includes, but is not necessarily limited to, the following: New two-story laboratory building for housing Southern Nevada Health district testing and analysis laboratories. The building will house BSL-2 and BSL-3 laboratories.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 PHASED CONSTRUCTION

A. The Work shall be priced / conducted in two phases, there will be the Phase 1 facility construction including interior improvements and the Phase 2 construction which is interior improvements to Phase 1 Shell areas within the building. Owner may elect to only complete Phase 1 at this time or may complete both phases. Each phase is further defined as indicated:

1. Phase 1 is the construction of the building and the interior improvements defined as the unshaded areas in the construction documents sheets A1.1 and A1.2.
2. Phase 2 is the construction of the interior improvements defined as the shaded areas in the construction documents sheets A1.1 and A1.2.
3. The Phase 1 construction scope shall be aligned with the Phase 1B Site Civil work currently bidding under a separate issuance.

B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates, and move-out and -in dates of Owner's personnel for all phases of the Work.

1.6 OWNER-FURNISHED CONTRACTOR-INSTALLED PRODUCTS

A. Owner-Furnished Products:

1. See the laboratory equipment list included in the construction documents for the owner furnished contractor installed equipment.

1.7 ACCESS TO SITE

A. General: Contractor shall have full use of premises for construction operations, including use of Project site, during construction period. Contractor's use of premises is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Limit site disturbance, including earthwork and clearing of vegetation, to 40 feet beyond building perimeter; 10 feet beyond surface walkways, patios, surface parking, and utilities less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces such as pervious paving areas, and stormwater detention facilities that require additional staging areas in order to limit compaction in the constructed area.
2. Owner Occupancy: Allow for Owner occupancy of Project site of the existing building and associated parking north of this building. .
3. Driveways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.8 OWNER'S OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.9 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours of 6:00a.m. to 6:00p.m., Monday through Friday, except as otherwise indicated.

1. Weekend Hours: To be confirmed with contractor.
2. Early Morning Hours: To be confirmed with contractor.
3. Hours for Utility Shutdowns: To be confirmed with contractor.
4. Hours for noisy activity: To be confirmed with contractor.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect and Owner not less than 21 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission through the Architect.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Architect, Construction Manager & Owner not less than two days in advance of proposed disruptive operations.
2. Obtain Owner's written permission before proceeding with disruptive operations.

E. Controlled Substances: Use of tobacco products and other controlled substances both within the existing building and on Project site is not permitted.

F. Employee Identification: Owner will provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.

1.10 SPECIFICATION FORMATS AND DRAWING CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

C. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.11 SEISMIC REQUIREMENT

A. All architectural, mechanical, electrical, structural and nonstructural systems, components and elements shall be designed and installed to meet the code requirements of the AHJ, (AUTHORITY HAVING JURISDICTION).

B. The seismic criteria to be used for these requirements are indicated on Drawing No. SG.2.

C. Where manufactured or pre-engineered items are provided, the manufacturer or fabricator shall provide calculations or certification that the furnished and installed item, including its components and attachments, complies with the requirements of the projects specifications in addition to all code prescribed loadings and criteria, including wind and seismic loading conditions.

D. Coordinate the installation of all seismic requirements to allow for performance of Special Inspections as indicated in Section 01 41 00 of this specification.

1.12 INFECTION CONTROL RISK ASSESSMENT

A. The Contractor shall comply with all provisions stated in Owner's infection control construction plan. Copies of the plan may be reviewed at the Owner's office.

1.13 SUBSTRATE FOR FLOORING MATERIALS

A. It is the responsibility of the Contractor to provide appropriate substrate, acceptable in writing from the flooring manufacturer, meeting vapor transmission and pH values and flatness required by flooring manufacturer for installation of their product.

1.14 MISCELLANEOUS PROVISIONS

A. Project Identification and Temporary Signs

1. Provide Project identification and other signs in accordance with local sign ordinances. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.

a. One painted sign, not less than 4 feet x 8 feet, with painted graphic content to include:

1) Title of Project
2) Name of Owner
3) Names and Titles of authorities
4) Name of Architect
5) Name of Contractor or Construction Manager

b. Provide temporary, directional signs for construction personnel and visitors.
c. Maintain and touchup signs so they are legible at all times.

d. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.
e. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints. Thickness: As required by standards to span framing members (not less than 3/4-inch thick), to provide even, smooth surface without waves or buckles.
f. Rough Hardware: Galvanized.
g. Paint: Exterior quality, as specified in Section 09 91 13.

1) Use Bulletin colors for graphics
2) Colors for Structure, Framing, Sign Surfaces and Graphics: As selected by Architect

h. Paint all exposed surfaces of supports, framing and surface material; one coat of primer and one coat of exterior paint.
i. Paint graphics in styles, sizes and colors selected.

B. Compliance with Industry Standards

1. Review specified means, methods, techniques, sequences and procedures, including those recommended by manufacturers and referenced standards. Advise the Architect of any specified means, methods, techniques, sequences and procedures which deviate from good construction practice, affect warranties, including the Contractor's general warranty or are objectionable to the Contractor. If any of these conditions exist, the Contractor shall propose in writing to the Architect alternate means, methods, techniques, sequences and procedures for performing the Work.

C. Electrical Ratings

1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be submitted for approval and be completed by the Contractor at no additional cost to the Owner.

D. Short Circuit Current Ratings (SCCR) for HVAC Equipment

1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered mechanical equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the HVAC equipment shall be

equal to or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

Equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment, and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.

All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned 'Resubmit' or 'Rejected'.

No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

E. References

1. All references refer to the latest published edition or revision as of the date of the Contract Documents.

END OF SECTION 01 10 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Division 01 Section "Allowances" for products selected under an allowance.
2. Division 01 Section "Alternates" for products selected under an alternate.
3. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use CSI Form 13.1A. Submit both pages of form, fully executed. Subcontractor may fill-out form but it must be signed by the General Contractor.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

c. Detailed, side-by-side comparison of significant qualities of proposed substitution with those of the Work specified. Include a matrix chart comparing salient physical features, including ASTM standards, etc. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

    1) Do NOT submit unmarked copies of manufacturers literature. All submitted documents should contain Contractor's highlights of included options and commentary specific to the Work.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.

h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

    a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.

    b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.7 SUBSTITUTIONS

A. General: Contractor is advised to consider long-lead items and supply chain issues to eliminate Substitution Requests due to availability.

B. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

C. Substitutions for Convenience: Are not permitted.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Division 01 Section “Product Requirements” for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions" or Architect’s ASI form.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change, including fringe benefits. Include wage rate breakdowns for each trade involved.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
e. Quotation Form: Use AIA Document G709 2018.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change, including fringe benefits. Include wage rate breakdowns for each trade involved.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use AIA Document G709.

1.5 ADMINISTRATIVE CHANGE ORDERS

A. Allowance Adjustment: See Division 01Section "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

B. Unit-Price Adjustment: See Division 01Section "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701-2017.

1.7 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714-2017. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections include the following:

1. Division 01 Section "Allowances" for procedural requirements governing handling and processing of allowances.
2. Division 01 Section "Unit Prices" for administrative requirements governing use of unit prices.
3. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
4. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules.
2. Include the following:

a. Application for Payment forms with Continuation Sheets
b. Submittals Schedule
c. Items required to be indicated as separate activities in Contractor's construction schedule.

3. Submit the Schedule of Values to Architect through Construction Manager at earliest possible date but no later than 10 days after award of contract and before the submission of the initial Application for Payment.
4. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

    a. Project name and location
    b. Name of Architect
    c. Architect's project number
    d. Contractor's name and address
    e. Date of submittal

2. Arrange schedule of values consistent with format of AIA Document G702, Application and Certificate for Payment and Document G703 Continuation Sheets.
3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

    a. Related Specification Section or Division
    b. Description of the Work
    c. Name of subcontractor
    d. Name of manufacturer or fabricator
    e. Name of supplier
    f. Change Orders (numbers) that affect value
    g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

        1) Labor.
        2) Materials.
        3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

    a. Include separate line items under principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.

7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
8. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
9. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
10. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
11. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
12. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
13. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.
14. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and Construction Manager and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Submit Application for Payment to Architect by the last day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month .

    1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.

D. Additional information required prior to reviewing monthly pay application.

1. An updated project construction schedule coordinated with pay application
2. An updated submittals schedule coordinated with pay application

E. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets AIA Document G702/CMa and AIA Document G703 Continuation Sheets as form for Applications for Payment.

F. Application for Payment Forms: Use forms acceptable to Architect Construction Manager and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.

G. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.

H. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

I. Transmittal: Submit 1 original and 4 signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

J. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

K. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors
2. Schedule of Values
3. Contractor's Construction Schedule (preliminary if not final)
4. Products list
5. Schedule of unit prices
6. Submittals Schedule
7. List of Contractor's staff assignments
8. List of Contractor's principal consultants
9. Copies of building permits
10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work
11. Initial progress report
12. Report of preconstruction conference
13. Certificates of insurance and insurance policies
14. Performance and payment bonds
15. Data needed to acquire Owner's insurance

L. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

M. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims"

5. AIA Document G706A, "Contractor's Affidavit of Release of Liens"
6. AIA Document G707, "Consent of Surety to Final Payment"
7. Evidence that claims have been settled
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final, liquidated damages settlement statement
10. Final Change Order Adjustments

    a. Final Allowance Adjustments
    b. Deductions for uncorrected Work
    c. Deductions for reinspection payments.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination Drawings
3. Administrative and supervisory personnel
4. Requests for Interpretation (RFIs)
5. Digital project management procedures.
6. Project meetings

B. Related Sections include the following:

1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.
4. Division 01 Section "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.3 DEFINITIONS

A. BIM: Building Information Modeling.

B. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

C. Weathertight: Erected with the specified air/vapor barrier intact and encircling the building without gaps, holes or missing transitions between building elements which may cause the finished building to perform at less than specified levels.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

B. Additional Procedures:

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors:

    a. To ensure maximum accessibility for required maintenance, service, and repair, including mechanical and electrical access.
    b. To ensure components are assembled in the order intended and in a weathertight manner.

3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule
2. Preparation of the Schedule of Values
3. Installation and removal of temporary facilities and controls
4. Delivery and processing of submittals
5. Progress meetings
6. Preinstallation conferences
7. Startup and adjustment of systems
8. Project closeout activities

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. It is the intent of the coordination drawings to identify coordination problems and interferences prior to installation and to establish the layout of this work where exposed in finished spaces for the Architect's review. Drawings shall show the work of all trades covered and shall show clearly that all work can be installed without interference. This effort shall be led by the Contractor.
2. Time of Coordination of Drawing Preparation: The coordination drawings shall be prepared, submitted and accepted before any sleeves or inserts are set, any floor openings are core drilled, or any mechanical or electrical equipment or bases or related work is fabricated or installed. The completion of the coordination drawings by each trade will be a prerequisite for any progress payment for any material or equipment delivered or for any work by these trades. The preparation of coordination drawings acceptable to the Architect is a contract requirement, the cost of which is included in the contract price. The cost of coordination drawings shall be included as a separate line item in the Schedule of Values.
3. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

    a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.

b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
f. Indicate required installation sequences.
g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. File Preparation Format: DWG, Version 2023, operating in Microsoft Windows operating system.
3. File Submittal Format: Submit or post coordination drawing files usingPDF format.
4. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.

    a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

5. Architect will furnish Contractor with digital data files of Drawings for use in preparing coordination digital data files.

    a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    b. Digital Data Software Program: Drawings are available in REVIT 2022.
    c. Contractor and Subcontractors shall execute a data licensing agreement in the form of Architect’s “Agreement For Delivery Of Instruments Of Service In Electronic Form”.

1.7 BUILDING ENCLOSURE COORDINATION DRAWINGS

A. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

1. Indicate functional and spatial relationships of components of building enclosure systems.
2. Indicate required installation sequences.

B. Development of Building Enclosure Coordination Drawings

1. The Contractor and the Roofing, Fenestration, Expansion Joint, Building Facade, Insulation, Air/Vapor Barrier, Sheathing and any other involved subcontractors are each

required to participate in the creation and updating of building enclosure coordination drawings. The purpose of the coordination drawings is to preplan the installation of air/vapor barrier, flashings, expansion/control joints, penetrations, ETAs and any other involved subcontractors in relation to the existing and new facility and its structure, framing, sheathing, fenestration, skin, etc. It is the intent of these coordination drawings to identify coordination problems and proper installation sequences prior to erection and to establish the layout of this work for the Architect's and Owner's Commissioning Agent's review. Drawings shall show the work of all trades covered (including both existing and new), shall show clearly in both plan and section that all work can be installed in a weathertight manner without exception. This effort shall be led by the Contractor.

2. Time of Coordination of Drawing Preparation: The coordination drawings shall be prepared, submitted and accepted before any sheathing or roofing materials are installed. The completion of the coordination drawings will be a prerequisite for any progress payment for any material or equipment delivered or for any work by these trades. The preparation of coordination drawings acceptable to the Architect is a contract requirement, the cost of which is included in the contract price. The cost of building enclosure coordination drawings shall be included as a separate line item in the Schedule of Values.
3. Procedure

    a. The Contractor shall produce drawings at a scale which is acceptable to the Architect, showing constraints such as structural, substrate information, adjacent materials, flashings, sealants, and sequencing requirements that are coordinated between the affected trades and ready for execution in the field. These shall be used as the coordination drawing base.
    b. The Contractor will then hold a meeting with all involved subcontractors in attendance to resolve any conflicts or problems. After the coordination drawings are reviewed and any conflicts resolved, the originals shall be signed by the Contractor and each of the involved subcontractors. Any non-resolvable conflicts shall be brought to the attention of the Architect.
    c. The Contractor shall then make copies and submit the coordination drawings to the Architect and Owner's Commissioning Agent, as record drawings. He shall also transmit copies to the above subcontractors.
    d. The Contractor shall retain the drawings to be used in preparing the field mockup, the sequenced construction of the building, the third-party field testing and the preparation of record documents.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
2. File Preparation Format: DWG, Version 2023, operating in Microsoft Windows operating system.
3. File Submittal Format: Submit or post coordination drawing files using PDF format.
4. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.

    a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

5. Architect will furnish Contractor digital data files of Drawings for use in preparing coordination digital data files.

    a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    b. Digital Data Software Program: Drawings are available in REVIT 2022.
    c. Contractor shall execute a data licensing agreement in the form of Architect's "Agreement For Delivery Of Instruments Of Service In Electronic Form".

1.8 WORK INSTALLED WITHOUT PRIOR APPROVAL

A. Any work fabricated or installed prior to the signing of coordination drawings shall be at the subcontractor's risk. Subsequent relocations or reinstallation required to avoid interferences or to correct non-weathertight conditions shall be made without additional expense to the Owner.

1. If interference develops, the Contractor shall recommend (subject to Architect's review and acceptance) which work shall be relocated, regardless of which was installed first.
2. Building Envelope issues shall be resolved by the Contractor, Owners Commissioning Agent and Architect.

1.9 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

B. Supervision: The Contractor shall employ a competent superintendent and necessary assistants, acceptable to the Owner, who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

C. This Project will require the use of full-time supervision for the performance of the Work.

1. The Contractor is required to have a superintendent present at the site of the Project at all times when performance of the Work is actively underway regardless of the day or shift. During these times the superintendent will not be assigned to any other project and will not perform any trade work on the Project. Consistent with the foregoing as well as for superintendent's personal reasons, at those times when the superintendent is taken away from the site of the Project, a replacement superintendent suitable to the Owner shall be assigned to the Project.

1.10 REQUESTS FOR INTERPRETATION (RFIs)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, the Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.

2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:

1. Project name
2. Project number.
3. Date
4. Name of Contractor
5. Name of Architect
6. RFI number, numbered sequentially
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate
9. Drawing number and detail references, as appropriate
10. Field dimensions and conditions, as appropriate
11. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI
12. Contractor's signature
13. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation

    a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

C. RFI Form: Software-generated form with substantially the same content as indicated above.

1. Attachments shall be electronic files in Adobe Acrobat PDF format

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by the Architect after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

    a. Requests for approval of submittals
    b. Requests for approval of substitutions
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents
    e. Requests for adjustments in the Contract Time or the Contract Sum
    f. Requests for interpretation of Architect's actions on submittals
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following

1. Project name
2. Name and address of Contractor
3. Name and address of Architect
4. RFI number including RFIs that were returned without action or withdrawn
5. RFI description
6. Date the RFI was submitted
7. Date Architect's response was received
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate
9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

1.11 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
3. Digital Drawing Software Program: Contract Drawings are available in REVIT 2022.
4. Contractor shall execute a data licensing agreement in the form of Architect’s “Agreement For Delivery Of Instruments Of Service In Electronic Form”.

    a. Subcontractors, and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of Architect’s “Agreement For Delivery Of Instruments Of Service In Electronic Form”.
5. The following digital data files will be furnished for each appropriate discipline:

    a. Floor plans.
    b. Reflected ceiling plans.

B. Web-Based Project Software: Provide, administer, and use web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project software site includes, at a minimum, the following features:

a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
c. Document workflow planning, allowing customization of workflow between project entities.
d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creating and distributing meeting minutes.
j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility, including smartphones and tablets.
m.

2. Provide up to seven web-based Project software user licenses for use of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and Architect's consultants. Provide eight hours of software training at Architect's office for web-based Project software users.
3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
4. Provide one of the following web-based Project software packages under their current published licensing agreements:

a. Autodesk; Buzzsaw Constructware.
b. Corecon Technologies, Inc.
c. Meridian Systems; Prolog.
d. Newforma, Inc.
e. Procore Technologies, Inc.
f. Viewpoint, Inc.; Viewpoint for Project Collaboration.

C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.12 PROJECT MEETINGS

A. General: Contractor Construction Manager shall be responsible to preside at meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Architect, within three days of the meeting.
4. Contractor shall make physical arrangements for meetings.
5. Representatives of contractors, subcontractors and suppliers invited to attend meetings shall be qualified and authorized to act on behalf of the entity each represents.

B. Preconstruction “Kickoff” Meeting

1. Architect will schedule and administer preconstruction meeting in conjunction with the Owner and Contractor. The Architect will prepare the meeting agenda and distribute. The Architect will preside at the meeting and shall record and distribute the minutes.
2. Preconstruction Meeting Agenda:

a. Discuss items of significance that could affect progress, including the following:

1) Review of projected Construction Schedule.
2) Review project Phasing Requirements.
3) Review critical work sequencing and long-lead items
4) Requirements for Receipt of the Submittal Schedule
5) Procedures for receipt and review of Submittals
6) Procedures for receipt and review of RFIs

b. Discuss procedures for the processing of the following:

1) Distribution of the Contract Documents.
2) Procedures for processing Applications for Payment
3) Procedures for processing field decisions and Change Orders
4) Procedures for disruptions and shutdowns.
5) Maintenance and Preparation of Record Documents
6) Procedures for moisture and mold control.
7) Procedures for testing and inspecting
8) Designation of key decision making personnel and their responsibilities.
9) Lines of communications.
10) List of major subcontractors and suppliers
11) Submission of insurance certificates to Owner.
12) Procedures for Photographic Records and Distribution.
13) Submittal procedures.

c. Discuss Construction Facilities and Operations

1) Use of the premises and existing building

2) Owner's occupancy requirements
3) Responsibility for temporary facilities and controls
4) Use of web-based Project software.
5) Work restrictions
6) Working hours.
7) Temporary utilities
8) Security
9) Contractor office, laydown and storage areas
10) Equipment deliveries and priorities
11) Construction waste management and recycling
12) Safety and first aid procedures
13) Contractor parking availability
14) Progress cleaning and housekeeping procedures

C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. The Contract Documents
b. Options
c. Related RFIs
d. Related Change Orders
e. Purchases
f. Deliveries
g. Submittals
h. Review of mockups
i. Possible conflicts
j. Compatibility problems
k. Time schedules
l. Weather limitations
m. Manufacturer's written recommendations
n. Warranty requirements
o. Compatibility of materials
p. Acceptability of substrates
q. Temporary facilities and controls
r. Space and access limitations
s. Regulations of authorities having jurisdiction
t. Testing and inspecting requirements
u. Installation procedures
v. Coordination with other work
w. Required performance results
x. Protection of adjacent work
y. Protection of construction and personnel

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress (OAC) Meetings: Contractor will conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period

    b. Review present and future needs of each entity present, including the following:

        1) Review, approve of minutes of previous meeting
        2) Review of unsettled matters
        3) Problems which impede Construction Schedule
        4) Pending changes and substitutions
        5) Review proposed changes for

            a) Effect on Construction Schedule and on completion date
            b) Effect on other contracts of the Project

        6) Field observations, problems, conflicts
        7) Review of work progress since previous meeting
        8) Contractor’s statement of corrective measures and procedures to regain projected schedule
        9) Revisions to Construction Schedule
        10) Progress, schedule, during succeeding work period
        11) Coordination of schedules
        12) Maintenance of quality standards
        13) Other business
        14) Interface requirements

15) Sequence of operations
16) Status of submittals
17) Deliveries
18) Off-site fabrication
19) Access
20) Site utilization
21) Temporary facilities and controls
22) Work hours
23) Hazards and risks
24) Progress cleaning
25) Quality and work standards
26) Status of correction of deficient items
27) Field observations
28) RFIs
29) Status of proposal requests
30) Pending changes
31) Status of Change Orders
32) Pending claims and disputes
33) Documentation of information for payment requests

3. Minutes: Contractor will record and distribute the meeting minutes to the Owner, Architect, all additional designates and all attendees.

    a. Record and distribute meeting minutes within 48 hours of each meeting.
    b. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

E. Coordination Meetings: Contractor shall conduct Project coordination meetings at biweekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to Combined Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise Combined Contractor's Construction Schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
c. Review present and future needs of each contractor present, including the following:

1) Interface requirements
2) Sequence of operations
3) Resolution of BIM component conflicts.
4) Status of submittals
5) Deliveries
6) Off-site fabrication
7) Access
8) Site utilization
9) Temporary facilities and controls
10) Work hours
11) Hazards and risks
12) Progress cleaning
13) Quality and work standards
14) Status of RFIs.
15) Proposal Requests.
16) Change Orders.
17) Pending changes.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

F. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Procedures for completing and archiving web-based Project software site data files.
d. Submittal of written warranties.
e. Requirements for preparing operations and maintenance data.
f. Requirements for delivery of material samples, attic stock, and spare parts.
g. Requirements for demonstration and training.
h. Preparation of Contractor's punch list.

i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
j. Submittal procedures.
k. Owner's partial occupancy requirements.
l. Installation of Owner's furniture, fixtures, and equipment.
m. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary (Start-up) Construction Schedule
2. Contractor's Construction Schedule
3. Submittals Schedule
4. Daily construction reports
5. Material location reports
6. Field condition reports
7. Special reports

B. Related Sections include the following:

1. Division 01 Section "Payment Procedures" for submitting the Schedule of Values
2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes
3. Division 01 Section "Photographic Documentation" for submitting construction photographs
4. Division 01 Section "Submittal Procedures" for submitting schedules and reports
5. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

H. Major Area: A story of construction, a separate building, or a similar significant construction element.

I. Milestone: A key or critical point in time for reference or measurement.

J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For scheduling consultant.

B. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF file.

C. Submittals Schedule: Submit PDF of schedule. Arrange the following information in a tabular format:

1. Scheduled date for first submittal

2. Specification Section number and title
3. Submittal category (action or informational)
4. Name of subcontractor
5. Description of the Work covered
6. Scheduled date for Architect's final release or approval

D. Preliminary Construction Schedule: Submit PDF two opaque copies.

1. Submittal of cost-loaded preliminary construction schedule will not constitute approval of Schedule of Values for cost-loaded activities.

E. Preliminary Network Diagram: Submit PDF, large enough to show entire network for entire construction period. Show logic ties for activities.

F. Contractor's Construction Schedule: Submit PDF of initial schedule, large enough to show entire schedule for entire construction period.

1. Submit an electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.

G. CPM Reports: Concurrent with CPM schedule, submit PDF of each of the following computer-generated reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work or the Notice to Proceed, whichever occurs first, until most recent Application for Payment.

H. Construction Schedule Updating Reports: Submit with Applications for Payment.

I. Daily Construction Reports: Submit PDF at weekly intervals.

J. Material Location Reports: Submit PDF at weekly intervals.

K. Field Condition Reports: Submit PDF at time of discovery of differing conditions.

L. Special Reports: Submit PDF at time of unusual event.

1.5 QUALITY ASSURANCE

A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.

B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
5. Review schedule for work of Owner's separate contracts.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.
9. Review and finalize list of construction activities to be included in schedule.
10. Review submittal requirements and procedures.
11. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 SUBMITTAL REGISTER

A. Preparation: Submit a Submittal Register in PDF or .XLS listing all submittals required by the Contract Documents, arranged in CSI specification section order, in matrix format similar to the following example:

SECTION 013300.01 - SUBMITTAL REGISTER

	ACTION SUBMITTALS							INFORMATION SUBMITTALS																											
SECTION	Product Data	LEED Submittals	Shop Drawings	Samples	Veneer Anchor Analysis	Product Schedule	Delegated-Design Submittal	Warranty	Material List	Qualification Data	Source Quality Control Reports	Proposed Protection Measures	Inventory	Photos or Video	Statement of Refrigerant Recover	Product/Material Certificates	Mix Designs / Design Data	Welding Certificates	Product/Material Test Reports	Quality Control Test Reports	Field Test Reports	Statement of Compressive Strength	Cold/Hot Weather Procedures	Certification Letter	Operation and Maintanance Data	Energy Performance Certificate	Coordination Drawings	Inspection and Operating Permits	Keys	Research/Evaluation Reports	Slip-Resistance
015639 - Temporary Tree Protection	✓						✓																											
024116 - Structure Demolition		✓								✓		✓	✓	✓	✓																			
033000 - Cast-In-Place Concrete	✓	✓	✓	✓						✓		✓																						
042000 - Unit Masonry	✓	✓	✓	✓	✓				✓	✓						✓	✓	✓				✓												
044200 - Exterior Stone Cladding	✓	✓	✓	✓			✓			✓	✓								✓				✓											

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

1. Use Scheduling component of Project website software specified in Section 013100 "Project Management and Coordination," for current Windows operating system.

2. In-House Option: Owner may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
3. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

B. Time Frame: Extend schedule from date established for commencement of the Work or the Notice to Proceed, whichever occurs first to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story (floor) or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
4. Startup and Testing Time: Include not less than ten days for startup and testing.
5. Commissioning Time: Include no fewer than 15 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
4. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction
    b. Limitations of continued occupancies
    c. Uninterruptible services
    d. Partial occupancy before Substantial Completion
    e. Use of premises restrictions
    f. Provisions for future construction
    g. Seasonal variations
    h. Environmental control

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Subcontract awards
    b. Submittals
    c. Purchases
    d. Mockups
    e. Fabrication
    f. Sample testing
    g. Deliveries
    h. Installation
    i. Tests and inspections
    j. Adjusting
    k. Curing

l. Building flush-out.
m. Startup and placement into final use and operation
n. Commissioning.

6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

a. Structural completion
b. Temporary enclosure and space conditioning.
c. Permanent space enclosure
d. Completion of mechanical installation
e. Completion of electrical installation
f. Substantial Completion

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion, and the following interim milestones:

1. Temporary enclosure and space conditioning.

F. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.

1. Refer to Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
3. Each activity cost shall reflect an accurate value subject to approval by Architect.
4. Total cost assigned to activities shall equal the total Contract Sum.

G. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

H. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

I. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

J. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post hardcopies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

2.4 PRELIMINARY CONSTRUCTION SCHEDULE

A. Gantt (Bar)-Chart Schedule: Submit preliminary horizontal Gantt-chart-type construction schedule within seven days of date established for commencement of the Work or the Notice to Proceed, whichever occurs first.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.5 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work or the Notice to Proceed, whichever occurs first. Base schedule on the Preliminary Construction Schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.6 CPM SCHEDULE REQUIREMENTS

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Preliminary Network Diagram: Submit diagram within 14 days of date established for commencement of the Work or the Notice to Proceed, whichever occurs first. Outline significant construction activities for the first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized, cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work or the Notice to Proceed, whichever occurs first.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals
    b. Mobilization and demobilization
    c. Purchase of materials
    d. Delivery
    e. Fabrication
    f. Utility interruptions
    g. Installation
    h. Work by Owner that may affect or be affected by Contractor's activities
    i. Testing and commissioning
    j. Commissioning.
    k. Punch list and final completion.
    l. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of **5** percent of the Contract Sum.

    a. Each activity cost shall reflect an appropriate value subject to approval by Architect.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity
2. Description of activity
3. Principal events of activity
4. Immediately preceding and succeeding activities
5. Early and late start dates
6. Early and late finish dates
7. Activity duration in workdays
8. Total float or slack time
9. Average size of workforce
10. Dollar value of activity (coordinated with the Schedule of Values)

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed
2. Changes in early and late start dates
3. Changes in early and late finish dates
4. Changes in activity durations in workdays
5. Changes in the critical path
6. Changes in total float or slack time
7. Changes in the Contract Time

H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.

2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.

    a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
    b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.7 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site
2. List of separate contractors at Project site
3. Approximate count of personnel at Project site
4. Equipment at Project site
5. Material deliveries
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents
9. Meetings and significant decisions
10. Unusual events (refer to special reports)
11. Stoppages, delays, shortages, and losses
12. Meter readings and similar recordings
13. Emergency procedures
14. Orders and requests of authorities having jurisdiction
15. Change Orders received and implemented
16. Construction Change Directives received and implemented
17. Services connected and disconnected
18. Equipment or system tests and startups
19. Partial Completions and occupancies
20. Substantial Completions authorized

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.8 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following services:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.
4. Preconstruction video digital recordings.
5. Periodic construction video digital recordings.

B. Related Requirements:

1. Division 01 Section "Submittal Procedures" for submitting photographic documentation.
2. Division 01 Section "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
3. Division 01 Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
4. Division 02 Section "Selective Demolition" for photographic documentation before selective demolition operations commence.
5. Division 31 Section "Site Clearing" for photographic documentation before site clearing operations commence.

1.3 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.

1. Submit photos by uploading to web-based project software site. Include copy of key plan indicating each photograph's location and direction.
2. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Name and contact information for photographer.

c. Name of Architect.
d. Name of Contractor.
e. Date photograph was taken.
f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
g. Unique sequential identifier keyed to accompanying key plan.

C. Video Recordings: Submit video recordings within seven days of recording.

1. Submit video recordings by uploading to web-based project software site. Include copy of key plan indicating each video's location and direction.
2. Identification: With each submittal, provide the following information:

a. Name of Project.
b. Name and address of photographer.
c. Name of Architect**]**.
d. Name of Contractor.
e. Date video recording was recorded.
f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

3. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, three-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as corresponding video recording. Include name of Project and date of video recording on each page.

1.4 QUALITY ASSURANCE

1.5 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

1.6 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.

C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

D. Metadata: Record accurate date and time from camera.

E. File Names: Name media files with date, Project area and sequential numbering suffix.

1.7 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

D. Preconstruction Photographs: Before commencement of excavation, starting construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

1. Flag excavation areas and construction limits before taking construction photographs.
2. Take a sufficient number of photographs (20 minimum) to show existing conditions adjacent to property before starting the Work.
3. Take a sufficient number of photographs (20 minimum) of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required (20 minimum) to record settlement or cracking of adjacent structures, pavements, and improvements.

E. Periodic Construction Photographs: Take 20 photographs weekly, with timing each month coinciding with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. Architect -Directed Construction Photographs: From time to time, Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

G. Final Completion Construction Photographs: Take 20 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.

H. Additional Photographs: Architect and Owner may request photographs in addition to periodic photographs specified.

1. Three days' notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.

3. Circumstances that could require additional photographs include, but are not limited to, the following:

    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    d. Substantial Completion of a major phase or component of the Work.
    e. Extra record photographs at time of final acceptance.
    f. Owner's request for special publicity photographs.

1.8 CONSTRUCTION VIDEO RECORDINGS

A. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.

    1. Confirm date and time at beginning and end of recording.
    2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.

B. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.

C. Preconstruction Video Recording: Before starting excavation, record video recording of Project site and surrounding properties from different vantage points, as directed by Architect.

    1. Flag excavation areas before recording construction video recordings.
    2. Show existing conditions adjacent to Project site before starting the Work.
    3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of excavation and construction.
    4. Show protection efforts by Contractor.

1.9 CONSTRUCTION WEBCAM

A. Webcam: Provide one fixed-location camera with weatherproof housing, mounted to provide unobstructed view of construction site from location approved by Architect, with the following characteristics:

    1. Static view
    2. Capable of producing minimum 12megapixel images.
    3. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

B. Live Streaming Construction Site Images: Provide Web-accessible image of current site image from fixed location camera(s), updated at 15-minute intervals during daytime operation.

C. Web-Based Interface: Provide online interface to allow viewing of each high-definition digital still image captured and stored during construction, from the Internet.

1. Access Control: Provide password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
2. Storage: Maintain images on the website for reference during entire construction period, and for not less than 30 days after final completion. Provide sufficient memory on remote server to store all Project images.
3. Online Interface: Provide website interface with Project and client information and logos; calendar-based navigation interface for selecting images; pan and zoom capability within high-definition images.
4. Forward and Reverse: Provide capability to browse through images, moving forward and backward in time by individual image and by day.
5. Slideshow: Provide capability to automatically display current images from sites when there are three or more cameras used.
6. Time-Lapse: Provide capability for online display of project time-lapse.
7. Dashboard: Provide capability to view thumbnails of all cameras on one screen.
8. Weather: Provide corresponding weather data for each image captured.
9. Provide public viewer open access to most recent Project camera image.

D. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until final completion. Provide for service of cameras and related networking devices and software.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Division 01 Section "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Division 01 Section "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
5. Division 01 Section "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
6. Division 01 Section "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
7. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
8. Division 01 Section "Project Record Documents" for submitting record documents and record submittals.
9. Division 01 Section "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. Record Submittals: Written and graphic information and physical samples, that do not require Architect's responsive action, provided for record purposes.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

E. Days: For the purpose of this Section, days are defined as working days based on a 5-day normal work week.

F. CAD: Computer Aided Design.

G. BIM: Building Information Modeling.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Submittal Schedule: Submit, as an action submittal, a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections. Comply with list of submittals and time requirements for scheduled performance of related construction activities.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action or Informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled date of fabrication.
    j. Scheduled dates for installation.
    k. Activity or event number.

5. Submit schedule a minimum of 10 days before initial submittal is required.

B. Architect's Digital Data Files: Electronic copies of CAD Drawings or BIM files of the Contract Drawings will not be provided by Architect for Contractor's use in preparing submittals unless specifically agreed to in the Architect's contract with the Owner. Where provisions for file sharing are contractually stipulated, all procedures, protocols and responsibilities shall be agreed to in writing in advance of distribution of any electronic files.

C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received and shall return the submittal "Not Reviewed".

5. Each separate section of the Specification Divisions 1 through 48 lists the submittals that are requested and will be accepted for review by the Architect. Submittals not requested specifically will be returned to Contractor without review or accepted for information only.

D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. The start time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

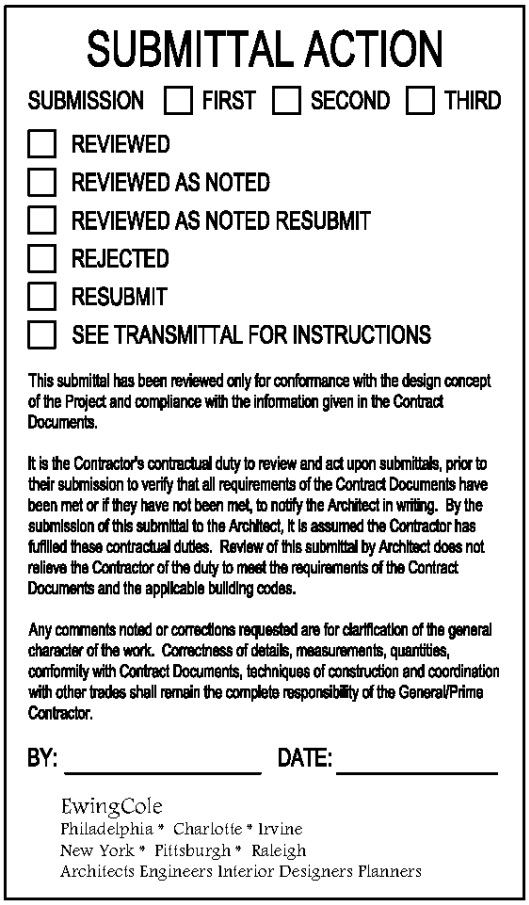
1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 10 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 20 days for initial review of each submittal.
5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.

E. Submittal Media (Electronic): The submittal media shall be determined and approved prior to the receipt of the first submittal and shall remain consistent through the entire project duration.

F. Electronic Submittals: When approved by the Owner, the Architect will accept submittals electronically. When electronic submittals are chosen as the preferred method of transmission, all submittals must be transmitted electronically (with the exception of physical samples).

1. Submit electronic submittals via email as PDF electronic files.

a. PDF resolution shall be a minimum of 100 dpi but no larger than 300 dpi.
b. All aforementioned procedures shall apply including transmittal criteria.
c. No submittals shall be accepted directly from any subcontractor.
d. Submittals of different trades, subcontractors, specification sections, or non-relevant items shall not be submitted within the same submittal transmittal or electronic submission.
e. The Contractor shall transmit all electronic submittals to ESubmittals@EwingCole.com. Other project team members may be copied as appropriate, but primary recipient shall be "ESubmittals"
f. Electronic submittals sent to "ESubmittals" shall have the Project name and number clearly identified in the subject line. A transmittal shall be included.
g. Drawing numbering system must be strictly adhered to in both the file name and within the PDF title block.
h. File sizes exceeding 20MB shall be transmitted using a large file transfer mechanism compatible with email. EwingCole can provide access to Newforma info exchange for this purpose, if the Contractor does not have a suitable means to do this. EwingCole will not search and download files from project sites. The only exception to this is if the Owner maintains a project site and this requirement is made known to EwingCole contractually at the time of project award. The Contractor must proactively transmit the files to Esubmittals@EwingCole.com. EwingCole will return the reviewed files either marked up electronically (or redlined and scanned) back to the designated address provided by the Contractor through Newforma.
i. Submittals/samples requiring finish, color and texture review may be scanned (in color) and sent to "ESubmittals" but one physical sample must be mailed to EwingCole for review.
j. Include the following EwingCole review stamp on each individual pdf of all electronic submittals:



2. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
3. Name file with submittal number and unique identifier as follows:

FORMAT:

- 042000_001.1_Face Brick_Product Data
- "042000" shall be the appropriate specification section for the submittal.
- "001" shall be the submission tracking number (not related to a specific category ie. Product data, Warranty, etc.)
- ".1" shall indicate the initial submittal.
- "Face Brick" shall be the item submitted.
- "Product Data" shall be the type of submittal.

Examples:

042000_001.1_Face Brick_Product Data
042000_002.1_Mortar and Grout_Product Data
042000_003.1_Embedded Flashing_Warranty
042000_004.1_Embedded Flashing _Shop Drawings
042000_005.1_Concrete Masonry Units_Calculations

- Subsequent Submissions of the same item (.2), (.3), etc.:
  042000_002.2_ Mortar and Grout _Product Data

FORMAT:

- 265100_001.1_Emergency Lighting Units_Product Data
- "265100" shall be the appropriate specification section for the submittal.
- "001" shall be the submission tracking number (not related to a specific category ie. Product data, Warranty, etc.)
- ".1" shall indicate the initial submittal.
- "Emergency Lighting Units" shall be the item submitted.
- "Product Data" shall be the type of submittal.

Examples:

265100_001.1_Interior Lighting Fixture L1_Product Data
265100_002.1_Emergency Lighting Units_Product Data
265100_003.1_Emergency Lighting Units_Warranty
265100_004.1_Lighting Fixture Supports_Shop Drawings
265100_005.1_Emergency Lighting Units_Calculations

- Subsequent Submissions of the same item (.2), (.3), etc.:
  265100_002.2_ Emergency Lighting Units_Product Data

4. Include file name on cover sheet of submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Cloud, bubble, or otherwise highlight and identify all revisions on the drawings. Submittals which do not identify changes and revisions will be returned as "Not Reviewed". Do not renumber submittal documents which have been previously submitted for review except to modify the revision number. Drawings that have been renumbered will be rejected and returned. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's and Construction Manager's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals (Action, Informational or Record) are indicated in individual trade Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

C. Design Data for Delegated Design Elements: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned “Not Reviewed”.

D. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit digitally signed PDF

electronic file of a Certification Letter from the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located.
2. Statement that the Professional Engineer is fully experienced in the type of design being performed.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
5. Statement that the Professional Engineer will submit an additional signed and sealed letter after construction of the delegated design element is complete, stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.

E. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

3. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.

    a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
    b. Refer to Section 01 31 00 "Project Management and Coordination" for requirements for coordination drawings.

F. Field Work Shop Drawings: Prepare location specific information illustrating the proposed field modification of an element. Submit proposed modification and received written approval prior to performing the field modification. Field work shop drawings shall clearly reference the latest related shop drawings. For additional requirements, refer to "Shop Drawings" above.

G. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Product name and name of manufacturer.
    d. Sample source.
    e. Number and title of applicable Specification Section.
    f. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

6. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected. Final approval to be authorized with samples submitted with Samples for Verification.

7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit three sets of samples, unless otherwise noted in the individual technical sections. Architect will retain two Sample sets; remainder will be returned.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

H. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

I. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."

J. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."

K. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."

L. Maintenance Data: Comply with requirements specified in Section 01 78 23 "Operation and Maintenance Data."

M. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

N. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

O. Installer Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the Installer, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

P. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying

that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

Q. Product Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying that product complies with requirements in the Contract Documents. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

R. Material Certificates: Submit written statements on manufacturer's letterhead, signed by an officer or other individual authorized to sign documents on behalf of the manufacturer, certifying that material complies with requirements in the Contract Documents. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

S. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

T. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

U. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

V. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

W. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

X. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents. Field tests include all tests that are performed by the contractor in conjunction with systems installations. Unless noted in the

individual specification section, these field tests do not include testing and inspection reports provided by the Owner's independent testing and inspection agency.

Y. Final Certification Letter from Delegated-Design Professional: After construction of the delegated design element is complete, submit digitally signed PDF electronic file of a Certification Letter from the responsible design professional stating that the fabrication and installation of the delegated design elements have been performed in accordance with the Professional Engineer's design.

Z. Record Submittals: Refer to Division 01 Section "Project Record Documents" for requirements.

AA. Closeout Documents and Maintenance Material Documents: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. BIM Incorporation: Incorporate delegated-design drawing and data files into BIM established for Project.

1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Project Closeout and Maintenance Material Documents: See requirements in Division 01 Section "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, Architect's Project No., submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Regardless of language on Contractor's stamp (reviewed, checked, etc.), submittals by Contractor for Architect's review will be considered "Approved" by Contractor.

D. Determine and verify:

1. Field measurements.
2. Field construction criteria.
3. Catalog numbers and similar data.

E. Coordinate each submittal with other submittals as well as with requirements of the Work and Contract Documents.

F. Advise priority requirements, if any, for review of submittals.

1. If submittals are made in large quantities from any one subcontractor or a large quantity of drawings from several subcontractors all at one time, the normal time required by the Architect for review cannot be expected to suffice; Contractor shall, in such instances, indicate the priority and/or sequence of review desired.
2. If no priority requirement is indicated, Architect will review submittals in the order received.

G. Identify all material list items and submittals by the title of the specification section, paragraph, and page from which they are specified.

H. Contractor and/or manufacturer Shall Not use the color red when marking their notations on the submittal. Green shall be used to distinguish the Contractor's comments.

3.2 ARCHITECT'S RESPONSE

A. General: Architect will not review submittals that do not bear Construction Manager's or Contractor's approval stamp and may return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

Submittal Code Letter	Description
A	Reviewed: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents. Architect will not include any comments. Fabrication can proceed. No further submissions are required prior to the record submission (when applicable).
B	Reviewed As Noted: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents, except for corrections indicated. Fabrication can proceed on the basis that Contractor is fully responsible for incorporating indicated corrections into the work. No further submissions are required prior to the record submission (when applicable).
C	Reviewed as Noted and Resubmit: Indicates the submission conforms generally to the design concept and the information given in the Contract Documents, except for corrections indicated. Shop fabrication can proceed on the basis that Contractor is fully responsible for incorporating indicated corrections into the work. Resubmission is required prior to commencement of erection, installation or placement for confirmation of corrections noted.

D Rejected: Procedural or technical nonconformity with the design concept and the information given in the Contract Documents. Fabrication should NOT proceed pending further review.

E Resubmit: Indicates that corrections of a major nature are required, should be incorporated in the submittal, and the submittals shall be resubmitted for Architect's further review. Fabrication should NOT proceed pending further review.

F See Transmittal for Instructions: Refer to the Response Transmittal for specific direction.

C. Informational Submittals: Architect will receive Informational Submittals and respond "Accepted for Information" or "Not Accepted for Information". Transmittals only will be returned to the Contractor indicating status of acceptance and will include any comments or reasons for not accepting. Architect will forward each submittal to appropriate party.

D. Record Submittals: Only where specifically required in the individual trade Specification Sections, Architect will receive Record Submittals and respond "Accepted for Record" or "Not Accepted for Record". Transmittals only will be returned to the Contractor indicating status of acceptance and will include any comments or reasons for not accepting.

E. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

F. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

G. Submittals not required by the Contract Documents may be returned by the Architect without action or accepted for information only.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Architect or Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

C. Related Sections include the following:

1. Division 01 Section "Allowances" for testing and inspecting allowances.
2. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
3. Division 01 Section "Execution" for repair and restoration of construction disturbed by testing and inspecting activities.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed

construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

D. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

K. Experienced: When used with an entity or individual, "experienced" unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction. If individual sections specify more than 5 years, the specified number of years shall take precedence.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. Where two or more quantities or quality levels of the same Work are indicated, provide the most stringent. The actual installation must comply with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits as determined by the Architect. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.

2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

E. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of [Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager shall not have other Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."

3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, or installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. Authorized Installer: A firm which has been authorized by a manufacturer to appropriately install their product.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project unless specifically noted otherwise.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.]

K. Mockups General: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Mockups shall be erected in stages in sufficient steps as required to clearly demonstrate construction techniques and sequence from initial materials to finishes. All constructability issues shall be resolved to the satisfaction of the Architect and Contractor during mockup erection.
6. The Contractor shall not release materials for purchase or fabrication until the mockup has been reviewed and approved by the Owner and Architect. Materials released prior to approval by both are done so at the Contractors own risk.
7. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.

    a. Allow seven days for initial review and each re-review of each mockup.

8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
9. Demolish and remove mockups when directed, unless otherwise indicated.

L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility in Division 01 Section “Testing Laboratory Services”, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor and the contract sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Contractor Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested.

Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 15 days of date established for commencement of the Work/the Notice to Proceed.

1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in Statement of Special Inspections.

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
2. Comply with the Contract Document requirements for Division 01 Section "Execution".

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

STATEMENT OF SPECIAL INSPECTIONS

Project:	New BSL Lab Building
Location:	700 South MLK Blvd., Las Vegas, NV 89106
Owner:	Southern Nevada Health District
Owner's Address:	700 South MLK Blvd. Las Vegas, NV 89106
Architect of Record:	EC Nevada
Structural Engineer of Record:	EC Nevada
Building Code:	International Building Code 2021 (IBC 2021)

This Statement of Special Inspections is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the International Building Code. It includes a Schedule of Special Inspection Services applicable to this project as well as the name of the Special Inspections Administrator and the identity of other approved agencies intended to be retained for conducting these inspections. The structural drawings contain additional inspections required for the Seismic Force Resisting System (SFRS).

The Special Inspections Administrator shall keep records of all inspections and shall furnish inspection reports to the Building Official, Structural Engineer of Record and Architect of Record. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official, Structural Engineer of Record and Architect of Record. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted on a WEEKLY basis to the Building Official, Owner, Structural Engineer of Record and Architect of Record.

A Final Report of Special Inspections documenting completion of all required Special Inspections and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Prepared by:

(Type or Print Name)

Signature Date

Owner's Authorization:

Signature Date

Building Official's Acceptance:

Signature Date

The following sheets contain the required schedule of special inspections services for this project.

(Agent No.) Inspection Agents	Firm	Address
1. Special Inspections Administrator	To be hired by the owner	
2. Testing Laboratory and Field Inspector	To be hired by the owner	
3. Geotechnical Engineer	To be hired by the owner	
4. Other		

The qualifications of all personnel performing Special Inspection activities are subject to the approval of the Building Official.

The Special Inspections Administrator and testing agent shall be engaged by the Owner or the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the Building Official, prior to commencing work.

The credentials of all inspectors, administrators and testing technicians shall be provided if requested.

It is required that the person administering the Special Inspections program be a Professional Engineer experienced in the design of buildings.

	Key for Minimum Qualifications of Inspection Agents (where indicated on Schedules)
PE	Professional Engineer - an engineer specializing in the design of building structures, licensed in the state where the project is located
GE	Geotechnical Engineer - an engineer specializing in soil mechanics and foundations, licensed in the state where the project is located
EIT	Engineer in Training with relevant experience
ICC-RCSI	International Code Council (ICC) Certified Reinforced Concrete Special Inspector
ACI-CFTT	American Concrete Institute Certified Concrete Field Testing Technician - Grade 1
ACI-CCI	American Concrete Institute Certified Concrete Construction Inspector
ACI-LTT	American Concrete Institute Certified Laboratory Testing Technician - Grades 1 and 2
ICC-PCSI	International Code Council (ICC) Certified Prestressed Concrete Special Inspector
PTI-L1-UB	Post-Tensioning Institute (PTI) Level 1 Certified Unbonded PT Inspector
PTI-L2-UB	Post-Tensioning Institute (PTI) Level 2 Certified Unbonded PT Inspector
PTI-L1-B	Post-Tensioning Institute (PTI) Level 1 Certified Bonded PT Inspector
PTI-L2-B	Post-Tensioning Institute (PTI) Level 2 Certified Bonded PT Inspector
ICC-SSBSI	International Code Council (ICC) Certified Structural Steel and Bolting Special Inspector
ICC-SWSI	International Code Council (ICC) Certified Structural Welding Special Inspector
AWS-CWI	American Welding Society Certified Welding Inspector
AWS/AISC-SSI	American Welding Society/American Institute of Steel Construction Structural Steel Inspector
ICC-SMSI	International Code Council (ICC) Certified Structural Masonry Special Inspector
ICC-SFSI	International Code Council (ICC) Certified Spray-Applied Fireproofing Special Inspector
EDI-EIFS	Exterior Design Institute - EIFS Level 1 Third Party inspector
AWCI-CEI	Association of the Wall and Ceiling Industry (AWCI) Certified EIFS Inspector
ASNT-L2	American Society of Non-Destructive Testing - Level II
ASNT-L3	American Society of Non-Destructive Testing - Level III
NICET-GETC	National Society for Professional Engineers – Geotechnical Engineering Technology/Construction – Level II (or higher)
ICC-SSI	International Code Council (ICC) Certified Soils Special Inspector
NEBB-CAB	National Environmental Balancing Bureau (NEBB) Certified Air Balancer with expertise in Mechanical and Fire Protection Engineering
AABC-CAB	Associated Air Balance Council (AABC) Certified Test and Balance Engineer (TBE) with expertise in Mechanical and Fire Protection Engineering

Notes:

1. Qualifications of Inspection Agents may be indicated on the Schedule in instances where the Structural Engineer of Record deems such requirements are appropriate.
2. Individual Inspector qualification requirements may be waived at the discretion of the Special Inspections Administrator if the inspections are performed under the supervision of a PE.
3. See Special Inspections Services specification for definition of continuous and periodic inspection frequency.

SCHEDULE OF SPECIAL INSPECTION SERVICES (IBC 2021)					
PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Inspection of Fabricators		IBC 1704.2.5			
Verify fabrication/quality control procedures	In-plant review		Y	Periodic	1 (PE)
Steel Construction		IBC 1705.2	**Y**		
(References to Steel Construction in this Specification include Structural Steel, Architecturally Exposed Structural Steel, Steel Joist Framing, Metal Fabrications, Metal Stairs and Railings, Decorative Metal Railings, and Cold Formed Metal Framing-CFMF)					
Fabricator and Erector Quality Control Program	In-plant Self evaluation	AISC 360, Chapter N, Section N2.	**Y**		N/A
The fabricator's Quality Control Inspector shall inspect the following as a minimum, as applicable: a. Shop welding, high-strength bolting, and details in accordance with AISC 360 Section N5. b. Shop cut and finished surfaces in accordance in accordance with AISC 360, Section M2. c. Shop heating for straightening, cambering and curving in accordance with AISC 360, Section M2.1. d. Tolerances for shop fabrication in accordance with Code of Standard Practice Section 6.4. The erector's Quality Control Inspector shall inspect the following as a minimum, as applicable: a. Field welding, high-strength bolting, and details in accordance with AISC 360, Section N5. b. Steel deck in accordance with SDI Standard for Quality Control and Quality Assurance for Installation of Steel Deck. c. Headed steel stud anchor placement and attachment in accordance with Section N5.4. d. Field cut surfaces in accordance with AISC 360, Section M2.2. e. Field heating for straightening in accordance with AISC 360, Section M2.1. f. Tolerances for field erection in accordance with Section 7.13 of the Code of Standard Practice.					
Fabricator and Erector Documents	In-plant Self evaluation	AISC 360, Chapter N, Section N3.	**Y**		N/A
Submittals for Steel Construction and Available Documents for Steel Construction shall conform to AISC 360, Section N3.					
Inspection of Fabricators and Fabrication Procedures	In-plant review	IBC 1704.2.5, AISC 360, N6	**Y**		1 (PE)
Inspection of fabricators and fabrication procedures shall be performed by the Quality Assurance Inspector (special inspector) and shall conform to IBC Sections 1704.2.5 and 1704.2.5.1. The requirements of IBC Section 1704.2.5.2 may apply subject to AHJ Approval.					
Inspection and Nondestructive Testing Personnel		AISC 360, Chapter N, Section N4	**Y**		
Quality Control Inspector (fabricator or erector) Qualifications, Quality Assurance Inspector (special inspector) Qualifications and Nondestructive Testing Personnel (inspection agency personnel) Qualifications shall conform to AISC 360, Section N4.					
Welder qualification records and continuity records	Shop and field inspection		**Y**		
Inspection Tasks Prior to Welding		AISC360 Chapter N, Table N5.4-1			
Welder qualification records and continuity records	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Welding procedure specifications (WPSs) available	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Manufacturer certifications for welding consumables available	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Material identification (type/grade)	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Welder identification system*	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)

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SCHEDULE OF SPECIAL INSPECTION SERVICES (IBC 2021)					
PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Fit-up of groove welds (including joint geometry) • Joint preparation • Dimensions (alignment, root opening, root face, bevel) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location) • Backing type and fit (if applicable)	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Fit-up of CJP welds of HSS, T-, Y- and K-joints without backing (including joint geometry) • Joint preparations • Dimensions (alignment, root opening, root face, bevel) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location)	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Configuration and finish of access holes	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Fit-up of fillet welds • Dimensions (alignment, gaps and root) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location)	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Check welding equipment	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
* The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.					
Inspection Tasks During Welding		AISC360 Chapter N, **Table N5.4-2**			
Control and handling of welding consumables • Packaging • Exposure control	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
No welding over cracked tack welds	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Environmental conditions • Wind speed within limits • Precipitation and temperature	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
WPS followed • Settings on welding equipment • Travel speed • Selected welding materials • Shielding gas type/flow rate • Preheat applied • Interpass temperature maintained (min./max.) • Proper position (F, V, H, OH)	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Welding techniques • Interpass and final cleaning • Each pass within profile limitations • Each pass meets quality requirements	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Placement and installation of steel headed stud anchors	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)

SCHEDULE OF SPECIAL INSPECTION SERVICES (IBC 2021)					
PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Inspection Tasks After Welding		AISC360 Chapter N, **Table N5.4-3**			
Welds cleaned	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
Size, length and location of welds	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Welds meet visual acceptance criteria • Crack prohibition • Weld/base-metal fusion • Crater cross section • Weld profiles • Weld size • Undercut • Porosity	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Arc strikes	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
k-area[a]	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Weld access holes in rolled heavy shapes and built-up heavy shapes[b]	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Backing removed and weld tabs removed (if required)	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Repair activities	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
Document acceptance or rejection of welded joint of member	Shop and field inspection		**Y**	Continuous	2 (AWS/ AISC-SSI, AWS-CWI)
No prohibited welds have been added without the approval of the EOR	Shop and field inspection		**Y**	Periodic	2 (AWS/ AISC-SSI, AWS-CWI)
[a]When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 in. of the weld. [b]After rolled heavy shapes (see Section A3.1c) and built-in heavy shapes (see Section A3.1d) are welded, visually inspect the weld access hole for cracks.					
Inspection Tasks Prior to Bolting		AISC360 Chapter N, **Table N5.6-1**			
Manufacturer's certifications available for fastener materials	Shop and field inspection		**Y**	Continuous	2 (ICC-SSBSI)
Fasteners marked in accordance with ASTM requirements	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Correct bolting procedure selected for joint detail	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and method used	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Protected storage provided for bolts, nuts, washers and other fastener components	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Inspection Tasks During Bolting		AISC360 Chapter N, **Table N5.6-2**			
Fastener assemblies placed in all holes and washers and nuts are positioned as required	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Joint brought to the snug-tight condition prior to the pre-tensioning operation	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Fastener component not turned by the wrench prevented from rotating	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Fasteners are pre-tensioned in accordance with RCSC Specification, progressing systematically from the most rigid point toward the free edges	Shop and field inspection		**Y**	Periodic	2 (ICC-SSBSI)
Inspection Tasks After Bolting		AISC360 Chapter N, **Table N5.6-3**			
Document acceptance or rejection of bolted connections	Shop and field inspection		**Y**	Continuous	2 (ICC-SSBSI)
Nonconforming Materials and Workmanship		AISC360 Chapter N, Section N7	**Y**	Continuous	
Identification and rejection of materials or workmanship that is not in conformance with the construction documents shall not be permitted at any time during the progress of the work. Nonconforming material and workmanship shall be brought to the immediate attention of the General Contractor and the fabricator or erector, as applicable. Nonconforming material or workmanship shall be brought into conformance, or made suitable for its intended purpose as determined by the Structural Engineer of Record. Structural repairs shall be reviewed and approved by the AHJ.					
Cold-formed Steel Deck		**IBC 1705.2.2**			
1. Material verification of cold-formed steel deck: a. Identification markings to conform to ASTM standards in the approved construction documents. b. Manufacturer's certified test reports.	Field inspection	Applicable ASTM material standards	**Y**	Periodic	2 (ICC-SSBSI)
2. Inspection of welding: a. Cold-formed steel deck: 1) Floor and roof deck welds	Field inspection	AWS D1.3 IBC 1705.2.2	**Y**	Periodic	2 (ICC-SSBSI) (AWS-CWI)
Open Web Steel Joists and Joist Girders		**Table 1705.2.3**			
1. Installation of Open-Web steel joists and joist girders: a. End connections – welded and bolted.		**SJI 2207.1**	**N**	Periodic	2 (EIT, PE or ICC-SSBI)
b. Bridging – horizontal			**N**		
1) Standard bridging			**N**	Periodic	
2) Bridging that differs from the SJI specifications listed in Section 2207.1			**N**	Periodic	
Cold-formed steel trusses spanning 60 feet or greater		**IBC 1705.2.4**			
1. Verify temporary and permanent restraint/bracing is installed in accordance with the approved truss submittal package.	Field inspection		**N**	Continuous	2 (EIT, PE, OR ICC-SSBI)

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SCHEDULE OF SPECIAL INSPECTION SERVICES (IBC 2021)					
PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Concrete Construction		**Table 1705.3[a]**			
1. Inspect reinforcement, including prestressing tendons, and verify placement.	Shop and field inspections	IBC 1908.4, ACI 318 Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	**Y**	Periodic	
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706;		AWS D1.4 and ACI 318: 26.6.4	**Y**	Periodic	
b. Inspect single-pass fillet welds, maximum 5/16"; and			**Y**	Periodic	
c. Inspect all other welds			**Y**	Continuous	
3. Inspect anchors cast in concrete.		ACI 318: 17.8.2	**Y**	Periodic	
4. Inspect anchors post-installed in hardened concrete members.[b] a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4. a		ACI 318: 17.8.2.4 ACI 318: 17.8.2	**Y**	Continuous Periodic	2 (ACI-CCI, OR ICC-RCSI)
5. Verify use of approved design mix.	Shop and field inspections	ACI 318: Chapter 19 and Sections 26.4.3, 26.4.4 and IBC 1904.1, 1904.2	**Y**	Periodic	2 (EIT OR HIGHER)
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	Shop and field inspections	ASTM C172, ASTM C31, ACI 318: 26.5, 26.12	**Y**	Continuous	
7. Inspect concrete and shotcrete placement for proper application techniques.	Shop and field inspections	ACI 318: 26.5	**Y**	Continuous	2 (ACI-CCI, OR ICC-RCSI)
8. Verify maintenance of specified curing temperature and techniques.	Shop and field inspections	ACI 318: 26.5.3-26.5.5	**Y**	Periodic	2 (ACI-CFTT, ACI-LTT,ACI-CCI, OR ICC-RCSI)
9. Inspect prestressed concrete:					
a. Application of prestressing forces. b. Grouting of bonded prestressing tendons.	Shop and field inspections	ACI 318: 26.10	**N**	Continuous Continuous	2 (ICC-PSCSI)
10. Inspect erection of precast concrete members.	Field inspection	ACI 318: 26.9	**N**	Periodic	2 (ICC-PSCSI)
11. For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deformability elements (MDE or HDE) in structures assigned to Seismic Design Category C, D, E, or F inspect such connections and reinforcement in the field for: a. Installation of the embedded parts. b. Completion of the continuity of reinforcement across joints. c. Completion of connections in the field.	Field inspection Continuous	ACI 550.5	**N**	Continuous Continuous Continuous	2 (ICC-PSCSI)
12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5	Field inspection	ACI 318: 26.13.1.3	**N**	Periodic	2 (ICC-PSCSI)
13. Verify in-situ concrete strength, prior to stressing of tendons in posttensioned concrete and prior to removal of shores and forms from beams and structural slabs.	Review field testing and laboratory reports	ACI 318: 26.11.1.2	**N**	Periodic	2 (ICC-PSCSI)
14. Inspect formwork for shape, location and dimensions of the concrete member being formed.	Field inspection	ACI 318: 26.11.1.2(b)	**Y**	Periodic	2 (EIT OR HIGHER)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
15.Inspection of concrete placement and reinforcement for special moment frames, boundary elements of special structural walls, coupling beams, and precast concrete diaphragms assigned to SDC C, D, E, or F using moderate or high-deformability connections.	Field inspection	ACI 318; 26.13.1.3	**Y**	Periodic	2(ICC-RCSI)
[a] Where applicable (for concrete construction), see Section 1705.13, Special Inspections for Seismic Resistance. [b] Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.					
Masonry Construction		**IBC 1705.4**			
MASONRY **LEVEL 1** QUALITY ASSURANCE Masonry construction shall be inspected and verified in accordance with TMS 402 **(Table 3.1)** and TMS 602 (**Table 3**) quality assurance program requirements.					
MINIMUM VERIFICATION					
Prior to construction, verify compliance with the approved submittals	Field inspection	TMS 602 Article 1.5	**N**	Periodic	1 (ICC-SMSI or PE)
MASONRY **LEVEL 2** QUALITY ASSURANCE Masonry construction shall be inspected and verified in accordance with TMS 402 (**Table 3.1**) and TMS 602 (**Table 3**) quality assurance program requirements.					
MINIMUM VERIFICATION					
Prior to construction, verify compliance with the approved submittals.	Field inspection	TMS 602 Article 1.5	**Y**	Periodic	1, 2 (ICC-SMSI or PE)
Prior to construction, verification of f'm & f'aac in accordance with TMS 602 Specification Article 1.4 B, except where specifically exempted by TMS 402 Code.	Testing by unit strength method or prism test method	TMS 602 Article 1.4B	**N**	Periodic	2 (ICC-SMSI)
During construction, verification of slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602 Specification Article 1.5 & 1.6.3 for self-consolidating grout.	Field inspection	TMS 602, Article 1.5 & 1.6.3	**Y**	Periodic	1 (ICC-SMSI)
MINIMUM INSPECTION					
1. As masonry construction begins, verify that the following are in compliance:					
a. Proportions of site-prepared mortar.	Field inspection	TMS 602 Article 2.1, 2.6A & 2.6C	**Y**	Periodic	2 (ICC-SMSI)
b. Grade and size of prestressing tendons and anchorages.	Field inspection	TMS 602 Article 2.4B, 2.4H	**N**	Periodic	1, 2 (ICC-SMSI or PE)
c. Grade, type and size of reinforcement, connectors, anchor bolts and prestressing tendons and anchorages.	Field inspection	TMS 602 Article 3.4, 3.6A	**Y**	Periodic	1, 2 (ICC-SMSI or PE)
d. Prestressing technique	Field inspection	TMS 602 Article 3.6B	**N**	Periodic	1, 2 (ICC-SMSI or PE)
e. Properties of thin-bed mortar for AAC masonry.	Field inspection	TMS 602 Article 2.1C.1	**N**	Continuous/ Periodic*	2 (ICC-SMSI)
f. Sample panel construction	Field inspection	TMS 602 Article 1.6D	**N**	Periodic	1, 2 (ICC-SMSI or PE)
2. Prior to grouting, verify that the following are in compliance:					
a. Grout space.	Field inspection	TMS 602, Article 3.2D, 3.2F	**Y**	Periodic	2 (ICC-SMSI, EIT or Higher)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
b. Placement of prestressing tendons and anchorages.	Field inspection	TMS 402 Sec10.8 & 10.9 & TMS 602, Article 2.4, 3.6	**N**	Periodic	2 (ICC-SMSI, EIT or Higher)
c. Placement of reinforcement, connectors, and anchor bolts.	Field inspection	TMS 402 Sec. 6.1, 6.3.1, 6.3.6 & 6.3.7 & TMS 602 Article 3.2E, 3.4	**Y**	Periodic	2 (ICC-SMSI)
d. Proportions of site-prepared grout and prestressing grout for bonded tendons.	Field inspection	TMS 602 Article 2.6B, 2.4G.1.b	**Y**	Periodic	2 (ICC-SMSI)
3. Verify compliance of the following during construction:					
a. Materials and procedures with the approved submittals	Field inspection	TMS 602 Article 1.5	**Y**	Periodic	2 (ICC-SMSI)
b. Placement of masonry units and mortar joint construction	Field inspection	TMS 602 Article 2.3b	**Y**	Periodic	2 (ICC-SMSI)
c. Size and location of structural members.	Field inspection	TMS 602, Article 3.3F	**Y**	Periodic	2 (ICC-SMSI, EIT or Higher)
d. Type, size, and location of anchors, including other details of anchorages of masonry to structural members, frames, or other construction.	Field inspection	TMS 402 Sec. 1.2.1(e), 6.2.1 & 6.3.1	**Y**	Periodic	2 (ICC-SMSI, EIT or Higher)
e. Welding of reinforcement.	Field inspection	TMS 402 Sec. 6.1.6.1.2	**Y**	Continuous	2 (ICC-SMSI or AWS-CWI)
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F).	Field inspection	TMS 602 Article 1.8C, 1.8D	**Y**	Periodic	2 (ICC-SMSI)
g. Application and measurement of prestressing force.	Field inspection	TMS 602 Article 3.6B	**N**	Continuous	2 (ICC-SMSI)
h. Placement of grout and prestressing grout for bonded tendons is in compliance.	Field inspection	TMS 602 Article 3.5, 3.6C	**Y**	Continuous	2 (ICC-SMSI, EIT or Higher)
i. Placement of AAC masonry units and construction of thin-bed mortar joints.	Field inspection	TMS 602 Article 3.3B.9 & 3.3F.1.b	**N**	Continuous/ Periodic*	2 (ICC-SMSI, EIT or Higher)
4. Observe preparation of grout specimens, mortar specimens, and/or prisms.	Field inspection	TMS 602 Article 1.4 B.2.a.3, 1.4 B.2.b.3, 1.4 B.2.c.3, 1.4 B.3, 1.4 B.4	**Y**	Periodic	2 (ICC-SMSI)
* Continuous required for first 5,000 square feet of AAC masonry then Periodic there after					
MASONRY **LEVEL 3** QUALITY ASSURANCE - Masonry construction shall be inspected and verified in accordance with TMS 402 (**Table 3.1.3**) and TMS 602 (**Table 3**) quality assurance program requirements.					
MINIMUM VERIFICATION					
Prior to construction, verify compliance with the approved submittals.	Field inspection	TMS 602 Article 1.5	**N**	Periodic	2 (ICC-SMSI)
Prior to construction, verification of f'm and f'aac in accordance with TMS 602, Specification Article 1.4 B prior to construction and for every 5000 square feet during construction.	Field inspection	TMS 602 Article 1.4B	**N**	Continuous/ Periodic	2 (ICC-SMSI)
Prior to construction, verification of Slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602, Specification Article 1.5 & 1.6.3 for self-consolidating grout.	Field inspection	TMS 602 Article 1.4B	**N**	Continuous	2 (ICC-SMSI)
During construction, verification of proportions of materials in premixed or preblended mortar, prestressing grout, and	Field inspection	TMS 602 Article 1.4B	**N**	Continuous	2 (ICC-SMSI)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
grout other than self-consolidating grout as delivered to the project site.					
MINIMUM INSPECTION					
1. As masonry construction begins, verify that the following are in compliance:					
a. Proportions of site prepared mortar.	Field inspection	TMS 602 Article 2.1, 2.6A, 2.6C	**N**	Periodic	2 (ICC-SMSI)
b. Grade, type, and size of prestressing tendons and anchorages.	Field inspection	TMS 602 Article 2.4B & 2.4H	**N**	Periodic	2 (ICC-SMSI)
c. Grade, type, and size of reinforcement, connectors, anchor bolts, and prestressing tendons and anchorages.	Field inspection	TMS 602 Article 3.4 & 3.6A	**N**	Periodic	2 (ICC-SMSI)
d. Prestressing technique.	Field inspection	TMS 602 Article 3.6B	**N**	Periodic	2 (ICC-SMSI)
e. Properties of thin-bed mortar for AAC masonry	Field inspection	TMS 602 Article 2.1C.1	**N**	Continuous	2 (ICC-SMSI)
f. Sample panel construction	Field inspection	TMS 602 Article 1.6D	**N**	Continuous	2 (ICC-SMSI)
2. Prior to grouting, verify that the following are in compliance:					
a. Grout space.	Field inspection	TMS 602 Article 3.2D, 3.2F	**N**	Continuous	2 (ICC-SMSI)
b. Placement of grout and prestressing grout for bonded tendons.	Field inspection	TMS 402 Section 10.8 & 10.9 & TMS 602 Article 2.4 & 3.6	**N**	Continuous	2 (ICC-SMSI)
c. Placement of reinforcement, connectors, and anchor bolts	Field inspection	TMS 402 Section 6.1, 6.3.1, 6.3.6, & 6.3.7 & TMS 602 Article 3.2 E & 3.4	**N**	Continuous	2 (ICC-SMSI)
d. Proportions of site-prepared grout and prestressing grout for bonded tendons	Field inspection	TMS 602 Article 2.6B & 2.4 G.1.b	**N**	Periodic	2 (ICC-SMSI)
3. Verify compliance of the following during construction:					
a. Materials and procedures with the approved submittals	Field inspection	TMS 602 Article 1.5	**N**	Periodic	2 (ICC-SMSI)
b. Placement of masonry units and mortar joint construction	Field inspection	TMS 602 Article 3.3 B	**N**	Periodic	2 (ICC-SMSI)
c. Size and location of structural elements.	Field inspection	TMS 602 Article 3.3F	**N**	Periodic	2 (ICC-SMSI)
d. Type, size, and location of anchors including other details of anchorage of masonry to structural members, frames, or other construction.	Field inspection	TMS 402 Sec. 1.2.1(e), 6.2.1 & 6.3.1	**N**	Continuous	2(ICC-SMSI)
e. Welding of reinforcement.	Field inspection	TMS 402 Sec. 6.1.6.1.2	**N**	Continuous	2 (ICC-SMSI)
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F).	Field inspection	TMS 602 Article 1.8C, 1.8D	**N**	Periodic	2 (ICC-SMSI)
g. Application of measurement of prestressing force.	Field inspection	TMS 602 Article 3.6B	**N**	Continuous	2 (ICC-SMSI)
h. Placement of grout and prestressing grout for bonded tendons is in compliance.	Field inspection	TMS 602 Article 3.5 & 3.6C	**N**	Continuous	2 (ICC-SMSI)
i. Placement of AAC masonry units and construction of thin-bed mortar joints.	Field inspection	TMS 602 Article 3.3B.9 & 3.3.3F.1.b	**N**	Continuous	2 (ICC-SMSI)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
4. Observe preparation of grout specimens, mortar specimens, and/or prisms.	Field inspection	TMS 602 Article 1.4 B.2.a.3, 1.4 B.2.b.3, 1.4 B.2.c.3, 1.4 B.3, 1.4 B.4	**N**	Continuous	2 (ICC-SMSI)
Wood Construction		**IBC 1705.5**			
1. Inspection of the fabrication process of prefabricated wood structural elements and assemblies in accordance with Section 1704.2.5	In-plant review		**N**	Periodic	1,2 (PE)
2. For high-load diaphragms, verify grade and thickness of structural panel sheathing agree with approved building plans.	Field inspection	IBC 1705.5.1, 2306.2	**N**	Periodic	1,2 (EIT OR HIGHER)
3. For high-load diaphragms, verify nominal size of framing members at adjoining panel edges, nail or staple diameter and length, number of fastener lines and that spacing between fasteners in each line and at edge margins agree with approved building plans.	Field inspection	IBC1705.5.1, 2306.2	**N**	Periodic	1,2 (PE)
Metal-plate-connected wood trusses					
Where a truss clear span is 60 feet or greater, verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.	Field inspection	**IBC 1705.5.2**	**N**	Continuous	2 (EIT OR HIGHER)
Mass Timber Construction [APPLICABLE TO BUILDING TYPES IV-A, IV-B, AND IV-C]	Field inspection	**IBC 1705.5.3**			2(PE)
1. Inspection of anchorage and connections of mass timber construction to deep foundation systems.			**N**	Periodic	
2. Inspect erection of mass timber construction.			**N**	Periodic	
3. Inspection of connections where installation methods are required to meet design loads.			**N**	Periodic	
Threaded fasteners: Verify use of proper installation equipment.			**N**	Periodic	
Threaded fasteners: Verify use of pre-drilled holes where required.			**N**	Periodic	
Threaded fasteners: Inspect screws including diameter, length, head type, spacing, installation angle and depth.			**N**	Periodic	
Adhesive anchors install in horizontal or upwardly included orientation to resist sustained tension loads.			**N**	Continuous	
Adhesive anchors not defined in proceeding cell.			**N**	Periodic	
Bolted connections.			**N**	Periodic	
Concealed connections			**N**	Periodic	

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MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Soils (Earthwork)		**IBC 1705.6**			
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Field inspection	Table 1705.6	**Y**	Periodic	3 (GE, NICET-GETC, OR ICC-SSI)
2. Verify excavations are extended to proper depth and have reached proper material.	Field inspection	Table 1705.6	**Y**	Periodic	3 (GE, NICET-GETC, OR ICC-SSI)
3. Perform classification and testing of compacted fill materials.	Field inspection	Table 1705.6	**Y**	Periodic	3 (GE, NICET-GETC, OR ICC-SSI)
4. During fill placement, verify use of proper materials and procedures in accordance with the provisions of the approved geotechnical report. Verify densities and lift thicknesses during placement and compaction of compacted fill.	Field inspection	Table 1705.6	**Y**	Continuous	3 (GE, NICET-GETC, OR ICC-SSI)
5. Prior to placement of compacted fill and subgrade and verify that site has been prepared properly.	Field inspection	Table 1705.6	**Y**	Periodic	3 (GE, NICET-GETC, OR ICC-SSI)
Driven Deep Foundations		**IBC 1705.7**			
1. Verify element materials, sizes and lengths comply with the requirements.	Field inspection	Table 1705.7	**N**	Continuous	3 (GE, NICET-GETC, OR ICC-SSI)
2. Determine capacities of test elements and conduct additional load tests as required.	Field inspection	Table 1705.7	**N**	Continuous	3 (GE, NICET-GETC, OR ICC-SSI)
3. Inspect driving operations and maintain complete and accurate records for each element.	Field inspection	Table 1705.7	**N**	Continuous	3 (GE, NICET-GETC, OR ICC-SSI)
4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element	Field inspection	Table 1705.7	**N**	Continuous	3 (GE, NICET-GETC, OR ICC-SSI)
5. For steel elements, perform additional inspections per Section 1705.2 as shown in the steel section of this schedule	See Section 1705.2	Table 1705.7	**N**	See Section 1705.2	See Section 1705.2
6. For concrete elements and concrete-filled elements, perform additional inspections per Section 1705.3 as shown in the concrete section of this schedule.	See Section 1705.3	Table 1705.7	**N**	See Section 1705.3	See Section 1705.3
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	Field inspection	Table 1705.7	**N**	In accordance with construction documents	1/3 (GE, NICET-GETC, OR ICC-SSI)
Cast-in-place Deep Foundations		**IBC 1705.8**			
1. Inspect drilling operations and maintain complete and accurate records for each element.	Field inspection	Table 1705.8	**N**	Continuous	2 (EIT OR HIGHER)
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes.	Field inspection	Table 1705.8	**N**	Continuous	2 (GE, NICET-GETC, OR ICC-SSI)
3. For concrete elements, perform tests and additional special inspections in accordance with Section 1705.3 as shown in the concrete section of this schedule..	See Section 1705.3	Table 1705.8	**N**	See Section 1705.3	2 (See Section 1705.3)

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MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Helical Pile Foundations		**IBC 1705.9**			
1. Verify and record installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the registered design professional in responsible charge. The approved geotechnical report and the construction documents prepared by the registered design professional shall be used to determine compliance.	Field inspection		**N**	Continuous	2 (EIT OR HIGHER)
Structural Wood Special Inspections for Wind Resistance		**IBC 1705.12.1**			
1. Inspection during field gluing operations of elements of the main wind force-resisting system.	Field inspection		**N**	Continuous	2 (PE)
2. Inspection of nailing, bolting, anchoring and other fastening of components within main wind force-resisting system, including wood shear walls, wood diaphragms, collectors, drag struts, braces and hold-downs.	Shop and field inspections		**N**	Periodic	2 (PE)
Cold-Formed Steel Light-Frame Construction Special Inspections for Wind Resistance		**IBC 1705.12.2**			
1. Inspection during welding operations of elements of the main wind force-resisting system.	Shop and field inspections		**N**	Periodic	2 (ICC-SWSI, AWS-CWI, or AWS/AISC-SSI)
2. Inspection for screw attachment, bolting, anchoring and other fastening of components within the main wind force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs	Shop and field inspections		**N**	Periodic	1, 2 (PE)
Wind Resisting Components Special Inspections for Wind Resistance		**IBC 1705.12.3**			
1. Roof covering, roof deck and roof framing connections.	Shop and field inspections		**N**	Periodic	1, 2 (PE)
2. Exterior wall covering and wall connections to roof and floor diaphragms and framing.	Shop and field inspections		**N**	Periodic	1, 2 (PE)
Structural Steel Special Inspections for Seismic Resistance		**IBC 1705.13.1**			
1. Perform inspection of structural steel in accordance with AISC 341. *See contract drawings for more information.	Shop and field inspections	AISC 341	**Y**	In accordance with AISC 341	1, 2 (PE)
Structural Wood Special Inspections for Seismic Resistance (SDC C, D, E, OR F)		**IBC 1705.13.2**			
1. Inspection during field gluing operations of elements of the seismic-force-resisting system.	Field inspection		**N**	Continuous	1, 2 (PE)

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PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
2. Inspection of nailing, bolting, anchoring and other fastening of elements of the seismic-force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.	Shop and field inspections		**N**	Periodic	1, 2 (PE)
Cold-Formed Steel Light-Frame Construction Special Inspections for Seismic Resistance (SDC C, D, E, OR F)		**IBC 1705.13.3**			
1. Inspection during welding operations of elements of the seismic-force-resisting system.	Shop and field inspections		**N**	Periodic	2 (ICC-SWSI, AWS-CWI, or AWS/AISC-SSI)
2. Inspection for screw attachment, bolting, anchoring and other fastening of elements of the seismic force-resisting system, including shear walls, braces, diaphragms, collectors (drag struts) and hold-downs.	Shop and field inspections		**N**	Periodic	1, 2 (PE)
Designated Seismic System Verifications Special Inspections for Seismic Resistance		**IBC 1705.13.4**			
1. Inspect active mechanical and electrical equipment and components with hazardous substances in accordance with Section 13.2.2 of ASCE 7 and verify that label, anchorage and mounting conform to the certificate of compliance.	Field inspection		**Y**	Periodic	1, 2 (PE)
Architectural Components Special Inspections for Seismic Resistance		**IBC 1705.13.5**			
1. Inspection during the erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneers. (SDC C, D, E, OR F)	Field inspection		**Y**	Periodic	1, 2 (PE)
2. Inspection of the anchorage of access floors (SDC D, E, or F).				Periodic	
Plumbing, Mechanical and Electrical Components Special Inspections for Seismic Resistance		**IBC 1705.13.6**			
1. Inspection during the anchorage of electrical equipment for emergency and standby power systems in structures assigned to *Seismic Design Category* C, D, E or F.	Field inspection		**Y**	Periodic	1, 2 (PE)
2. Inspection during the anchorage of other electrical equipment structures assigned to *Seismic Design Category* E or F.	Field inspection		**N**	Periodic	1, 2 (PE)
3. Inspection during the installation and anchorage of piping systems intended to carry hazardous materials and their associated mechanical units in structures assigned to *Seismic Design Category* C, D, E or F.	Field inspection		**Y**	Periodic	1, 2 (PE)
4. Inspection during the installation and anchorage of ductwork designed to carry materials in structures assigned to *Seismic Design Category* C, D, E or F.	Field inspection		**Y**	Periodic	1, 2 (PE)
5. Inspection during the installation and anchorage of vibration isolation systems in structures assigned to *Seismic Design Category* C, D, E or F where the	Field inspection		**Y**	Periodic	1, 2 (PE)

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MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint.					
6. Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed in structures assigned to Seismic Design Category C, D, E or F to verify one of the following:			**Y**		
a. Minimum clearances have been provided as required by Section 13.2.3 ASCE/SEI 7. b. A nominal clearance of not less than 3 inches has been provided between fire protection sprinkler system drops and sprigs and: structural members not used collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems other systems' piping.	Field inspection		**Y**	Periodic	1, 2 (PE)
Storage Racks Special Inspections for Seismic Resistance		**IBC 1705.13.7**			
1. Materials used, to verify compliance with one or more of the material test reports in accordance with the approved construction documents.2. Fabricated storage rack elements. {Section 1704.2.5}3. Storage rack anchorage installation. {ANSI/MH16.1 Section 7.3.2}4. Completed storage rack system, to indicate compliance with the approved construction documents.	Field inspection		**N**	Periodic	1, 2 (PE)
Seismic Isolation System Special Inspections for Seismic Resistance (SDC B, C, D, E, or F)		**IBC 1705.13.8**			
1. Inspection during the fabrication and installation of isolator units and energy dissipation devices used as part of the isolation system.	Shop and field inspections		**N**	Periodic	1, 2 (PE)
Cold-Formed Steel Special Bolted Moment Frames Special Inspections for Seismic Resistance (SDC D, E, or F)		**IBC 1705.13.9**			
1. Inspection for installation of cold-formed steel special bolted moment frames in the seismic force-resisting systems of structures.			**N**	Periodic	
Structural Steel Elements Testing for Seismic Resistance		**IBC 1705.14.1**			
1. Test in accordance with the quality assurance requirements of AISC 341.	Shop and field inspections	AISC 341	**Y**	Per AISC 341	1, 2 (PE)
Testing for Seismic Resistance Nonstructural Components		**IBC 1705.14.2**			
1. Review certificate of compliance for nonstructural components, supports or attachments.	Certificate of compliance review	ASCE Section 13.2.1	**Y**	Each submittal	2 (EIT or HIGHER)

SCHEDULE OF SPECIAL INSPECTION SERVICES (IBC 2021)					
PROJECT	SNHD - New BSL Lab Building				
MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
Designated Seismic Systems Testing for Seismic Resistance					
1. Review certificate of compliance for active mechanical and electrical equipment and components with hazardous substances.	Certificate of compliance review	ASCE 7 Section 13.2.2	**Y**	Each submittal	
Seismically Isolated Structures		**IBC 1705.14.4**			
1. Test seismic isolation structures in accordance with ASCE 7, Section 17.8	Prototype testing	ASCE 7 Section 17.8	**N**	Per ASCE 7	1, 2 (PE)
Sprayed Fire-Resistant Materials		**IBC 1705.15**			
1. Verify surface condition preparation of structural members is in accordance with approved fire-resistance design and the written instructions of approved manufacturers.	Field inspection	IBC 1705.15.2	**N**	Periodic	2 (ICC-SFSI)
2. Verify application of sprayed fire-resistant materials, including the minimum ambient temperature and ventilation before, during and after application are as specified by the written instructions of approved manufacturers.	Field inspection	IBC 1705.15.3	**N**	Periodic	2 (ICC-SFSI)
3. Verify average thickness of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members.	Field inspection	IBC 1705.15.4 ASTM E605	**N**	Periodic	2 (ICC-SFSI)
4. Verify density of the sprayed fire-resistant material complies with approved fire-resistant design.	Field inspection and testing	IBC 1705.15.5 ASTM E605	**Y**	Per IBC Section 1704.12.5	2 (ICC-SFSI)
5. Verify the cohesive/adhesive bond strength and condition of the cured sprayed fire-resistant material.	Field inspection and testing	IBC 1705.15.6 ASTM E736	**Y**	Per IBC Section 1704.12.6	2 (ICC-SFSI)
Mastic and Intumescent Fire-Resistant Coatings		**IBC 1705.16**			
1. Inspect mastic and intumescent fire-resistant coatings applied to structural elements and decks.	Field inspection	AWCI 12-B	**Y**	Periodic	2 (ICC-SFSI)
Exterior Insulation and Finish Systems (EIFS)		**IBC 1705.17**			
Inspect all EIFS applications.	Field inspection		**Y**	Periodic	2 (EDI-EIFS)
Fire Resistant Penetrations and Joints		**IBC 1705.18**			
Penetration Firestops Inspect & test in accordance with ASTM E2174	Field testing	IBC 1705.18.1/ ASTM E 2174	**Y**		2 (ICC-SFSI)
Fire-resistant joint systems test & inspect according to ASTM E2393	Field testing	IBC 1705.18.2/ ASTM E 2393	**Y**		2 (ICC-SFSI)
Special Inspection for Smoke Control		**IBC 1705.19**			
1. Perform leakage testing and record device locations during erection and prior to concealment of ductwork.	Field testing		**N**	Periodic	2 (NEBB-CAB or AABC-CAB)

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MATERIAL/ACTIVITY VERIFICATION AND INSPECTION	**SERVICE**	**REFERENCE STANDARD**	**REQ'D (Y/N)**	**FREQUENCY**	**AGENT No. (Qualification)**
2. Perform pressure difference testing, flow measurements and detection and control verification prior to occupancy and after sufficient completion for the purposes of testing.	Field testing		**N**	Periodic	2 (NEBB-CAB or AABC-CAB)
Sealing of Mass Timber		**IBC 1705.20**			
1. Inspect sealants required by Section 703.7.	Field inspection		**Y**	Periodic	Per 703.7

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations, complete, functioning, and ready for the intended use.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

J. “RFI” – “Request for Interpretation”: Contractor’s request for clarification of Architect’s design intent.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. The information in this list is subject to change and is believed to be accurate and up to date as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.

20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/.
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.

64. CSA - CSA Group; www.csagroup.com.
65. CSA - CSA International; www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridaroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.
89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. ICBO - International Conference of Building Officials; (See ICC).
101. ICC - International Code Council; www.iccsafe.org.
102. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
103. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
104. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
105. IEC - International Electrotechnical Commission; www.iec.ch.
106. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
107. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
108. IESNA - Illuminating Engineering Society of North America; (See IES).
109. IEST - Institute of Environmental Sciences and Technology; www.iest.org.

110. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
111. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
112. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
113. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
114. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
115. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
116. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
117. ISO - International Organization for Standardization; www.iso.org.
118. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
119. ITU - International Telecommunication Union; www.itu.int/home.
120. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
121. LMA - Laminating Materials Association; (See CPA).
122. LPI - Lightning Protection Institute; www.lightning.org.
123. MBMA - Metal Building Manufacturers Association; www.mbma.com.
124. MCA - Metal Construction Association; www.metalconstruction.org.
125. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
126. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
127. MHIA - Material Handling Industry of America; www.mhia.org.
128. MIA - Marble Institute of America; www.marble-institute.com.
129. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
130. MPI - Master Painters Institute; www.paintinfo.com.
131. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
132. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
133. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
134. NADCA - National Air Duct Cleaners Association; www.nadca.com.
135. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
136. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
137. NBI - New Buildings Institute; www.newbuildings.org.
138. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
139. NCMA - National Concrete Masonry Association; www.ncma.org.
140. NEBB - National Environmental Balancing Bureau; www.nebb.org.
141. NECA - National Electrical Contractors Association; www.necanet.org.
142. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
143. NEMA - National Electrical Manufacturers Association; www.nema.org.
144. NETA - InterNational Electrical Testing Association; www.netaworld.org.
145. NFHS - National Federation of State High School Associations; www.nfhs.org.
146. NFPA - National Fire Protection Association; www.nfpa.org.
147. NFPA - NFPA International; (See NFPA).
148. NFRC - National Fenestration Rating Council; www.nfrc.org.
149. NHLA - National Hardwood Lumber Association; www.nhla.com.
150. NLGA - National Lumber Grades Authority; www.nlga.org.
151. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
152. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
153. NRCA - National Roofing Contractors Association; www.nrca.net.
154. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.

155. NSF - NSF International; www.nsf.org.
156. NSPE - National Society of Professional Engineers; www.nspe.org.
157. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
158. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
159. NWFA - National Wood Flooring Association; www.nwfa.org.
160. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
161. PDI - Plumbing & Drainage Institute; www.pdionline.org.
162. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
163. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
164. RFCI - Resilient Floor Covering Institute; www.rfci.com.
165. RIS - Redwood Inspection Service; www.redwoodinspection.com.
166. SAE - SAE International; www.sae.org.
167. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
168. SDI - Steel Deck Institute; www.sdi.org.
169. SDI - Steel Door Institute; www.steeldoor.org.
170. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
171. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
172. SIA - Security Industry Association; www.siaonline.org.
173. SJI - Steel Joist Institute; www.steeljoist.org.
174. SMA - Screen Manufacturers Association; www.smainfo.org.
175. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
176. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
177. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
178. SPIB - Southern Pine Inspection Bureau; www.spib.org.
179. SPRI - Single Ply Roofing Industry; www.spri.org.
180. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
181. SSINA - Specialty Steel Industry of North America; www.ssina.com.
182. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
183. STI - Steel Tank Institute; www.steeltank.com.
184. SWI - Steel Window Institute; www.steelwindows.com.
185. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
186. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
187. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
188. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
189. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
190. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
191. TMS - The Masonry Society; www.masonrysociety.org.
192. TPI - Truss Plate Institute; www.tpinst.org.
193. TPI - Turfgrass Producers International; www.turfgrasssod.org.
194. TRI - Tile Roofing Institute; www.tileroofing.org.
195. UL - Underwriters Laboratories Inc.; www.ul.com.
196. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
197. USAV - USA Volleyball; www.usavolleyball.org.
198. USGBC - U.S. Green Building Council; www.usgbc.org.

199. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
200. WA - Wallcoverings Association; www.wallcoverings.org.
201. WASTEC - Waste Equipment Technology Association; www.wastec.org.
202. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
203. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
205. WI - Woodwork Institute; www.wicnet.org.
206. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
207. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list This information is believed to be accurate and up-to-date as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is believed to be accurate and up-to-date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up to date as of the date of the Contract Documents.

1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS; California Department of Health Services; (See CDPH).
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservice.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Division 01 Section "Summary" for work restrictions and limitations on utility interruptions.
2. Divisions 02 through 49 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.
3. Division 31 Section "Dewatering" for disposal of ground water at Project site.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to Architect, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Owner will pay sewer-service use charges for sewer usage by all entities for construction operations.

C. Water Service: Owner will pay water-service use charges for water used by all entities for construction operations.

D. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.

E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

E. Provide Qualifications for Certified Industrial Hygienist.

F. Provide ongoing Moisture and Mold Testing Quality Control Reports for review in a timely manner.

G. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
3. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

H. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste handling procedures.
5. Other dust-control measures.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

B. The Contractor’s request for use of docks, corridors, elevators, stairs and other spaces outside of the project limit shall be limited to use on an as-needed basis and such use shall be approved in advance by the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Install fencing as required to protect site from theft and vandalism and to protect people from injury. All sizes indicated are minimums.

B. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top rails.

C. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide concrete or galvanized steel bases for supporting posts.

D. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

E. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E84 and passing NFPA 701 Test Method 2.

F. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches.

G. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no less than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot-square tack and marker boards.
3. Drinking water and private toilet.
4. Coffee machine and supplies.
5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
7. Computer with High-speed Internet Service: One compatible with Architect's, Owner's and Contractor's systems.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system or private system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.

a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

H. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

I. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

J. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service overhead or underground unless otherwise indicated.
2. Connect temporary service to Owner's existing power source, as directed by Owner.

K. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
2. Install lighting for Project identification sign.

L. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.

1. Provide additional telephone lines for the following:

a. Provide a dedicated telephone line for each facsimile machine in each field office.
b. Provide one telephone line for Owner's use.

2. At each telephone, Post a list of important telephone numbers.

a. Police and fire departments.
b. Ambulance service.
c. Contractor's home office.
d. Contractor's emergency after-hours telephone number.
e. Architect's office.
f. Construction Manager's home office.
g. Engineers' offices.
h. Owner's office.
i. Principal subcontractors' field and home offices.

3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

M. Electronic Communication Service:

1. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
2. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 15.0 Mbps upload and 150 Mbps download speeds at each computer.

3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.
2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.
3. Traffic Signals and Signs

    a. Provide and operate traffic control and directional signals required to direct and maintain an orderly flow of traffic in all areas under Contractor's control or affected by contractor's operations.
    b. Provide traffic control and directional signs, mounted on barricades or standard posts:

        1) At each change of direction of a roadway and at each crossroads.
        2) At detours.
        3) At parking areas.

4. Flagmen

    a. Provide qualified and suitably equipped flagmen when construction operations encroach on traffic lanes, as required for regulation of traffic.

5. Construction Parking Control

    a. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
    b. Monitor parking of construction personnel's private vehicles:

        1) Maintain free vehicular access to and through parking areas.
        2) Prohibit parking on or adjacent to access roads, or in non-designated areas.

C. Parking: Provide temporary parking areas for construction personnel.

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

F. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Division 01Sections "Execution"

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

H. Temporary Elevator Use: Use of elevators is not permitted

I. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 01 Section "Summary."

C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."

D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

F. Tree and Plant Protection: Comply with requirements specified in Division 01 Section "Temporary Tree and Plant Protection."

G. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

H. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

I. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations. Option in subparagraph below is only for projects connected to existing construction.
2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.

J. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

K. Keys: When necessary to perform the Work, the Contractor may be issued keys to existing mechanical and electrical spaces by the Owner. These keys shall be returned at the end of the project prior to Final Completion.

1. These keys shall not be duplicated without the consent of the Owner.

L. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

M. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

N. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

O. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
3. Insulate partitions to control noise transmission to occupied areas.
4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
5. Protect air-handling equipment.
6. Provide walk-off mats at each entrance through temporary partition.

P. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

Q. Provide a project security program, to:

1. Protect Work, stored products and construction equipment from theft and vandalism.
2. Protect premises from entry by unauthorized persons.
3. Protect Owner's operations at site from theft, vandalism or damage from Contractor's work or employees.
4. Initiate security program in compliance with Owner's system, prior to job mobilization.
5. Maintain security program throughout construction period, until Owner occupancy or Owner acceptance precludes the need for Contractor security.
6. Identification

    a. Provide identification to each person authorized to enter the Project premises, showing:

        1) Personal photograph
        2) Name of the individual and assigned number
        3) Name of employer

    b. Maintain a current list of accredited persons; submit a copy of the list to Owner on request.
    c. Require that identification be displayed by all persons entering, and on, the premises.

7. Exclude from site personnel not properly identified.
8. Entrance Control

    a. Provide control of all persons and vehicles entering and leaving Project site.

        1) Require display of proper identification by each person.
        2) Allow no visitors except with issuance of temporary identification.
        3) Maintain log of visitors.

    b. Owner will control deliveries and vehicles related to his own operations.

9. Patrol/Guard Service

    a. Contractor has the option of placing or not placing a watchman at the site at all times when the buildings are not in the charge of his superintendent. Contractor shall be responsible at all times for all work and materials.
    b. However, Contractor shall employ and pay for a watchman at all times, except normal working hours, that temporary heat is being used and as deemed necessary to meet provisions of the Contract.

3.6 MUD CONTROL

A. Provide methods, means and facilities to prevent the depositing of mud, etc., on public thoroughfares or Owner-used roads. Provide periodic inspection of traffic areas to enforce requirements.

3.7 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard, replace, or clean stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use permanent HVAC system to control humidity.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

    a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
    b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
    c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.8 MOISTURE AND MOLD FIELD QUALITY CONTROL INSPECTIONS

A. The Owner may elect to engage a Certified Industrial Hygienist to perform the following inspections during the installation of insulation and drywall products. The investigation and report preparation shall be completed under the direction of the Certified Industrial Hygienist.

1. Perform a visual inspection of the new construction areas monthly, from the beginning of insulation and drywall installation until inspections are terminated by the owner, to identify possible areas of mold or mildew growth due to the presence of moisture. Attention will be paid to areas where growth is likely, such as dust and dirt accumulation, areas with excessive moisture from rain, leaks and condensation.
2. Perform a visual inspection of the air handling units as each unit becomes accessible. Particular attention will be paid to conditions that may be conducive to mold or mildew growth such as system cleanliness, filter conditions, condensate drainage, and signs of visible growth.
3. Measurements shall be taken to assess airborne levels of mold in the construction area. Sampling for airborne and surface mold will be performed using instrumentation and sampling methods described herein. One (1) plate shall be used for each sample containing Malt Extract Agar. An Anderson N6 impactor sampler will be used to collect the airborne samples.

    a. Surface samples will be collected using either sterile transport swabs or transparent tape lift methods.
    b. Bio-aerosol samples will be sent to the microbiological laboratory for incubation and identification.
    c. Moisture meters and infrared thermographs will be used to identify areas and building components with high moisture content.

4. If deemed necessary by the Owner, the Contractor and affected Sub-Contractors and their on-site staff shall attend instructional programs designed to demonstrate awareness and the proper handling of materials to avoid moisture and mold issues.
5. A written report shall be prepared listing all findings with recommendations for corrective action, if applicable, after each inspection. The report will include:

    a. A list of problem areas and recommendations for corrective action.
    b. Status of previous action.
    c. List of items corrected.

B. Insulation and drywall products will be considered defective if they do not pass tests and inspections.

1. The Contractor shall repair or remove work where test results and inspections indicate that it has been deemed to contain unsatisfactory amounts of moisture or mold.
2. Defective products shall be repaired or removed and replaced at no additional expense to the Owner.
3. Testing and inspections will continue until the work is deemed to be free of moisture and mold.

3.9 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.

B. Provide equipment and personnel, perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids. Excavate and dispose of any contaminated earth off-site in a safe legal manner and replace with suitable compacted fill and topsoil.

C. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.

D. Provide systems for control of atmospheric pollutants.

1. Prevent toxic concentrations of chemicals
2. Prevent harmful dispersal of pollutants into the atmosphere

3.10 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; comparable products and low emitting material requirements.

B. Related Requirements:

1. Division 01 Section "Allowances" for products selected under an allowance.
2. Division 01 Section "Alternates" for products selected under an alternate.
3. Division 01 Section "Substitution Procedures" for requests for substitutions.
4. Division 01 Section "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable (Equivalent) Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a comparable product request. Architect will notify Contractor through Construction Manager of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

    a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
    b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

    a. Name of product and manufacturer.
    b. Model and serial number.
    c. Capacity.

d. Speed.
e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

a. Submit additional documentation required by Architect through Construction Manager in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect; whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: …"

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: …"

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

    a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: …"

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.

    a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: …"

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

    a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …"

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.

    a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: …"

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

    a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

2.3 BANNED MATERIALS

A. The Owner and Architect have not knowingly included any product which includes lead-based paint, PCBs or asbestos fiber.

B. The Contractor shall not purchase or install any product which, to his knowledge, knowingly incorporates lead based paint, PCBs or asbestos fiber in its manufacture or packaging whether a named product, a basis of design product, a comparable product or any product otherwise included on the drawings or in the project manual.

C. The Owner and Architect have not knowingly included any product installed on the building interior which has polyvinyl chloride (PVC) in its composition. The Contractor shall not purchase or install any product which, to his knowledge, knowingly incorporates polyvinyl chloride in its manufacture whether a named product, a basis of design product, a comparable product or any product otherwise included on the drawings or in the project manual.

1. If any product found to contain these banned substances has been specified or proposed, it shall be immediately brought to the attention of the Owner and Architect for review and action.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 – EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

B. Related Requirements:

1. Division 01 Section "Summary" for limits on use of Project site.
2. Division 01 Section "Submittal Procedures" for submitting surveys.
3. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
4. Division 02 Section "Selective Demolition" for demolition and removal of selected portions of the building.
5. Division 07 Section "Firestopping" for patching penetrations in fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor or professional engineer.

B. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

    a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

E. Certified Surveys: Submit two copies signed by land surveyor or professional engineer.

F. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Provide lintels in masonry where required. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection. Coring of concrete and masonry shall not be permitted without the prior approval of the Architect.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in

increased maintenance or decreased operational life or safety. Operational elements include the following:

a. Primary operational systems and equipment.
b. Fire separation assemblies.
c. Air or smoke barriers.
d. Fire-suppression systems.
e. Plumbing piping systems.
f. Mechanical systems piping and ducts.
g. Control systems.
h. Communication systems.
i. Fire-detection and -alarm systems.
j. Conveying systems.
k. Electrical wiring systems.
l. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

a. Water, moisture, or vapor barriers.
b. Membranes and flashings.
c. Roofing systems

1) Employ manufacturer or manufacturer’s approved installer to perform cutting and patching on roofing systems as required to maintain existing warranty.

d. Exterior curtain-wall construction.
e. Sprayed fire-resistive material.
f. Equipment supports.
g. Piping, ductwork, vessels, and equipment.
h. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

a. Employ manufacturer or manufacturer’s approved installer to perform cutting and patching on weather-exposed or moisture resistant building envelope elements.

C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping, underground electrical services, and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility or Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

D. Final Property Survey: Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

    a. Where sleeves have not been provided, holes in masonry walls and concrete slabs and walls shall be core drilled

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

K. Repair or remove and replace damaged, defective, or nonconforming Work.

1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Where cutting results in the unintended removal of or damage to operational, structural or other construction elements, the Contractor shall stop work, report the condition to the Architect and proceed again only after an emergency plan of action has been approved for implementation.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill. Coring of concrete and masonry shall not be permitted without the prior approval of the Architect.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.

5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
6. Where underground services are installed below existing site paving, curbing, grass, etc., damaged and disturbed areas shall be restored to their original condition.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable

timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.

2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Temporary Facilities and Controls" and Division 01 Section "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section "General Commissioning Requirements."

B. Permanent equipment used for temporary services:

1. Any permanent equipment used for temporary service must undergo (before being used) manufacturer's supervision and startup services as specified in the technical sections of the specifications.
2. Upon completion of such use of permanent equipment, equipment must again undergo manufacturer's supervision and startup services no earlier than one month prior to Substantial Completion.

C. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

D. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

E. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

A. Repair or remove and replace damaged, defective, or nonconforming Work, at the Owner's option. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
2. Nonconforming Work includes any Work that deviates from the Contract Documents *("Drawings and Specifications")*, that was furnished, installed and/or provided, without prior written approval of the deviation.
3. The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Division 01 Section “Payment Procedures” for instructions for the preparation of the final payment application.
2. Division 01 Section "Photographic Documentation" for providing final completion construction photographic documentation.
3. Division 01 Section "Execution" for progress cleaning of Project site.
4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
5. Division 01 Section "Project Record Documents" for submitting record documents and record submittals.
6. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 CLOSEOUT DOCUMENTS

A. Certificates of Release: From authorities having jurisdiction.

1. Certificate of Occupancy
2. Certificates of Inspection

    a. Elevators
    b. Mechanical
    c. Electrical
    d. Fire Protection

3. Operating Permits

    a. Boilers
    b. Emergency Generators

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

D. Miscellaneous Closeout Documents: As specified in individual trade Specification Sections.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submit a list of all Closeout Documents, including the location of document delivery, format and number of copies, for review by the Architect and Owner.

C. Submission Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys and similar final record information.
3. Submit closeout submittals specified in individual trade Specification Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit maintenance material submittals specified in individual trade Specification Sections, including tools, spare parts, extra materials. Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's, Construction Manager's and Owner's signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

D. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems as specified in individual trade Specification Sections.
6. Submit demonstration and training video recordings as specified in individual trade Specification Sections.
7. Advise Owner of changeover in heat and other utilities.
8. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
10. Complete final cleaning requirements, including touchup painting.
11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

E. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Should Architect determine that Work is not substantially complete, he will promptly notify Contractor in writing, giving the reasons therefor.
2. Contractor shall remedy deficiencies, and send a second written notice of substantial completion, and Architect will reinspect the Work.
3. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
4. Results of completed inspection will form the basis of requirements for final completion.

5. Reinspection Fees: Should Architect perform reinspections due to failure of Work to comply with claims made by the Contractor, Owner will compensate Architect for such additional services, and deduct the amount of such compensation from final payment of the Contractor.

1.7 FINAL COMPLETION PROCEDURES

A. Submissions Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.
5. Submit final completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A.

1. Organize list of spaces in sequential order, starting with exterior areas first and, proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect and Construction Manager.
    d. Name of Contractor.
    e. Page number.

4. Submit list of incomplete items in the following format:

    a. MS Excel electronic file. Architect, through Construction Manager, will return annotated file.
    b. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

1.9 SUBMISSION OF PROJECT WARRANTIES

A. Time of Submission: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submission of warranties might limit Owner's rights under warranty.

1. Compile specified warranties and bonds.
2. Compile specified service and maintenance contracts.
3. Compile specified product and Contractor's certifications and certificates.
4. Review documents to verify compliance with Contract Documents.
5. Co-execute documents when so specified.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond documents package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.

1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.

p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
q. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

D. Construction Waste Disposal: Comply with waste disposal requirements in Division 01 Section "Temporary Facilities and Controls." and Division 01 Section "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Sections include the following:

1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
4. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit 2 draft copies of each manual at least 30 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return one copy of draft and mark whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit one copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.

1. Correct or modify each manual to comply with Architect's and Commissioning Authority's comments. Submit 3 copies of each corrected manual within 15 days of receipt of comments and prior to commencing demonstration and training.

E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents
2. List of systems
3. List of equipment
4. Table of contents

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.8 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page
2. Table of contents
3. Manual contents

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name, address, and telephone number of Contractor, including responsible principal and their telephone number.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Quality Assurance

1. Preparation of data shall be done by personnel:

a. Trained and experienced in maintenance and operation of described products.
b. Familiar with requirements of this Section.
c. Skilled as technical writer to the extent required to communicate essential data.
d. Skilled as draftsman competent to prepare required Drawings.

D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
2. List, with each product, name, address and telephone number of:

a. Subcontractor or installer.
b. Maintenance contractor, as appropriate.
c. Identify area of responsibility of each.
d. Local source of supply for parts and replacement.

3. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Coordinate Drawings with information in Project Record Documents to assure correct illustration of completed installation. Do not use Project Record Documents as Maintenance Drawings.
2. Written text, as required to supplement product data for the particular installation:

a. Organize in consistent format under separate headings for different procedures.
b. Provide logical sequence of instructions for each procedure.

3. Copy of each warranty, bond and service contract issued.

a. Provide information sheet for Owner's personnel, give:

1) Proper procedures in event of failure.
2) Instances which might affect validity of warranties or bonds.

4. Copy of operating permits from the appropriate authority having jurisdiction. Original permits shall be delivered directly to the Owner with a copy of the transmittal submitted to Architect for record.

F. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.9 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.10 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire
2. Flood
3. Gas leak
4. Water leak
5. Power failure
6. Water outage
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.11 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor are delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

1.12 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.13 PRODUCT MAINTENANCE MANUAL

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - (Not Used)

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

G. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Documents.
2. Record Submittals.
3. Signature of Contractor or his authorized representative, certifying the correctness and completeness of the Record Documents

B. Related Requirements:

1. Division 01 Section “Project Management and Coordination” for coordination drawings for record.
2. Division 01 Section "Submittal Procedures" for general submittal procedures.
3. Division 01 Section "Execution" for final property survey.
4. Division 01 Section "Closeout Procedures" for providing closeout documents.
5. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
6. Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Submit PDF electronic files of scanned record prints.
3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit PDF electronic files of scanned record prints.
2) Print each drawing, whether or not changes and additional information were recorded.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

F. Coordination Drawings: Refer to Specification Section 01 31 00 for requirements.

1.4 RECORD SUBMITTALS

A. Record Product Data: Submit annotated PDF electronic files and directories of each submittal. Include the “as fabricated/manufactured” condition of the product that is described. Additionally, include any modifications that were made in the field, showing the “as installed/erected” condition of the product that is described. Record Product Data is only required where specifically noted in the individual trade Specification Sections.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

B. Record Shop Drawings: Include the “as fabricated/manufactured” condition of the element that is detailed on the shop drawing. Additionally, include any modifications that were made in the field, showing the “as installed/erected” condition of the element that is detailed on the shop drawing. Record Shop Drawings are only required where specifically noted in the individual trade Specification Sections.

C. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately before Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit annotated PDF electronic files and directories of each submittal. Miscellaneous records include, but are not limited to, the following:

1. Field records on excavations and foundations.
2. Field records on underground construction and similar work.

3. Surveys showing locations and elevations of underground lines.
4. Invert elevations of drainage piping.
5. Surveys establishing building lines and levels.
6. Authorized measurements using unit prices or allowances.
7. Records of plant treatment.
8. Ambient and substrate condition tests.
9. Certifications received in lieu of labels on bulk products.
10. Batch mixing and bulk delivery records.
11. Testing and qualification of trade's persons.
12. Documented qualification of installation firms.
13. Load and performance testing.
14. Inspections and certifications by governing authorities.
15. Leakage and water-penetration tests.
16. Fire-resistance and flame-spread test results.
17. Final inspection and correction procedures.

1.5 RECORD DRAWINGS AND SHOP DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations below first floor.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Construction Work Change Directive.
    k. Changes made following Architect's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.

n. Record information on the Work that is shown only schematically.
o. Field changes of dimension or data

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
4. Refer instances of uncertainty to Architect for resolution.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" or "PROJECT RECORD SHOP DRAWING," as appropriate, in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS"
d. Name of Architect.
e. Name of Contractor.

1.6 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
3. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

1.7 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

C. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

D. RECORD SAMPLES

1. Immediately before date of Substantial Completion, meet with Architect and Owner's personnel at Project site to determine which Samples maintained during the construction period shall be transmitted to Owner for record purposes.
2. Comply with Architect's instructions for packaging, identification marking, and delivery to Owner's Sample storage space. Dispose of other Samples in the manner specified for disposing surplus and waste materials.

1.8 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 2 - (Not Used)

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 91 00 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Applicable Sections of Division 23 Specification.

1.2 SUMMARY

A. Employment of Testing, Adjusting and Balancing Contractor:

1. Construction Manager will employ and pay for services of a qualified organization to perform specified testing, adjusting and balancing (TAB) services.
2. Employment of the organization shall in no way relieve Contractor's obligation to perform Work of the Contract.
3. Organization shall be completely independent of all Division 23 Contractors and Subcontractors.

B. This Section includes TAB to produce design objectives for the following:

1. Air systems.
2. Hydronic Piping Systems.
3. Vibration measuring.
4. Verifying that automatic control devices are functioning properly.
5. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. BAS: Building Automation System.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

F. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

G. TAB: Testing, adjusting, and balancing.

H. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Notification of Deficiencies Report: Within 45 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report, notifying Architect of any deficiencies, as specified in “Examination” Article.

C. Certified TAB Reports: Submit two copies of final TAB reports prepared, as specified in this Section, on approved forms certified by TAB firm.

D. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. The organization in which performs the TAB service shall be a current member in good standing, certified to perform services required for the project, of either:

1. Associated Air Balance Council (AABC).
2. National Environmental Balancing Bureau (NEBB).

B. The TAB Work performed by TAB Contractor shall be under the direct supervision of a Registered Professional Engineer, a full-time employee of TAB Contractor. Technicians performing the work must be properly trained, experienced and full-time employees of TAB Contractor.

C. Comply with applicable procedures and standards of the certification sponsoring association unless more stringent requirements are specified in this section; either:

1. Current issue of “National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems”, by AABC.
2. Current issue of “Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems”, by NEBB.
3. Calibration and maintenance of instruments shall be in accord with requirements of the standards. Instruments used in the performance of the TAB Work must have been calibrated within six months preceding the date of usage. Calibration histories for each instrument shall be included with the TAB report.
4. Accuracy of measurements shall comply with the more stringent of the requirements of the standards or the tolerances specified hereinafter.

D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

E. TAB Report Forms: Use standard forms from AABC or NEBB. Other forms may be used upon receiving prior approval from Architect or Owner.

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Participate and cooperate with the efforts of Installing Contractor and/or factory-authorized service representatives for systems and equipment, and BAS Contractor to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide adequate advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. Provide a National Certification Guarantee from the AABC or the NEBB, applicable for the TAB work performed under this contract. Guarantee must include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. After completion of the work specified under this Section, provide an extended warranty encompassing one full heating season and one full cooling season, during which time any balancing device which had been adjusted earlier as part of this work shall be rechecked and reset when such additional work is deemed necessary by the Owner or the Architect.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Verify that quantities and locations of balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation. Prepare a report that identifies any deficiencies and specifically note required work to be done to allow effective balancing.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

D. Examine system and equipment test reports.

E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

I. Examine plenum ceilings or raised floors used for supply air to verify that they are airtight. Verify that pipe and duct penetrations and other holes are sealed.

J. Examine strainers for clean screens.

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine equipment for installation and for properly operating safety interlocks and controls.

O. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.

2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

P. Report deficiencies discovered before and during performance of TAB procedures. Record default set points if different from indicated values.

3.2 DUCTWORK LEAKAGE TEST VERIFICATION

A. Installing Contractor will install ductwork as specified in Section 23 30 00 and will perform leakage tests. TAB Contractor shall witness all duct leakage tests.

B. Verify and record that all duct sections have been tested, indicate both successful and unsuccessful tests. Verify sections where resealing and retesting resulted in successful tests. Include date of tests and initials of balancing technician who witnessed tests.

3.3 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Include verification of the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balancing, smoke, and fire dampers are open.
6. Isolating and balancing valves are open, and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 COMMISSIONING

A. Commissioning will be provided by the Commissioning Agent as specified in Section 01 91 13. TAB Contractor shall cooperate and participate in the commissioning work in accordance with the requirements of Section 01 91 13.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB, and otherwise as specified in this Section.

B. Obtain approved submittals for all equipment and devices required for proper system balancing. Balance systems to achieve capacities and flow quantities indicated on drawings and approved submittals. Should there be a conflict between the drawings and submittals, the approved submittal values shall be used.

C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed- control levers, and similar controls and devices, to show final settings.

E. Take and report testing and balancing measurements in the same units, inch-pound (IP) or metric (SI), to match what is shown on Contract Documents.

3.6 BALANCING TOLERANCES

A. Air Balancing:

1. All measured air quantities shall agree with design air quantities within tolerances listed herein or otherwise acceptable to the Architect. The measurements recorded in the TAB Report for the total CFM of all branches, and the grand total shall agree with the measured air volume of the fan, less an air quantity not greater than the specified maximum percentage of leakage.
2. Balance all equipment, air outlets and air intakes in accordance with the air quantities shown on the drawings with permissible tolerances as follows:

a.	Supply, return and exhaust fans		
	1)	Fan serving multiple rooms	-5% to +10%
	2)	Fan serving individual room	±5%
b.	Minimum outside air		-0% to +5%
c.	Terminal Units		
	1)	Terminal unit serving multiple rooms	-5% to +10%
	2)	Terminal unit serving individual room	±5%
d.	Air Outlets		
	1)	Room with multiple outlets	±10%
	2)	Room with individual outlet	±5%

B. Water Balancing: Balance all hydronic equipment, pumps, coils, etc., in accordance with the capacities and flow quantities shown on the drawings within an acceptable tolerance of ±5%.

C. If during progress of the construction or during balancing, the TAB Contractor encounters any condition that will not allow balancing to be performed within the above balancing tolerances, the fact(s) shall be reported immediately to the Architect with recommendations for corrective action. If feasible, report such conditions and recommendations prior to submission of balancing reports. Work shall then proceed in accordance with the response provided by the Architect.

3.7 AIR SYSTEM BALANCING

A. Prepare test reports for all air systems. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Locate start-stop and disconnect switches, electrical interlocks, motor starters, variable frequency motor speed controllers and DDC panels.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check condensate drains for proper connections and functionality. Confirm plenum pressure at trap connection and confirm trap depth and arrangement is in accordance with drawing detail.

G. Check for proper sealing of air-handling unit components.

H. Verify that clean filters have been provided by Installing Contractor. Simulate specified dirty filter condition when balancing.

I. Provide pitot tube test openings with covers as required for taking pressure and velocity readings in ductwork. Install openings and covers of a type and in a manner to insure against leakage. Remove, replace and repair insulation at pitot tube test openings in a neat and workmanlike manner. Where permanent instrument test ports are specified, advise Installing Contractor as to proper location.

J. Measure air quantities in main ducts by pitot tube traverse of the entire cross-sectional area of the duct. Where air measuring stations have been installed, measure air quantities by pitot tube traverse and verify calibration of air measuring station. Do not use air measuring station for balancing purposes. Where necessary for proper balancing, make similar measurements in branch ducts. Determine outlet and inlet air quantities in accordance with outlet and inlet manufacturer's recommendations.

K. Obtain total air quantities by adjustment of fan speeds or adjustment of belts and sheaves. Adjust branch duct air quantities by volume dampers. Permanently mark dampers after air balance is complete.

L. Volume dampers shall be used to balance air quantities at outlets and inlets, providing final adjustments do not produce objectionable drafts or sound levels. Air quantity adjustments using outlet pattern deflectors will not be permitted.

M. Balancing variable air volume (VAV) systems:

1. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set- point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Measure total system airflow. Adjust to within indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units.
3. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets.
4. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow.
5. Balance at design (maximum) airflow and to deliver design minimum outside air at both design maximum and design minimum total airflow. Determine minimum fan speed and system static pressure that will satisfy requirements and advise BAS Contractor accordingly. Retest at simulated partial load conditions, at scheduled minimum airflow.
6. Record the final fan performance data at maximum and minimum flow conditions. Using fan curves obtained from approved submittals, plot maximum and minimum operating conditions on fan curve and include in final report.
7. Test variable frequency drives through full range of Hertz for operating points that cause excessive vibration due to harmonic frequency, and program VFD to prevent operation at those frequencies.

N. Outside Air and Relief Air (Economizer) Damper Setup Procedure:

1. All airflow station calibration should be checked prior to beginning procedure listed below.
2. These procedures should be performed during unoccupied hours, since building temperatures will not be maintained during the adjustment procedure.
3. Disassociate AHU relief air damper control signal from outside air damper and return air damper control signal. Relief air damper shall be modulated to maintain return fan discharge static pressure at setpoint (Relief air damper setpoint to be initially set to
4. +0.20”).
5. De-energize all associated exhaust fans.
6. Index outside air damper to 100% open and return damper to 100% closed.
7. Index all associated AVB boxes to maximum scheduled airflow (This should cause supply fan VFD to index to near maximum design speed).
8. Set supply/return differential setpoint to zero. Replace or adjust the return fan sheave so that at VFD maximum speed the return fan airflow is less than or equal to the scheduled return fan airflow.
9. Set supply/return differential setpoint to scheduled minimum outside air cfm (This should slow down the return air fan VFD). Disable economizer controls and reset outside air and return air dampers to automatic control (outside air damper should be at minimum position and return air damper should be mostly open).
10. Energize all associated building general exhaust fans.
11. Adjust return damper position to maintain 0.10” positive pressure in the return fan discharge ductwork (this should establish maximum return damper and minimum outside air damper positions). Relief damper should be closed, and the outside airflow sensor should now read near

to the supply/return differential setpoint set in 8 above (There will be a difference due to flow sensor inaccuracy at low o/a flow).

12. Complete steps 1 to 10 above for each air handling unit. After completing set-up on all units, check return fan discharge pressure at each unit. The pressure should still be +0.1" at minimum outside airflow.
13. Check building pressurization at front doors, if it seems to take excess pressure to open doors or if there seems to be an in rush of air when doors are opened, increase supply/return differential setpoints for each air handling unit by 5%. (Note: Only perform this step when there is little or no wind outside).
14. Perform step 12 until the building is at a neutral or slightly positive pressure.
15. Index all boxes to minimum scheduled airflow and check building pressurization at front doors (it should be the same as at the end of step 13).
16. Index unit for 100% outside air and check building pressurization at front doors (again it should not change).
17. Return all systems to automatic control and check building pressurization at the front doors (final check that building pressurization is the same as it was after step 13).
18. After final set-up of all units is completed, submit to the owner a report containing:

    a. Final supply/return differential setpoint for each unit.
    b. Description of apparent building pressurization after AHU setup is completed.
    c. One hour trend logs for each unit listing: supply air CFM, return air CFM, outside air CFM (as measured at o/a flow station), and return fan discharge static pressure. These readings shall be taken every 5 minutes for one hour after AHU setup is complete.

O. Air Volume Control Boxes and Air Flow Measuring Stations: Check each terminal unit and air flow measuring station for calibration and adjust as necessary.

1. For Air Volume Control Boxes and Air Flow Measuring Stations with DDC Controls

    a. BAS Contractor will set up and calibrate the mass flow control device to the design contract values.
    b. BAS Contractor will index the system configuration as requested by TAB Contractor.
    c. TAB Contractor shall then test the mass flow output and shall proportionately adjust the distribution. If the mass flow results deviate from the design intent by greater than the nominal ($\pm$5%) amount, TAB Contractor shall provide those values to BAS Contractor for final adjustment.
    d. BAS Contractor will modify the previously mentioned correction factor to cause the controlled value to be consistent with the field measured value.
    e. TAB Contractor shall then retest as required to confirm that such corrections have resulted in values that conform to the specification requirements.

P. Diffuser Pattern Adjustment: Adjust individual outlets under procedures recommended by the manufacturers of the outlets, or as otherwise approved by Architect. Set pattern deflectors at each outlet for the air pattern required. Make changes in air patterns or settings necessary to achieve correct air balance and to minimize drafts. Bring to the attention of the Installing Contractor any air outlets with noticeable rattle caused by loose dampers or pattern adjusters.

3.8 AIR BALANCING DATA

A. Include the following data in the TAB Reports:

1. Air Moving Equipment Data

    a. Fan or Unit No.
    b. Location
    c. Area Served
    d. Manufacturer
    e. Model No. and Serial No.
    f. Rated and Actual Motor Data

        1) HP
        2) Phase
        3) Voltage
        4) Amperage

    g. Design and Actual Air Flow Measurements

        1) Total CFM
        2) Outside air CFM at minimum OA damper setting
        3) Total and external static pressures, in w.g.
        4) Fan suction static pressure, in w.g.
        5) Fan discharge static pressure, in w.g.
        6) Fan RPM

    h. Design and Actual Pressure Drops

        1) Across filter bank
        2) Across each heat transfer coil
        3) Provide complete pressure drop profile across each component in air handling unit

    i. Static pressure controls' identification (by service) and final setpoint.
    j. Evaluate building and room pressure conditions to determine adequate supply and return air proportions.
    k. Fan curves with actual operating conditions indicated.

2. Controllable Speed Fan with Variable Frequency Motor Speed Controller

    a. Establish the maximum speed setpoint by determining the following at maximum design air flow requirements:

        1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.
        2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
        3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.

    b. Establish the minimum speed setpoint by determining the following at minimum design air flow requirements:

        1) Lowest pressure reading at the most remote air controlling device that will satisfy requirements.

2) Supply fan air flow measuring station readings: CFM, velocity pressure, static pressure.
3) Return and/or exhaust fan airflow measuring station readings: CFM, velocity pressure, static pressure.

c. Record the operating conditions of the controllable speed fan system(s) with variable frequency motor speed controller(s) at the time the preceding work is performed, including control settings, damper positions, filter conditions and other pertinent data, to permit duplication of all operating conditions during final calibration of the controllable speed fan variable frequency motor speed controller(s).

d. After final calibration of the fan controller(s) has been performed again duplicate all system operating conditions and repeat the balancing and adjusting work, specified above, to demonstrate the proper operation, control and calibration of each controllable speed fan system variable frequency motor speed controller at both minimum and maximum air flow conditions.

3. Air Flow Measuring Station

a. Fan or unit number
b. Station symbol and location
c. Manufacturer and model number
d. Design and actual velocity
e. Design and actual cfm

4. Duct Velocity Traverse Data

a. Fan or Unit No.
b. Traverse location.
c. Design and actual CFM.
d. Duct dimensions and area.
e. Design and actual average velocity.
f. Duct static pressure at test holes, in. w.g.
g. Traverse measurements in FPM (show grid pattern).

5. Air Volume Control Box Data

a. Unit symbol and location.
b. Manufacturer and model number.
c. Design and actual air velocity.
d. Design and actual CFM.

6. Air Outlet and Inlet Data

a. Identify each outlet or inlet as to location, area and fan or unit system.
b. Manufacturer and model number.
c. Outlet or inlet size, effective area or Ak factor.
d. Design and actual velocity, FPM.
e. Design and actual CFM.

3.9 HYDRONIC SYSTEM BALANCING

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

D. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

E. Set calibrated balancing valves, if installed, at calculated presettings.

F. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

G. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

H. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

I. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

J. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

K. For variable flow systems, open or close sufficient valves to simulate design diversity, if applicable, and coordinate with BAS Contractor for setpoint and setting of all bypass valves.

L. For primary-secondary flow systems, first balance the primary system crossover flow, then balance the secondary system flow.

3.10 HYDRONIC BALANCING DATA

A. Include the following data in the TAB Reports:

1. Pump Data

    a. Identification and location.
    b. Service.
    c. Manufacturer, model and serial number.
    d. Type drive.
    e. RPM.
    f. Rated and Actual Motor Data

        1) HP
        2) Phase
        3) Voltage
        4) Amperage

    g. Discharge and suction pressures and differential pressure (feet).
    h. Design and actual pump head (feet) and GPM.
    i. No flow (discharge valve closed) suction and discharge pressure (feet).

2. Equipment Data (air handling unit, chiller, terminal unit, radiation, coils, etc.)

    a. Identification (symbol) and location.
    b. Service.
    c. Manufacturer and, except for coils and radiation and the like, model and serial number.
    d. Entering and leaving pressures and pressure differential (feet).
    e. Pressure differential across balancing valve (feet)
    f. Design and actual GPM.
    g. Entering and leaving water temperatures.

3. Flow Meter Data

    a. Identification (symbol) and location.
    b. Service.
    c. Type of meter.

d. Manufacturer, model and serial number.
e. Pipe size.
f. Design GPM and meter indication.
g. Actual GPM and meter indication.

3.11 SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed, and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the general room exhaust and return airflow to achieve the indicated pressure or airflow difference. Do not adjust hood exhaust to achieve space pressurization.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under- pressurization and observe and report on the system's ability to revert to the set point.
3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

H. Air Pressurization Report: For areas/rooms requiring pressurization, include in the TAB report a tabulation showing, for each room:

1. Room identification.
2. Design and actual total supply and total return/exhaust air quantity for variable air volume system.

3. Design and actual positive or negative cfm differential for variable air volume system.

3.12 VIBRATION MEASUREMENT OF ROTATING EQUIPMENT

A. Measure, and submit report, vibration displacement for all fans and pumps over 3 hp.

B. Perform vibration measurements after air and water balancing and equipment testing is complete.

C. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.

D. Maximum allowable vertical vibration of rotating equipment is as follows:

Equipment Speed (RPM)	Vibration Displacement (MILS peak to peak)
Under 600	4
600 to 1,000	3
1,000 to 2,000	2
Over 2,000	1

If equipment has an inertia base, allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment plus the inertia base weight.

E. Inspect, measure, and record vibration isolation.

1. Verify that vibration isolation is installed in the required locations.
2. Verify that installation is level and plumb.
3. Verify that isolators are properly anchored.
4. For spring isolators, measure the compressed spring height, the spring OD, and the travel- to-solid distance.
5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.13 VERIFICATION OF CONTROLS AND INSTRUMENTATION

A. The BAS Contractor is responsible to demonstrate the operation of the control system to the TAB Contractor to verify system performance is in accordance with requirements of the specifications.

B. Verify that controllers are properly calibrated.

C. Check transmitter and controller locations and note conditions that would adversely affect control functions.

D. Record controller settings and note variances between set points and actual measurements.

E. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

F. Check free travel and proper operation of control devices such as damper and valve operators.

G. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

H. Check the interaction of electrically operated switch transducers.

I. Check the interaction of interlock and lockout systems.

J. For pneumatic control systems, check main control supply-air pressure and observe compressor and dryer operations.

K. For electric control systems, record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.

L. Note operation of electric actuators using spring return for proper fail-safe operations.

3.14 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report.
11. Number each page in the report.
12. Summary of contents including the following:

a. Indicated versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

13. Nomenclature sheets for each item of equipment.
14. Data for terminal units, including manufacturer, type size, and fittings.
15. Notes to explain why certain final data in the body of reports varies from indicated values.
16. Test conditions for fans and pump performance forms including the following:

a. Settings for outside-, return-, and exhaust-air dampers.
b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Variable speed controller settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air System and Hydronic System Balancing Data:

1. Include all test data required for proper system balance and other test data specified elsewhere in this Section. Include all values, design and actual.
2. Provide all duct traverse readings, including traverse locations marked on drawings.

G. Vibration Measurement Reports:

1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
6. Calculate isolator efficiency using measurements taken.
7. Description of predominant vibration source.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.

c. Application.
d. Dates of use.
e. Dates of calibration.

3.15 INSPECTIONS

A. Periodically visit the site, as appropriate for size of project or as requested by Owner during the installation of the work. At a minimum, visit the site at the following times:

1. After major equipment is set in place and rough-ins are completed.
2. Prior to installation of shaft enclosures.
3. Prior to ceiling installation.

B. Should any potential or developing problems be discovered relating to accessibility, materials, equipment or methods being used in the work, and where such problems may adversely affect the TAB work, immediately report these findings in writing to the Architect with recommendations for correction.

C. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

1. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the setpoint.
2. Walk through the spaces and observe any excessive noise or vibration from the HVAC system.

D. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, perform a final inspection to verify the following:

a. Verify that all balancing devices are marked with final balance position.
b. Verify that all holes in ductwork for pitot-tube traverse have been plugged.
c. Verify that all insulation removed during TAB work has been replaced.
d. Review requirements for follow-up seasonal checks and schedule dates with Owner.

END OF SECTION 01 91 00

SECTION 01 91 13 - COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and other applicable sections, apply to this Section.

1.2 SUMMARY

A. Employment of Commissioning Agent:

1. For the purposes of this specification, a separate contractor hired by the General Contractor will act as the Commissioning Agent. As such, the General Contractor will assume overall responsibility of the commissioning process.

B. The goal of this project is to provide Owner with a higher level of assurance that the systems have been installed in the prescribed manner and will operate within the performance guidelinesThe basis for commissioning will be to provide sufficient documentation of protocols to support validation.

1.3 DEFINITIONS

A. BAS: Building Automation System.

B. Commissioning: The process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent (2007 Guideline 1.1 - HVAC Technical Requirements for the Commissioning Process).

C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

D. TAB: Testing, adjusting, and balancing.

E. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 REFERENCES

A. ASHRAE Guideline 1

B. AABC Commissioning Guideline

C. SMACNA HVAC Systems Commissioning Manual

1.5 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that Commissioning Agent meets the qualifications specified in "Quality Assurance" Article.

B. Document Reviews: Within 45 days of award of contract, submit report of having reviewed all project documents as specified in “Document Reviews” Article.

C. Commissioning Plan: Within 90 days of award of contract, submit Commissioning Plan and procedures. Include system verification checklists and data sheets to be used for each system and each piece of equipment.

D. Verification Checklists: Submit completed commissioning system verification checklists and functional performance test checklists organized and indexed by system and subsystem as one package. The results of failed tests shall be included along with a description of the corrective action taken and subsequent successful retest.

E. Final Report: Provide final Commissioning Report.

1.6 QUALITY ASSURANCE

A. The Commissioning Agent shall submit evidence of having commissioned at least five projects of similar size and scope within the past five years.

B. Forms of checklists shall be similar to sample forms published in either the AABC Commissioning Guideline, SMACNA HVAC Systems Commissioning Manual, or other form approved by Owner and/or Architect.

1.7 RELATED WORK

A. Commissioning is the primary responsibility of the Commissioning Agent, with secondary and support responsibility of the various Contractors as outlined elsewhere in this Section. The commissioning process does not relieve the Contractors from participation in the process or diminish their role and obligations to complete all portions of work in satisfactory and fully operational manner.

1.8 COORDINATION

A. The commissioning process, in order to be successful, requires the cooperation and coordination of all members of the Commissioning Team. The Commissioning Agent will coordinate directly with each Contractor on the project specific to their responsibilities and contractual obligations relative to the commissioning process.

B. Installing Contractor responsible for their Work will provide services described in their respective sections of the specifications.

C. Enlist the aid of Installing Contractor or equipment suppliers, at no cost to Owner, whenever such aid is necessary for the timely and proper performance of the Commissioning work.

D. Cooperate with Installing Contractor to effect smooth coordination of the commissioning activities with the project schedule.

1.9 PARTICIPANTS AND RESPONSIBILITIES

A. Commissioning Team

1. At a minimum, the commissioning team shall consist of representatives of the following:

a. Owner
b. Architect/Engineer
c. General Contractor
d. Commissioning Agent
e. TAB Contractor
f. Mechanical Contractor
g. Plumbing Contractor
h. BAS Contractor
i. Electrical Contractor

2. The Commissioning Agent shall lead the commissioning team and shall be responsible for the overall completion of the commissioning as outlined elsewhere in this section.

B. Commissioning Roles and Responsibilities

1. Owner

a. Develop and commit to the Owner's Program for the facility and its use.
b. Provide written approval, or "sign-off" of basis of design prepared by Architect/Engineer.
c. Assign operations and maintenance personnel and schedule them to participate in the various meetings, training sessions, and observation/inspections as follows:

1) Construction phase coordination meeting.
2) Initial owner training session at initial placement of major equipment.
3) Maintenance orientation and inspection.
4) Piping and ductwork test and flushing verification.
5) Procedures meeting for testing, adjusting and balancing.
6) Owner's training session.
7) Verification demonstrations.
8) Functional performance tests.
9) Final review and acceptance meeting.

d. Review and approve any changes made to design intent after original sign-off.
e. Review and approve Construction Documents prepared by Architect/Engineer.

f. Provide qualified personnel for videotaping and editing of training sessions.
g. Videotape or photograph construction progress.
h. Review and comment on the Commissioning Agent's verification report.
i. Review and accept the Commissioning Agent's Final Commissioning Report.

2. Architect/Engineer

a. Provide documentation of basis of design (Design Intent Document) from the information received from Owner's requirements.
b. Provide Contract Documents outlining system design parameters and revisions to the initial basis of design as necessary, after obtaining approval from owner.
c. Prepare Contract Documents, including Commissioning Specification.
d. Attend construction phase coordination meetings and perform site observations of installation for compliance with the contract documents at periodic intervals during the construction.
e. Review Contractor submittals for compliance with the contract documents.
f. Review TAB procedures submitted by the TAB Contractor.
g. Review system verification checklists and functional performance test procedures submitted by the Commissioning Agent.
h. Review TAB report and verification data sheets by system for conformance to the contract documents.
i. Review and accept final TAB report.

3. General Contractor

a. Include costs for commissioning requirements in the contract price.
b. After reviewing commissioning activities with Commissioning Agent, prepare commissioning schedule in conjunction with Construction Schedule.
c. Coordinate construction of systems and equipment.
d. Ensure that installing contractor's performing all commissioning responsibilities.
e. Process the following to the Commissioning Agent:

1) Shop Drawings
2) As-Built drawings
3) ASME certificates
4) Certification of installation
5) Manufacturer's operating and maintenance instructions
6) Manufacturer's service contracts and warranties.

f. Coordinate the installing contractor's participation in the commissioning process.
g. Instruct installing contractor's to maintain record as-built conditions.
h. Update Commissioning Agent as to progress of construction. Provide notice when systems and/or subsystems are complete and ready for commissioning.
i. As system or major equipment is checked, ensure that proper tagging is affixed to equipment, indicating acceptance or corrective action required. Do not make any changes to systems and/or equipment after acceptance, without prior approval from Commissioning Agent.
j. Any deviations due to construction or for any other reason should be recorded on the affected data sheet for that system or piece of equipment.

4. Commissioning Agent

   a. With the assistance of the General Contractor, organize and lead the Commissioning Team.
   b. Review the Owner's Program.
   c. Review the basis of design (Design Intent Document) prepared by Architect/Engineer.
   d. Review the Contract Documents prepared by the Architect/Engineer.
   e. Prepare a Commissioning Plan, for each type of system/subsystem, for demonstrating, verifying and documenting that the equipment and systems/subsystems installation, operation and functional performance are in accordance with the requirements of Contract Documents.
   f. Update Commissioning Plan as project progresses through its various phases.
   g. Schedule commissioning coordination meetings.
   h. Prepare system verification and functional performance test data sheets for each equipment/system to be commissioned.
   i. Review contractor submittals.
   j. Witness equipment and systems start-up and testing. Ensure that results are documented, including a summary of deficiencies, and included in the Operation and Maintenance Manuals.
   k. Schedule the Operation and Maintenance training sessions with the Contractors and Owner representatives.
   l. Submit system verification checklists and functional performance test procedures for review and acceptance by Owner and/or Architect/Engineer.
   m. Schedule and witness system demonstration of sequence of operation performed by BAS Contractor.
   n. Provide services of an experienced testing technician.
   o. Provide detailed checklists data sheets to document verification tests.
   p. Submit detailed list of test instrumentation with appropriate calibration records to be utilized for verification and functional performance tests. Record data as necessary.
   q. Conduct verification tests.
   r. Conduct functional performance tests, including seasonal variation tests, as required.
   s. Retest as necessary if performance deficiencies are found and corrected.
   t. Prepare Final Commissioning Report. Include Re-commissioning Manual in Final Report.
   u. Recommend acceptance of the equipment and systems to the Owner.

5. TAB Contractor

   a. Include costs for commissioning requirements in the contract price.
   b. Submit TAB procedures for review and acceptance by the Architect/Engineer and Commissioning Agent.
   c. Perform TAB work specified in Section 01 91 00.
   d. Attend commissioning coordination meetings scheduled by the Commissioning Agent.
   e. Participate in training sessions as scheduled by the Commissioning Agent.
   f. Provide notice of the completion of TAB work and submit final TAB report.
   g. Participate in verification tests, which will consist of repeating any selected measurement contained in the TAB report where required by Commissioning Agent.

6. Mechanical Contractor

   a. Include the costs of commissioning requirements in the contract price.
   b. Shall support the Commissioning Agent in the completion of data on system verification checklists.
   c. Process the following to the General Contractor:

      1) Shop drawings
      2) As-built drawings
      3) ASME certificates
      4) Certificate of installation
      5) Manufacturer's operating and maintenance instructions
      6) Manufacturer's service contracts and warranties.

   d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers and the BAS Contractor.
   e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.
   f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.
   g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.
   h. Provide notification a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.
   i. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.
   j. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.
   k. Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup TAB, and task completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.
   l. Attend initial O&M staff training session.
   m. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
   n. Update drawings for as-built condition and review with the commissioning team.
   o. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.

p. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.
q. Provide written notification that the following work has been completed in accordance with the Contract Documents and the equipment, systems and subsystems are operating as required.

1) HVAC equipment including all fans, air handling units, ductwork, dampers, terminals and all Division 23 equipment.
2) Refrigeration equipment, pumping systems and heat rejection equipment.
3) Fire-stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
4) Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.

7. Plumbing Contractor and Fire Protection Contractor

a. Include the costs of commissioning requirements in the contract price.
b. Shall support the Commissioning Agent in the completion of data on system verification checklists.
c. Process the following to the General Contractor:

1) Shop drawings
2) As-built drawings
3) ASME certificates
4) Certificate of installation
5) Manufacturer's operating and maintenance instructions
6) Manufacturer's service contracts and warranties.

d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers.
e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.
f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.
g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.
h. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.
i. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.

j. Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe system testing, flushing and cleaning, and task completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.
k. Attend initial O&M staff training session.
l. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
m. Update drawings for as-built condition and review with the commissioning team.
n. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.
o. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.

8. BAS Contractor

a. Include costs for commissioning requirements in contract price.
b. Support Construction Manager to complete data on checklists.
c. Process the following to the General Contractor:

1) Shop drawings
2) As-built drawings
3) Any approval letters from authorities
4) Provide paid-in-full service contract with cost for second year.

d. Training and instruction of Owner's personnel.
e. Review and confirm in writing that a proper hardware specification exists to permit functional performance testing as required by specification and sequence of operation.
f. Review and confirm in writing that proper safeties and interlocks are included in design.
g. Ensure the proper sizing of control valves and actuators, based on design pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to mechanical engineer.
h. Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to mechanical engineer.
i. Ensure the proper selection of sensor ranges, and include data with submittal to mechanical engineer.
j. Attend commissioning meetings scheduled by the commissioning team or Commissioning Agent.
k. Inspect, check and confirm the proper installation and performance of controls/BAS hardware and software provided by others.
l. Integrate installation and programming scheduling with construction and commissioning schedules.
m. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.
n. In conjunction with the mechanical contractor, demonstrate system performance to the commissioning team including all modes of system operation (e.g., occupied,

unoccupied, emergency) during the functional performance tests. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the commissioning team will stop the functional performance tests.

o. Provide control system technician to assist during system verification and functional performance testing.

p. Provide support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Make available, at no additional cost to the TAB and commissioning agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB and commissioning procedures.

9. Electrical Contractor and Fire Alarm Contractor

a. Include the costs of commissioning requirements in the contract price.

b. Shall support the Commissioning Agent in the completion of data on system verification checklists.

c. Process the following to the General Contractor:

1) Shop drawings
2) As-built drawings
3) Electrical certificates from electrical inspection agency
4) Manufacturer’s certification and warranties of system operation
5) Test reports as required by specifications
6) UL meter label certificates
7) Manufacturer's operating and maintenance instructions.

d. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agency, and with the participation of qualified technicians from major equipment suppliers.

e. Provide notification a minimum of two weeks in advance of scheduled equipment and system startups, so that all parties can be prepare to witness system verifications, and equipment and system startups.

f. Provide sufficient personnel to assist the commissioning as required during system verification and functional performance testing.

g. Prior to startup, inspect, check and confirm the correct and complete installation of all equipment and systems for which system verification checklists are included in the Commissioning Plan. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and recheck until the results are satisfactory and the system is ready for safe startup.

h. Provide equipment and systems startup resources as specified and required. If during an attempted equipment or system startup, deficient or incomplete work is discovered that would preclude safe operation, the startup shall be aborted until corrective action has been taken. Ensure such action is taken and verified before rescheduling a new startup.

i. Carry out performance checks to ensure that all equipment and systems fully functional and ready for the commissioning team to witness formal functional performance tests.

j. Prepare preliminary schedule for electrical system orientation and inspections. O&M manual submission, training sessions, and task completion for use by the

Commissioning Agent. Update schedule as appropriate throughout the construction period.

k. Attend initial O&M staff training session.
l. Conduct electrical system orientation and inspection at the equipment placement completion stage.
m. Update drawings for as-built condition and review with the commissioning team.
n. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification.
o. Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the Commissioning Agent.

1.10 SYSTEMS TO BE COMMISSIONED

A. The following Mechanical/HVAC systems are to be commissioned:

1. Air handling units and associated return fans
2. Fan Coil Units, Terminal VAV boxes and Phoenix valves
3. Exhaust fans
4. Chiller equipment and pumps
5. Boiler equipment and pumps
6. Building Automation System.

B. The following Mechanical/Plumbing systems are to be commissioned:

1. Domestic water supply pumps
2. Domestic hot water heaters
3. Sump pumps.

C. The following Electrical systems are to be commissioned:

1. Lighting control systems including daylight dimming controls
2. Emergency Generator
3. Uninterruptible Power Supply (UPS) systems
4. Manual and automatic transfer switches.

D. The following Fire/Life Safety systems are to be commissioned:

1. Fire alarm system
2. Fire sprinkler system.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DOCUMENT REVIEWS

A. Owner’s Program

1. Obtain and review the Owner's program requirements document.

B. Basis of Design (Design Intent Document)

1. Obtain and review the basis of design document prepared by the Architect/Engineer.
2. Compare scope of work identified in the basis of design to Owner's program requirements. Prepare written statement whether basis of design meets the intent of the Owner's program. Clearly note any significant deviations.

C. Contract Documents

1. Obtain and review latest submission of all Contract Documents including Addenda and Bulletins.
2. Compare scope of work identified on Contract Documents to basis of design. Prepare written statement whether the Contract Documents meet the intent of the basis of design. Clearly note any significant deviations.
3. Review documents for any specific condition or layout that will prevent commissioning from being completed, such as equipment accessibility and maintainability, installation clearances and available space, and coordination of other trades. Notify Architect/Engineer of such instances in a timely manner.
4. When Commissioning Agent is retained prior to issuance of final Contract Documents, review preliminary Contract Documents issued for progress review as outlined above.

D. Contractor Submittals

1. Obtain and review all submittal drawings, specifications and equipment vendor submittals for any deviations from design intent, either as shown on Contract Documents and/or basis of design documents. Notify Architect/Engineer of any potential deviations from design intent.
2. Review all drawings, specifications and equipment vendor submittals for any conflicts or design details that will hinder or prevent the systems from being balanced, commissioned and maintained. Notify Architect/Engineer of any problem areas of concern.

3.2 COMMISSIONING PLAN

A. Prepare a Commissioning Plan (or Agenda) that details the entire commissioning process. The plan shall include as a minimum:

1. Project Overview, Goals and Objectives
2. Systems to be commissioned
3. Definitions
4. A roster of the Commissioning Team with contact information
5. Roles and Responsibilities
6. Procedures for project communication
7. Commissioning process
8. Preliminary commissioning schedule.

3.3 SYSTEM VERIFICATION CHECKLISTS

A. Prepare detailed installation and functional performance criteria checklists for each type of equipment and for each type of system/subsystem. Provide individual data sheet for each piece of tagged equipment.

B. Data sheets and checklists shall be in tabular format with columns and rows to be filled in by the Commissioning Agent for: Project identification, equipment or system/subsystem identification, installation checklist and functional performance test checklist. Form of data sheets and checklists to be similar to sample forms included in the AABC Commissioning Guideline, SMACNA HVAC Systems Commissioning Manual, or other as approved by Owner and/or Architect/Engineer.

3.4 PRE-COMMISSIONING ACTIVITIES

A. After final review of the Commissioning Plan and system verification checklists, schedule a pre-commissioning meeting not less than 90 days prior to scheduled start of commissioning work for a detailed review of the Commissioning Plan with all participants in the commissioning process.

B. Equipment and systems are expected to be in full compliance with the design intent by the start of the commissioning phase. Do not proceed with the commissioning work for any specific piece of equipment/system/subsystem until notified by the installing contractor that such piece of equipment/system/subsystem is ready for commissioning.

C. Presence of obviously incomplete work shall be reported to the installing contractor and commissioning shall not proceed until the installation is complete. Equipment exhibiting problems during functional performance testing relating to lack of completion or noncompliance with the design intent shall require re-commissioning at the expense of the installing contractor.

D. Complete operational readiness of the heating, ventilating and air-conditioning system also requires that the following be accomplished:

1. Cleaning, flushing and chemical treatment of piping, ductwork and all system equipment has been carried out in accordance with the requirements of the specifications. Reports shall be submitted, and reviewed and accepted before this process is considered complete.
2. Pressure testing of piping and all supply, return and exhaust ductwork has been carried out. Reports shall be submitted, and reviewed and accepted before this process is considered complete. Complete test reports prior to initial start-up.

E. Testing, adjusting and balancing work must be performed prior to commissioning. Operational tests should also be conducted on equipment, duct, piping and control systems to verify that pressures and flow rates meet design requirements.

F. Building Automation System controls testing and calibration should begin concurrent with, and completed subsequent to, the testing, adjusting and balancing work. Commissioning Agent shall observe and verify all start-up and calibration activities as part of the ongoing commissioning process.

3.5 COMMISSIONING ACTIVITIES

A. Implement Commissioning Plan in conjunction with the installing contractors, and in the presence of an authorized representative of the Owner. Conduct system verification checks and functional performance tests by filling out the data requested using the approved checklists.

B. As a minimum, perform the following for each piece of equipment and each system/subsystem:

1. Document and verify that each piece of equipment and that each system has been properly installed in accordance with the Contract Documents and manufacturer's written installation instructions.
2. Document and verify that piping systems have been properly connected to each piece of equipment and have been properly tested and cleaned in accordance with the requirements of the Contract Documents.
3. Document and verify that duct systems have been properly connected to each piece of equipment and air delivery/exhaust/return device and have been properly tested and cleaned in accordance with the requirements of the Contract Documents.
4. Document and verify that Electrical work for equipment and systems to be commissioned has been properly installed and tested in accordance with the requirements of the Contract Documents.
5. Document and verify that each piece of equipment has been placed into operation in accordance with manufacturer's written installation instructions.
6. Document and verify that adjusting, balancing and system testing has been properly done in accordance with requirements of this section prior to functional performance testing. Make on-the-spot checks as deemed appropriate during functional performance testing.
7. Document that operation and maintenance instructions and submittal data have been provided in accordance with the requirements of the Contract Documents.
8. Document and verify that applicable code authority inspections and approvals and all construction certificates have been provided in accordance with the requirements of the Contract Documents.
9. Document and verify the functional performance testing of each piece of equipment and each system and subsystem. Document controls and instrumentation as specified hereinafter.
10. Document warranty start and end dates.

C. Documentation of Controls and Instrumentation

1. Document and verify that the controls and instrumentation work has been properly installed and tested and is performing in accordance with the requirements of the Contract Documents.
2. Functional performance testing shall be accomplished for each control device. Actuators shall be stroked for complete length of travel. All relays and adapters shall be checked for proper operation. Controllers shall be checked for proper action. All system interlocks, interconnections, smoke damper and safety devices shall be checked for proper function.
3. All control settings shall be verified by comparing actual input and output measured values to calculated values.

D. Owner Training Sessions

1. The Commissioning Agent shall facilitate all owner-training sessions. These sessions shall cover the operation and maintenance of each piece of equipment and system. Each contractor shall provide the training for his or her area of responsibility. The entire program shall be videotaped for future use by owner.

E. Seasonal Functional Performance Tests

1. The Commissioning Team shall provide an off-season functional performance tests for all HVAC systems. The intent of this test shall cover the ability of the system to maintain performance during the opposite season from the original commissioning season. The Commissioning Agent shall prepare a seasonal commissioning test report.

3.6 FINAL COMMISSIONING REPORT

A. A Commissioning Report must be prepared and presented to the Owner after all testing and system demonstration is complete.

B. The Commissioning Report must include the following, as a minimum:

1. Certification that building systems meet the design intent.
2. Certification that building systems meet the Contract Documents.
3. Completed system verification checklists ensuring proper installation.
4. Completed functional performance tests checklists ensuring proper operation.
5. Operation and maintenance (O&M) documentation.
6. Verification that Owner has received proper operator training.

C. The Final Commissioning Report shall be 8 ½ by 11 formats; contained in a hard cover, three ring binder(s), separated into sub-divided sections each tabbed and indexed in a table of contents. Drawings larger than 8 ½ by 11 shall be folded and inserted into clear plastic protective folders with drawing content clearly visible, single protective folder for each drawing. Drawing label shall be affixed to protective folder in order to reserve proper placement in the binder. Include the following:

1. Cover sheet.
2. Table of Contents.
3. Project Description.
4. Project Team Contact Information.
5. Basis of Design document.
6. Copy of Commissioning Specification.
7. Commissioning Plan.
8. Copy of Building Automation System Sequences of Operation.
9. Latest approved BAS shop drawings.
10. Listing of all approvals, inspections, certification required by local authorities having jurisdiction including copies of all letters, affidavits, certificates, etc.
11. Meeting minutes from commissioning meetings.
12. Commissioning Schedule.
13. Specification and calibration certificates for all equipment being used during commissioning.
14. Relevant certificates relating to work items such as pressure testing, system flushing, etc.

15. All equipment start-up and test certificates.
16. Shop drawing submittal cut sheets for each item in the system.
17. Startup Plan.
18. Record of system deficiencies and record of correction and acceptance of noted deficiencies.
19. Final version of functional performance test procedures.
20. Completed commissioning checklists.
21. Letters of certification from all members of the Commissioning Team that all systems have been properly commissioned otherwise giving clear definition of any deferred commissioning and deviation from Final Commissioning Plan.
22. Re-commissioning Plan.
23. O&M Manuals (Can be an appendix to the Final Commissioning Report).

END OF SECTION 01 91 13

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Sections include the following:

1. Division 01 Section "Summary" for use of premises and Owner-occupancy requirements.
2. Division 01 Section "Photographic Documentation" for preconstruction photographs taken before selective demolition operations.
3. Division 01 Section “Execution” for cutting and patching procedures.
4. Division 01 Section “Temporary Facilities and Controls” for disposal of non-hazardous demolition wastes.
5. Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of non-hazardous demolition wastes and for removal and storage of refrigerant.
6. Division 22 Sections for demolishing or relocating site plumbing items.
7. Division 26 Sections for demolishing or relocating site electrical items.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver them to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare them for reuse, and reinstall them where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

F. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PRE-DEMOLITION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For demolition firm.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

D. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.

6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
7. Means of protection for items to remain and items in path of waste removal from building.

E. Certificates

1. Permits and notices authorizing demolition.
2. Certificates of severance of utility services.
3. Permit for transport and disposal of debris.

F. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before Work begins.

G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1. Comply with submittal requirements in Division 01 Section "Construction Waste Management and Disposal."

H. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

I. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT DOCUMENTS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. Existing Warranties: Provide documentation at project closeout that existing warranties have been inspected as required and the warranty is still in effect.

1.8 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, Owner will remove the following items:

a. All items and equipment that will be reused elsewhere.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

E. Hazardous Material Removal: The responsibility to remove construction demolitions containing hazmats is defined as follows:

1. Materials to be removed by the Owner include:

a. PCBs
b. Mold growth in existing structures.
c. Asbestos and crystalline silica.
d. Radioactive materials and radon gas.
e. Explosives and existing containerized combustible materials, including paints.

2. Materials to be removed by the Contractor include:

a. Fluorescent tubes.
b. Halide lamps.
c. Mold growth in new construction.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

G. Protection of Existing Utilities: “Call Before You Dig.” Contractor shall call 811 at least three days prior to any excavation work.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.11 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, preconstruction video and templates.

1. Comply with requirements specified in Division 01 Section "Photographic Documentation."

F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

G. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."

C. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

D. Remove temporary barricades and protections where hazards no longer exist.

E. Erect weatherproof closures for exterior openings. Maintain exit requirements.

F. Erect and maintain dustproof and fireproof partitions as required to prevent spread of dust, fumes and smoke to other parts of the building. On completion, remove partitions and repair damaged surfaces to match adjacent surfaces.

G. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warming signs.

H. Remove temporary barricades and protections where hazards no longer exist.

I. Protection of Existing Utilities: “Call Before You Dig.” Contractor shall call 811 at least three days prior to any excavation work.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations.
5. Maintain fire watch during and after flame cutting operations per the requirements of the Owner, of NFPA 51B and NFPA 241, of the authority having jurisdiction or as established by local ordinance, whichever is more restrictive.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers. Remove all underlayments and leveling materials to structural slab. Scarify concrete as required to remove all adhesive residue and prepare concrete for new underlayments, leveling materials or adhesive as may be required.

F. Roofing: Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Refer to Division 07 Roofing Sections for new roofing requirements.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."

B. Burning: Burning of demolished materials on site will not be permitted.

C. Burning: Burning of demolished materials will be permitted.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including the following:

1. Cast-in-place concrete including mixture design, supplying, placing, consolidating, finishing, and curing.
2. Steel reinforcing complete with required supports, spacers, and related accessories.
3. Formwork and formwork design complete with required shoring, reshoring, bracing, and anchorage.
4. Accessories including dovetail anchor slots, waterstops, reglets, expansion joint fillers, and preformed construction joints.
5. Vapor retarders.
6. Execution for items furnished under other sections, such as anchor rods, leveling plates, bearing plates, and embedded plates, precast concrete connections, anchors for attaching other materials, sleeves, and inserts.
7. Concrete repairs.
8. Certified surveys of concrete frame formwork, anchor bolts and bearing plates.

B. Related Sections include the following:

1. Division 04 Section "Unit Masonry" for masonry reinforcement and accessories to be cast-in concrete.
2. Division 05 Section "Structural Steel Framing" for anchor rods and other items to be cast-in concrete.
3. Division 05 Section "Steel Decking".
4. Division 05 Section "Metal Fabrications".
5. Division 05 Section "Metal Stairs and Railings".
6. Division 07 Section "Joint Sealants".
7. Division 09 sections for coordination with floor finish substrate requirements.
8. Division 23, Mechanical items to be cast-in concrete; concrete foundations, and housekeeping pads for equipment.
9. Division 26, Electrical items to be cast-in concrete; concrete foundations, and housekeeping pads for equipment.
10. Division 31 Section "Earth Moving"

1.3 REFERENCES

A. General.

1. Except where local building code is more stringent or where expressly stated differently in the Contract Documents, the following standards form a part of this Specification.
2. Keep copies of ACI publications at the job site at all times.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one of the following: blended hydraulic cement, fly ash, or ground granulated blast-furnace slag; subject to compliance with requirements.

1.5 ACTION SUBMITTALS

A. Product Data and Material Certificates: For each type of product indicated. Include a letter signed by the manufacturer certifying that their product(s) meets the requirements of the Contract Documents and that all materials used in combination with other products produced by that manufacturer, or other manufactures are compatible with one another.

1. Cementitious materials.
2. Admixtures: Certification of compliance with the specified requirements, including, that admixtures do not contain calcium chloride or thyrocyanates and that admixtures are compatible with each other must be included in the mix design.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds: In addition to certification of compliance with the Contract Documents submit written certification signed by the finish and adhesive/setting material manufacturer, that the proposed Curing Compound will not have a detrimental effect on the bond of the finish to the concrete or otherwise damage the finish.
7. Floor and slab treatments.
8. Bonding agents
9. Adhesives.
10. Vapor retarders.
11. Semirigid joint filler.
12. Joint-filler strips.
13. Repair materials.

B. Design Mixes

1. For each concrete mixture proposed for use in the Project.
2. Alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
3. Complete and submit the "Concrete Mix Design Form" attached at the end of this section with each design mix. Provide copies to Architect and the Owner's Testing and Inspection Agency for review.

4. Design mixes shall be accompanied by each manufacturer's or producer's certification or test report indicating components of the mix comply with these specifications. Tests shall have been conducted within 90 days of submittal of the design mix.
5. Design mixes shall be accompanied by historical laboratory compressive strength test data or trial mix data, demonstrating that the performances of the proposed mixes are in conformance with the requirements of this specification. All data submitted must comply with section 5.3.3 in ACI 318.

C. Shop Drawings

1. Steel Reinforcement Shop Drawings.

a. Detail fabrication, bending, and placement. Indicate bar and wire fabric sizes, spacings, locations lengths, material, grade, bar schedules, bent bar diagrams, bar arrangement, splices and laps, stirrup spacing, tie spacing, and supports for concrete reinforcement.
b. Cloud, bubble, or otherwise highlight and identify all revisions on the drawings. Submittals which do not identify changes and revisions will be returned as "Not Reviewed". Do not renumber drawings that have already been submitted. Drawings that have been renumbered will be rejected. Refer to specification section 01 33 00 for more information.

2. Sleeves and Openings Shop Drawings.

a. Drawings indicating the size and dimensioned location of all sleeves and openings through structural members that are required by mechanical, electrical, plumbing, or other trades.
b. Provide one coordinated drawing for each floor or wall showing the penetrations requested by all trades.

3. Construction and Contraction Joints Shop Drawings: Drawings showing location of all construction, expansion, and contraction joints.

D. Samples

1. Waterstops.
2. Vapor retarders.

1.6 INFORMATIONAL SUBMITTALS

A. Welding Certificates.

B. Qualification Data.

1. Concrete Supplier.

a. Evidence that the plant has regular inspection of scales, gauges and other instruments at the maximum interval of 3 months for the past two years.
b. Copy of the Certificate of Conformance issued by the National Ready Mix Concrete Association (NRMCA) showing the plant currently meets the

requirements of NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

2. Installer.

a. Certification that all personnel working on the Project are qualified according as ACI-certified Flatwork Technicians and Finishers and the Project Supervisor is an ACI-certified Flatwork Technician.

C. Material Test Reports: For the following from a qualified testing agency indicating compliance with the requirements:

1. Aggregates, include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity (ASR).

D. Field Quality Control Reports

1. Surveys performed and certified by a registered Surveyor as follows:

a. Floor surface flatness and levelness after concrete placement.
b. Anchor rods.

2. Field quality control testing and inspection reports.
3. Provide certification of ADA slip resistance compliance for all walking surfaces along with test data from an independent testing laboratory in accordance with ANSI A137.1 (B101.3/BOT-3000 test). Test shall be performed on the completed installed floor surface.

1.7 QUALITY ASSURANCE

A. Concrete Supplier Qualifications: A firm experienced in ready-mixed concrete that complies with ASTM C94/C94M requirements for production facilities and equipment. Supplier shall be certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site

1. Notify the Owner and Architect at least seven business days before the conference.
2. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.

3. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, vapor retarders installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
4. Prepare and distribute official preinstallation conference minutes to all attendees and other appropriate parties.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Deliver reinforcement to job site bearing identification tag listing piece mark, size of bar and grade of steel.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.9 ADA COMPLIANCE

A. All exposed concrete slabs and floors shall be in accordance with OSHA requirements for slip resistance, COF of .6 for level; and .8 for ramped surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 CEMENTITIOUS MATERIALS

A. General: Use cementitious materials, of the same type, brand, and source throughout the Project.

B. Cement

1. Portland Cement: ASTM C150, Type V for all concrete to be used in contact with soils, Type I, II, or I/II for concrete not in contact with site soils.

C. Supplementary Cementitious Materials

1. Ground Granulated Blast Furnace Slag (GGBFS): ASTM C989, Grade 120.
2. Fly Ash: ASTM C618, Class F.

2.3 AGGREGATES

A. General: Store fine and coarse aggregates separately off ground on wooden platforms in such manner as to maintain segregation of size and avoid inclusion of dirt and other foreign materials.

B. Normal Weight Aggregate: ASTM C33, class 3M or better, well graded within prescribed limits. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Coarse aggregate size: Maximum as indicated nominal.
2. Fine aggregate: Free of materials that will have a harmful reaction with the alkali in the cement.

C. Lightweight Aggregate: ASTM C330, 3/4 inch nominal maximum aggregate size.

2.4 WATER

A. ASTM C94/ C94M. Clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. Water shall be potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

1. Available Manufacturers.

a. Euclid Chemical Company.
b. Grace Construction Products, W.R. Grace & Co.
c. Master Builders Solutions.
d. Sika Corporation.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride or thyrocyanates.

1. Available Manufacturers.

a. Euclid Chemical Company
b. Grace Construction Products, W.R. Grace & Co.
c. Master Builders Solutions
d. Sika Chemical Corporation

2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Accelerating Admixture: ASTM C494/C494M, Type C. Long-term test data shall confirm admixture does not have a corrosive effect on metal deck and reinforcing steel.
5. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
6. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
7. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
8. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
9. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.6 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Mix proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39.

a. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use on the project.
b. Laboratory trial mixtures shall be proportioned with the maximum permitted slump and air content.

3. Prepare alternate design mixes when the characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

B. Cementitious Materials:

1. Cement replacement: Total cementitious material in all concrete mixes shall be comprised of portland cement and other pozzolans as recommended by the concrete mix designer for each mix. Maximum cement replacement and pozzolan percentages shall be in accordance with ACI limitations.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement at all concrete elements.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing or high-range water-reducing admixture in concrete.
2. Use high range water-reducing admixture in pumped concrete, architectural concrete, concrete for heavy-use industrial slabs, parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

2.7 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Interior Footings and Pedestals: Proportion normal-weight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.

B. Exterior Footings and Pedestals: Proportion normal-weight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.

C. Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.

D. Interior Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.
2. Air Content:

a. Do not allow air content of troweled finished floors to exceed 3 percent.

E. Exterior Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.

F. Slabs on Metal Deck: Proportion structural lightweight concrete mixture as follows:

1. Refer to Concrete Mix table on Structural General Notes drawing.
2. Air Dry Unit Weight: 110 lb/cu. ft. plus or minus 3 lb/cu. ft. as determined by ASTM C567.
3. Air Content:

   a. 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch.
   b. 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch or less.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and furnish batch ticket information.

1. When air temperature is between 85 and 90° F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90° F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

2.9 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed, where reinforcement is shown to be welded.

C. Epoxy-Coated Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed bars, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

D. Plain-Steel Welded Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

B. Seismic Criteria

1. Detail project in accordance with the seismic provisions of the 2021 International Building Code for the Seismic Design Category indicated.

2.11 REINFORCING ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Diamond or Plate Dowels: ASTM A36 steel plate

C. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, ASTM A775/A775M epoxy coated.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-tipped steel wire or CRSI Class 2, Type A steel wire bar supports with stainless-steel tips.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. Bar supports shall be manufactured from at least 80% recycled material.

F. Mechanical Splices: Positive locking, taper threaded type coupler manufactured from high quality steel. The bar ends must be taper threaded using the manufacturer's requirements. Develop in tension or compression, as required, at least 125 percent of specified yield strength F_y of the bar.

2.12 FORM MATERIALS

A. Smooth Formed Finish: Panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Exterior-grade plywood panels, suitable for use as concrete forms, complying with DOC PS 1, minimum 5/8 inch thick and as follows:

a. Structural 1, B-B or better; mill oiled and edge sealed.

2. Metal.

B. Rough-Formed Finish: Plywood, lumber, metal, or another approved material suitable for use as concrete forms.

C. Forms for Cylindrical Members: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Formulate form-release agent with rust inhibitor for steel form-facing materials.

1. Available Products.

a. Euclid Chemical Company; Formshield Pure or Formshield WB.
b. Nox-Crete Company; Nox-Crete or Nox-Crete PCE.

G. Form Ties: Metal or glass-fiber-reinforced plastic adjustable in length, free of devices that will leave a hole or depression larger than 1 inch in diameter on exposed surface of concrete, and such that when forms are removed, no metal shall be within 1 inch of finished surface. Appearance as acceptable to Architect.

2.13 EXPANSION JOINTS

A. Expansion joint filler strips at interior and exterior joints shall consist of preformed strips of a durable, elastic sponge rubber compound, using synthetic rubber or natural rubber as a base and containing no reclaim rubber. Filler strips shall be gray in color and shall conform to requirements of ASTM D1752, Type I.

B. Filler strips shall be of sizes indicated.

2.14 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Available Products.

a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
b. Concrete Sealants Inc.; Conseal CS-231.
c. Greenstreak; Swellstop.

2.15 VAPOR RETARDERS

A. Plastic Vapor Retarders: ASTM E1745, Class A, not less than 15 mil thick with permeance of less than 0.01 perms. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Available Products.

    a. Raven Industries Inc.; Vapor Block 15
    b. Reef Industries, Inc.; Griffolyn 15 Mil Green
    c. Stego Industries, LLC; Stego Wrap, 15 Mil
    d. Poly-America, L.P.; Husky Yellow Guard, 15 Mil

2.16 FLOOR AND SLAB TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products.

    a. Conspec by Dayton Superior; Intraseal
    b. Dayton Superior Corporation; Day-Chem Sure Hard
    c. Euclid Chemical Company; Euco Diamond Hard
    d. Nox-Crete Products Group, Duranox

2.17 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Available Products.

    a. Conspec by Dayton Superior Company; Aquafilm
    b. Master Builders Solutions; MasterKure ER50
    c. Euclid Chemical Company; Eucobar
    d. Sika Corporation, Inc.; SikaFilm

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating, complying with New Jersey and California VOC emission limits.

1. Available Products.

    a. Conspec Marketing by Dayton Superior; W.B. Resin Cure
    b. Euclid Chemical Company; Kurez DR VOX

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A, complying with New Jersey and California VOC emission limits.

1. Available Products.

    a. Conspec by Dayton Superior; Sealcure 1315 WB
    b. Master Builders Solutions; MasterKure 1315 WB
    c. Euclid Chemical Company; Super Diamond Clear VOX

2.18 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.0217 inch thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Nonshrink Grout (premixed)

1. Minimum compressive strength of 6,000 psi at 28 days.
2. Nonmetallic, Shrinkage-Resistant Grout: For general use. ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

    a. Available Products.

        1) Euclid Chemical Co.; NS Grout
        2) Master Builders Solutions; MasterFlow 713.

C. Adhesive, Post installed anchors and reinforcing dowels: Epoxy as manufactured by Hilti, Inc. Type of epoxy and method of application shall be as recommended by the manufacturer and reviewed by the Architect.

2.19 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.

B. Repair Topping: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

C. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color.

1. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.

PART 3 - EXECUTION

3.1 GENERAL

A. Install concrete work in accordance with ACI 301 except as amended by this Section.

3.2 FIELD QUALITY CONTROL

A. General:

1. Owner will engage a special inspector and qualified Testing and Inspecting Agency to perform field tests and inspections and prepare test reports.
2. Cooperate with Testing and Inspection Agency in supplying materials and means of access to permit testing and inspection of concrete work.
3. Provide an adequate storage box with a minimum/maximum reading thermometer for initial field curing of concrete specimens.
4. Notify Inspection and Testing Agency a minimum of 48 hours in advance of the work being completed and ready for the required tests and inspections.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Sampling and testing of fresh concrete.
6. Concrete placement, including conveying and depositing.
7. Curing procedures and maintenance of curing temperature.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd., or fraction thereof of each concrete mixture placed each day. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing

shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231, pressure method, for normal-weight concrete; ASTM C173/C173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F. and below and when 80 deg F. and above, and one test for each composite sample.
5. Unit Weight: ASTM C567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C31/C31M. Cast five sets of two standard cylinders for each composite sample.

    a. Laboratory cure three sets of two standard cylinder specimens.
    b. Field cure two sets of two standard cylinder specimens.

        1) Remove test specimens from molds at end of 24 hours and store in structure as near point of placement as possible; maintain conditions similar to those portions of structure that they represent.
        2) Do not remove from structure for transmittal to laboratory prior to expiration of three-fourths of proposed period before removal of forms.

7. Compressive-Strength Tests: ASTM C39/C39M

    a. Test laboratory-cured specimens as follows:

        1) One set of two specimens at 7 days.
        2) One set of two specimens at 28 days.
        3) Hold one set of two specimens in reserve. Test when directed by the Architect.

    b. Test field-cured specimens as follows:

        1) One set of two specimens at an age determined by the Contractor for form stripping, but not later than 7 days.
        2) One set of two specimens at 28 days.

    c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength

and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete as directed by Architect when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met; and when Work is repaired or replaced. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect. Additional testing and inspecting shall be performed at the Contractor's expense.
13. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

D. Surveys: Obtain surveys prepared by a Surveyor registered in the State of Nevada.

1. Measure floor and slab flatness and levelness according to ASTM E1155 (ASTM E1155M) within 24 hours of finishing.
2. Upon completion of setting anchor rods determine the following:

    a. Location and elevation of anchor rods.

3.3 FORMWORK

A. Construction

1. Construct forms, complete with centering, cores and molds, to conform to shape, form, line and grade required, and to maintain sufficiently rigid to prevent deformation under load, within tolerances specified in ACI 117.
2. Construct forms tight enough to prevent loss of concrete mortar. The bottoms of forms shall be tight against previously placed, hardened concrete.
3. Coat bolts and nuts used for temporary internal ties with grease and arrange so that when forms are removed metal will be not less than 1 inch from any concrete surface.
4. Chamfer exterior corners and edges of permanently exposed concrete.
5. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
6. Use individual sills for shores supported on grade or fill to allow individual adjusting.
7. If adequate foundation for shores cannot be secured, provide trussed supports.
8. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

9. Install keyways, reglets, recesses, and the like, for easy removal.
10. Do not use rust-stained steel form-facing material.
11. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
12. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
13. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
14. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
15. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.4 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F. for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

B. In no case shall supporting forms or shoring be removed until members have acquired sufficient strength to support safely their weight and load thereon, including construction and shoring loads. Exercise care to ensure that structure is not subjected to heavy construction or material loading.

C. Loosen tie-rod clamps that are to be entirely removed from wall 24 hours after concrete pour.

D. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Withdraw nails from lumber once used in forms. Apply new form-release agent.

E. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

F. Except in freezing weather, wet forms with water in advance of placing concrete so that joints will tighten to prevent seepage of cement grout from mix.

3.5 STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Minimum concrete cover over reinforcing shall be as indicated, but not less than the requirements of ACI 318 (ACI 318M).

C. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

D. Reinforcement reduced in section shall not be used.

E. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain true alignment and minimum concrete cover. Do not tack weld crossing reinforcing bars.

F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

G. Place additional reinforcing around all openings with an area greater than one square foot as indicated on the Drawings.

H. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets to provide a full tension splice conforming to ACI 318 (ACI 318M). Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

I. Lap splice reinforcing bars as indicated and in accordance with ACI 318 (ACI 318M).

J. Welding of reinforcing bars is not permitted unless specifically indicated on the Drawings. Where required, welded reinforcing shall conform to ASTM A706 and welding shall be performed in accordance with AWS D1.4.

K. If reinforcement is not shown, provide as shown in similar cases, but not less than #4 @ 12 inches (#13 @ 300 each way in each face or minimum temperature steel in accordance with ACI 318 (ACI 318M), whichever is greater.

3.6 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded so they are straight, level, and plumb.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.7 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

2. Turn film up vertical surfaces a distance equal to the slab thickness. Tape edges of vapor retarders continuously to foundation walls.
3. Tape seal penetrations through vapor retarders.

3.8 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Do not displace reinforcing. Install in longest lengths practicable.

3.9 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Expansion and Isolation Joints in Slabs-on-Grade

1. Install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

    a. Joints shall be 1/2 inch wide, unless otherwise shown on the Drawings.

2. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
3. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section Joint Sealants, are indicated.
4. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
5. Finish edges of concrete slabs along joints neatly with a slightly rounded edging tool.
6. In no case shall reinforcement, corner protection angles, or other fixed items embedded in or bonded to concrete, be continuous through an expansion or isolation joint.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Coordinate location of slab-on-grade contraction joints with the location of joints in the floor finish.
2. The maximum dimension of a slab-on-grade panel without contraction joints shall be 15 feet in each direction.
3. Contraction joints shall be installed saw cut, within 12 hours after the pour is completed

    a. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
2. Coordinate location of slab-on-grade construction joints with the location of joints in the floor finish.
3. Form keyed joints as indicated. Unless noted otherwise, embed keys at least 1-1/2 inches into concrete.
4. Locate joints for continuous foundations, grade beams, framed beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of deepest, slab, beam, or girder framing thereto and at the top of footings or floor slabs.
6. Space vertical joints in walls no greater than 40 feet apart. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Space construction joints in floor framing, supported slabs, beams, and girders no greater than 80 feet apart.
8. Each concrete placement for slab-on-grade shall not exceed 8,000 sq. ft. with a maximum distance between construction joints of 90 feet. Allow a minimum of 48 hours between adjacent concrete placements.
9. Fill all joints with sealant.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.10 PREPARATION FOR PLACING CONCRETE

A. Remove water from excavations before depositing concrete. Divert flow of water through proper side drains without washing over freshly deposited concrete.

B. Remove hardened concrete, debris and foreign matter from interior of forms and from inner surfaces of mixing and conveying equipment.

C. Ensure forms, reinforcement, and joints are not disturbed during concrete placement.

D. Use clean compressed air to remove foreign matter from the forms.

E. Remove freestanding water, ice and snow from within forms.

F. Provide runways, or other means for wheeled equipment or convey the concrete to point of deposit.

1. Do not wheel equipment used to deposit concrete over reinforcement.
2. Do not support runways on reinforcement.

G. Do not use deicing salts.

H. Before depositing new concrete on or against concrete that has set, thoroughly roughen and clean existing surfaces free of laitance, foreign matter, and loose particles. Retighten forms.

I. In locations where new concrete is doweled to existing concrete, drill holes in existing concrete, insert steel dowels and pack solidly with epoxy adhesive.

J. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

3.11 PLACING CONCRETE

A. Do not add water to concrete during delivery, after adding high-range water-reducing admixtures, at Project site, or during placement.

B. Place concrete in the forms within the time limits specified in Part 2, Concrete Mixing.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated.

1. Deposit concrete to avoid segregation.
2. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
3. Do not splash forms or reinforcement of adjacent areas with concrete at the time of pouring. Deposit concrete in forms as nearly as practicable in final position.
4. Where pumping of concrete is employed for placement, provide the proper size equipment for the operation, including any backup equipment.

D. Free fall shall not exceed 10 feet for concrete containing the High Range Water Reducing Admixture or 5 feet for other concrete, unless noted otherwise. Not more than 8 feet and 3 feet respectively for exposed concrete work. Where greater drops are required, employ a trunk, tremie or other means in accordance with ACI standards to reduce the free fall.

E. Do not pump lightweight concrete when the temperature is below 40^{o} F.

F. Consolidate placed concrete with internal mechanical vibrating equipment according to ACI 301.

1. Do not use form vibrators.
2. Maintain at least one spare vibrator as a relief.
3. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in concrete.
4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

G. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

H. Allow at least 24 hours to elapse between beginning concrete placement in vertical elements and placing concrete for members supported thereon.

I. Allow at least 48 hours to elapse between beginning concrete placements for adjacent sections of horizontal Work.

J. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40° F. for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

K. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90° F. at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

L. Earth Supported Concrete

1. Place concrete directly supported by earth upon clean, undisturbed subgrade, free from standing water, mud, frost, or ice.
2. Do not place concrete until all pipes under proposed slabs and structural members have received the required testing and been accepted.

3.12 FORMED FINISHES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and

defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.13 FLOOR FINISHES

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces or dust with dry cement.

1. Coordinate concrete floor / slab finishing with Div-09 floor finish substrate requirements.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.

1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
2. Specified overall values of flatness, F(F) 20; and of levelness, F(L) 15; with minimum local values of flatness, F(F) 15; and of levelness, F(L) 10.

C. Float Finish (Rough Floor Finish): Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing.
2. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

D. Type 1 Finish (Trowel Finish): After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, wood, carpet, ceramic or quarry tile set over a cleavage membrane, epoxy terrazzo, resinous flooring, paint, or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E1155 (ASTM E1155M), for a randomly trafficked floor surface:

a. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
b. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Exterior Sidewalk: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.14 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1 for at least 7 days while maintaining the concrete at a temperature of at least 50 deg F. by one or a combination of the following methods. The

method and material must be compatible with and not be detrimental to the bond of any subsequently applied finish.

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.15 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor rods for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.16 JOINT FILLING

A. Prepare, clean, and install joint sealant according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.17 CONCRETE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect at no additional cost to the Owner. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Fill form-tie voids with patching mortar plugs secured in place with bonding agent.
2. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Undercut exposed reinforcing at least 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean and saturate surface with water, remove excess standing water, and scrub in a brush-coat patching mortar. Fill and compact with patching mortar before brush coat has dried. Strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

C. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that

penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

D. Perform structural repairs of concrete, subject to Architect's approval.

E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.18 CERTIFIED SURVEY OF ANCHOR BOLTS

A. Upon completion of the setting of anchor bolts obtain a certified survey, prepared by a registered surveyor, of the following:

1. Location and elevation of anchor bolts.

This Contractor shall correct any deficiencies in location, levelness and elevation at the direction of the Architect and have the corrected work resurveyed at his own cost.

END OF SECTION 03 30 00

SECTION 04 20 00 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Ground and Split faced decorative concrete masonry units.
3. Pre-faced concrete masonry units.
4. Stone trim units.
5. Mortar and grout.
6. Steel reinforcing bars.
7. Masonry-joint reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Miscellaneous masonry accessories.
11. Masonry-cell insulation.
12. Cavity wall insulation
13. Masonry cleaners

B. Products Installed but not Furnished under This Section:

1. Steel lintels in unit masonry.

C. Related Requirements:

1. Division 03 Section "Cast-In-Place Concrete" for installing dovetail slots for masonry anchors.
2. Division 05 Section "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Division 05 Section “Cold Formed Metal Framing” for structural studs used in masonry veneer construction.
4. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
5. Division 07 Section "Joint Sealants" for waterproof sealants applied to masonry construction
6. Division 32 Section "Unit Paving" for exterior unit masonry paving.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
4. Submit shop drawings for lintels including reinforcement details, span and bearing conditions. Include span and load calculations for all lintel conditions.

C. Samples for Initial Selection:

1. Decorative CMUs, in the form of small-scale units.
2. Pre-faced CMUs.
3. Colored mortar
4. Weep holes/cavity vents.

D. Samples for Verification: For each type and color of the following:

1. Decorative CMUs.
2. Pre-faced CMUs.
3. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
4. Weep holes and cavity vents.
5. Accessories embedded in masonry.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.

b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C67.
d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Integral water repellent used in CMU's.
4. Cementitious materials. Include name of manufacturer, brand name, and type.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Provide certification that flexible flashing materials are compatible with air and vapor barrier materials.
8. Reinforcing bars.
9. Mortar Admixtures
10. Joint reinforcement.
11. Anchors, ties, and metal accessories.

C. Veneer Anchor Engineering Analysis: Provide analysis performed by the anchor manufacturer's professional structural engineer indicating that veneer anchors are in compliance with the structural design criteria and applicable codes. Analysis will bear the seal and signature of the manufacturer's professional structural engineer.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with proportion specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

B. Masonry Standard: Comply with most recent edition of TMS 602 unless modified by requirements in the Contract Documents.

C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

D. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness.
2. Build sample panels facing south.
3. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
4. Clean exposed faces of panels with masonry cleaner indicated.
5. Protect approved sample panels from the elements with weather-resistant membrane.
6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical wall area as described in Specification 01 40 00.

    a. Include a sealant-filled joint at least 16 inches long in exterior wall mockup.
    b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
    c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include metal studs, sheathing, sheathing joint-and-penetration treatment air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.

2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
4. Protect accepted mockups from the elements with weather-resistant membrane.
5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
3. Maintain materials and surrounding air temperature to minimum 50°F prior to, during and 48 hours after completion of masonry work unless otherwise permitted by Architect. See paragraph titled "Cold Weather Construction".
4. During freezing or near freezing weather, if Architect permits construction to proceed, follow the detailed requirements in paragraph titled "Cold Weather Construction".
5. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.
6. Keep cavities, expansion joint and control joint voids clear of mortar.
7. Provide temporary bracing during masonry erection. Maintain in place until building structure provides permanent bracing.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

    a. Protect masonry units, cementitious materials and sand so that they are not wetted by rain, snow or ground water.
    b. Cover tops of masonry at all times when work is not in progress. Cover shall extend a minimum of 2 feet down both sides and shall be securely held in place.
    c. Heat masonry units to at least 40°F.
    d. In no case shall calcium chloride be used, nor shall any admixture intended to lower the freezing point be used.
    e. Units with suctions in excess of 20 g. per 30 sq. in. shall be sprinkled with heated water just prior to laying. Water temperature shall be above 70°F when units are above 32°F. Water temperature shall be above 120°F when temperature of units is 32°F or below.
    f. High-early-strength Portland Cement may be used in mortar. If used, decrease protection period from 48 hr. to 24 hr. Keep mortar temperatures less than 120^{o} F to avoid flash set.

2. Construction Requirements (masonry being worked on)

    a. Air Temperature 40°F to 32°F: Heat sand or mixing water to minimum of 70°F and maximum of 160°F.
    b. Air Temperature 32°F to 25°F: Heat sand and mixing water to minimum of 70°F and maximum of 160°F.
    c. Air Temperature 25°F to 20°F.

        1) Heat sand and mixing water to minimum of 70°F and maximum of 160°F.
        2) Use salamanders or other sources of heat on both sides of walls under construction.
        3) Employ windbreaks when wind is in excess of 15 mph.

3. Air Temperature 20°F and Below

    a. Heat sand and mixing water to minimum of 70°F and maximum of 160°F.

        1) Provide enclosure and auxiliary heat to maintain air temperature above 32°F.
        2) Temperature of units when laid shall be not less than 20°F.

4. Protection Requirements (completed masonry or sections not being worked on)

a. Mean Daily Air Temperature 40°F to 32°F: Protect masonry from rain or snow for 48 hours.
b. Mean Daily Air Temperature 32°F to 25°F: Completely cover masonry for 48 hours.
c. Mean Daily Air Temperature 25°F to 20°F: Completely cover masonry with insulating blankets for 48 hours.
d. Mean Daily Air Temperature 20°F and Below: Maintain masonry temperature above 32°F for 48 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps or other approved method.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

1. Implement approved hot weather procedures and comply with the following provisions:
   a. When the ambient air temperature exceeds 100°F or exceeds 90°F with a wind velocity greater than 8 mph:

      1) Maintain sand piles in a damp, loose condition.
      2) Provide necessary conditions and equipment to produce mortar having a temperature below 120°F.

   b. When the ambient temperature exceeds 115°F or exceeds 105°F with a wind velocity greater than 8 mph, comply with the requirements above and shade materials and mixing equipment from direct sunlight.

2. Construction Requirements: These requirements apply to work in progress and are based on the following weather conditions:

   a. When the ambient air temperature exceeds 100°F or exceeds 90°F with a wind velocity greater than 8 mph:

      1) Maintain temperature of mortar and grout below 120°F.
      2) Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients or mortar.
      3) Maintain mortar consistency by re-tempering with cool water.
      4) Use mortar within 2 hours of initial mixing.
      5) Spread thin-bed mortar no more than four feet ahead of AAC masonry units.
      6) Set AAC masonry units within one minute after spreading thin-bed mortar.

   b. When the ambient temperature exceeds 115°F or exceeds 105°F with a wind velocity greater than 8 mph, implement the above requirements and use cool mixing water for mortar and grout. Ice is permitted in the mixing water prior to use. Do not permit ice in the mixing water when added to the other mortar or grout materials.

3. Protection After Erection:

   a. When the mean daily temperature exceeds 100°F or exceeds 90°F with a wind velocity greater than 8 mph, fog spray newly constructed masonry until damp at least three times a day until the masonry is three (3) days old.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

    a. Basis-of-Design Product: Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block
    b. Other Acceptable Products: Subject to compliance with requirements, the following comparable products may be provided:

        1) ACM Chemistries; RainBloc.
        2) BASF Corporation; MasterPel 240.
        3) Euclid Chemical Company (The); an RPM company; Blocktite.
        4) GCP Applied Technologies Inc; Dry-Block.
        5) Moxie International; Moxie Shield 1800.

C. CMUs: ASTM C90.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated in the Work include but are not limited to, the following:

    a. Adams an Oldcastle Company, Morrisville, NC
    b. CEMEX, Greensboro, NC
    c. Clayton Block, Lakewood, New Jersey
    d. Fizzano Brothers, Crum Lynne, Pennsylvania
    e. E. P. Henry, Woodbury, New Jersey
    f. Johnson Concrete Products, Willow Springs, NC
    g. Nitterhouse Block, Carlisle, Pennsylvania

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
3. Density Classification: Normal weight.
4. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
5. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

D. Decorative CMUs: ASTM C90.

1. Basis-of-Design Product: Match existing building color and texture with one of the manufacturers products for a 8” x 12” x 4” block.
2. Other Acceptable Products: Subject to compliance with requirements, the following comparable products may be provided:

    a. See 2.4 D.1 for approved manufacturers.

3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
4. Density Classification: Normal weight.
5. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.

6. Pattern and Texture:

    a. Standard pattern, ground-face finish. Match Architect's samples.
    b. Standard pattern, split-face finish. Match Architect's samples.

7. Colors: Match Architect's samples as selected by Architect from manufacturer's full range.
8. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

2.5 CONCRETE AND MASONRY LINTELS

A. Lintels shall match adjacent walls and coursing, in widths to match wall thickness, and reinforced for an ultimate breaking load of 1,000 lb. per linear foot up to 6 feet in span, and 750 lb. per linear foot from 6 to 8 feet. Lintels shall have a minimum 8 inch bearing on solid CMU or brick and the edge of lintel shall be a minimum 12 inches from a control joint.

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from 7-5/8 inch x 7-5/8 inch x 15-5/8 inch bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

    1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Cement: Not acceptable for use in mortar.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

    1. Basis of Design Manufacturer: Davis Colors
    2. Manufacturers: Subject to compliance with requirements, products by one of the following are acceptable:

        a. Davis Colors; True Tone Mortar Colors.
        b. Solomon Colors, Inc.; SGS Mortar Colors.

F. Colored Cement Products: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Basis of Design Manufacturer: Lafarge North America, Inc.
b. Manufacturers: Subject to compliance with requirements, products by one of the following are acceptable:

1) Essroc
2) Holcim (US) Inc.
3) Lafarge North America, Inc.
4) Lehigh Hanson; HeidelbergCement Group

2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
3. Pigments shall not exceed 10 percent of portland cement by weight.

G. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

H. Aggregate for Grout: ASTM C404.

I. Cold-Weather Admixture: Is not permitted.

J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Basis-of-Design Product: Grace Construction Products, W. R. Grace & Co. - Conn.; Dry- Block Mortar Admixture.
2. Other Acceptable Products: Subject to compliance with requirements, the following comparable products may be provided:

a. ACM Chemistries; RainBloc for Mortar.
b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.

K. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

2.8 JOINT REINFORCEMENT, TIES AND ANCHORS

A. General:

1. Adjustable Masonry-Veneer Anchors: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing and metal studs.
2. Adjustable Anchors for Connecting to Concrete and Steel: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

B. Manufacturers:

1. Basis-of-Design Product: Hohmann & Barnard, Inc. (H&B), Hauppauge, New York.
2. Other Acceptable Products: Subject to compliance with requirements, the following equivalent products may be provided:

    a. Wire-Bond, Charlotte, North Carolina
    b. Heckmann Building Products, Inc.

C. Horizontal Joint Reinforcement - Single Wythe Exterior Walls: H&B Ladder-Mesh, No. 220 EH, of width to suit wall dimension, 3/16-inch diameter deformed side rods (2), 9-gauge smooth cross rods meeting ASTM A82, carbon steel hot dipped galvanized in accordance with ASTM A153, Class B2 1.50 oz./s.f.

D. Veneer Curtain Wall Anchors and Ties for Cold Formed Steel Stud/Sheathing Back-up: Provide H&B No. 213 Adjustable Veneer Anchor, of total dimension to suit wall cavity and insulation. Provide anchor back plate (ASTM A366; 12 gauge) and 2X-hook masonry pintle with Mighty Loc (ASTM A82; 1/4 diameter flattened and serrated). All components shall be hot dipped galvanized in accordance with ASTM A153, Class B2 (1.5 oz/ft$_2$ min. H&B 200 HS back plate shall be sized to support cavity wall insulation. Masonry tie pintle shall lock insulation into place without compressing and be sized to achieve minimum 1-7/8 inches embedment into veneer.

1. Concrete Masonry Veneer Reinforcing: H&B No. 220 Reinforcement. Provide with 9 ga. side and cross rods by 1-5/8 inch wide. All components shall be hot dipped galvanized in accordance with ASTM A153, Class B2 (1.5 oz/ft$_2$ min.) ASTM A580 stainless steel AISI type 304.

E. Seismiclip No. 187 PVC extrusion 16 inches on center both ways and 3/16-inch diameter continuous deformed wire reinforcement in the facing wythe; wire shall be carbon steel hot dipped galvanized in accordance with ASTM A153, Class B2 (1.50 oz./s.f.).

F. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954; manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter (minimum 0.190 inch shank) by length required to penetrate steel stud flange with not less than three exposed threads. Provide with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B117.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Buildex; Teks Maxiseal with Climaseal finish.
b. Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.

2.9 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from smooth stainless steel.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Cheney Flashing Company.
        2) Keystone Flashing Company, Inc.
        3) Hohmann & Barnard, Inc.
        4) Mastercraft Metals, Inc.

4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed exterior lead flush with the exterior face of brick.
6. Fabricate flashings with sealed end dams where discontinuous over expansion joints, lintels, sills, step flashing, shelf angles, and any other breaks in the construction.

B. Flexible Membrane Flashing:

1. Flexible Flashing General

    a. Flexible Membrane Flashing is not permitted to be installed in lieu of stainless steel.
    b. PVC flashings are not permitted.
    c. Flexible transitions between air vapor barrier and embedded masonry flashing are included in Division 07 Section Fluid-Applied Membrane Air and Vapor Barrier (AVB).
    d. Flexible flashing products shall be compatible with Air and Vapor Barrier products.
    e. All flexible flashing installed within the cavity shall be supported by metal flashing.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use stainless steel flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use stainless steel flashing with a drip edge.

D. Single-Wythe CMU Flashing: Flash single wythe walls with stainless steel flashing.

E. Solder and Sealants for Stainless Steel Flashings:

1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C1311, flashing manufacturer’s recommended single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied, as required to seal joints in sheet metal flashing and trim and remain watertight.

F. Adhesives and Primers for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates. Seam tapes are not acceptable.

G. Termination Bars: Aluminum bars 1/8 inch by 1 inch.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene. Product: Hohmann and Barnard, Inc.; NS – Closed Cell Neoprene Sponge.

B. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated. Product: Hohmann and Barnard, Inc.; VS Series - PVC Control Joint.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 x 1-1/2 x 3-1/2 inches long. Product: Hohmann & Barnard, Inc.; No. 342 Weep Vent.
2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe in color selected from manufacturer's standard. Product: Hohmann & Barnard, Inc.; Quadro-Vent.

    a. Color: As selected

E. Aluminum Brick Vent

1. Extruded aluminum, min .125 thickness 6063-T5 alloy. Equivalent to H&B Model E825, 8-1/8 x 2-3/8 x 4 inches deep, kynar (2 coats fluoropolymer 70% kynar in accordance with AAMA 2605) coated in color as selected by Architect.

F. Cavity Drainage Mesh: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity with 7-inch-tall dovetail shaped notches designed to prevent clogging from mortar droppings.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Mortar Net USA, Ltd.; Mortar Net
    b. Holmann & Barnard; Mortar Trap

2. Size: Strips, full-depth of cavity and 10 inches high.
3. Provide above all cavity interruptions where weeps are installed and at the bottom of cavity.

G. Cavity Drainage Mat: Free draining mat made from polymer strands, to be used where standard cavity depth is restricted.

1. Products: Subject to compliance with requirements, provide products by one of the following:

    a. Keene Building Envelope Products; Cav-Air-Ator

2. Sheets or strips not more than .04 thick and installed to full height and width of restricted cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.

2.11 CAVITY-WALL INSULATION

A. Unfaced Mineral Wool Board Insulation: ASTM C612 Type 1; with maximum flame-spread and smoke-developed indexes of 25 and zero, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Thermafiber; Rainbarrier 45
    b. Roxul, Inc.; Cavity Rock DD

2. Minimum density of 4 lb/cu. ft., Types IA and IB, thermal resistivity of 4°F x h x sq. ft./Btu x in. at 75°F.

B. Extruded-Polystyrene Board Insulation: ASTM C578, Type X, closed-cell product extruded with an integral skin.

1. Basis of Design: Owens Corning; Foamular
2. Other Acceptable Products: Subject to compliance with requirements, the following equivalent products may be provided:

    a. Dow Chemical Company: Styrofoam
    b. DiversiFoam Products: CertaFoam

3. Adhesive: Type recommended by insulation board manufacturer for cavity wall installation.

C. Closed-Cell Polyurethane Foam Insulation: ASTM C1029, Type II, with minimum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84. Products shall be certified to be chlorofluorocarbon (CFC) free.

1. Basis of Design: BASF Corporation; Walltite Series
2. Other Acceptable Products: Subject to compliance with requirements, the following equivalent products may be provided:

    a. Henry Company; PerMax 2.0.
    b. Demilec (USA) LLC; Heatlok Soy 200.

3. Closed cell polyurethane foam insulation designed for use in horizontal and vertical building insulation applications; installed where indicated.
4. System includes accessories, transitions, mineral wool, foam sealant, tapes and adhesives required for a complete installation.
5. Minimum Requirements.

    a. 90% minimum closed cell content: ASTM D2856
    b. Minimum Core density: ASTM D1622- 2.0 lbs per cubic foot
    c. Compressive Strength: ASTM D1621- 22 psi.
    d. Water Vapor Transmission- ASTM E96 / E96M

        1) Permeance- 1.82 perms
        2) Maximum 0.91 perms for 2-inch thickness.
        3) Maximum 0.61 perms for 3-inch thickness.

    e. R-Value: ASTM C518- R = 6.2 per inch of thickness.
    f. Flame Spread / Smoke Developed: ASTM E84- less than 25 / less than 450.
    g. Air Leakage: ASTM E283- 0.000025 L/s/m^2 @ Pa

2.12 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, products by one of the following are acceptable:

    a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
    b. EaCo Chem, Inc.
    c. ProSoCo, Inc.

2.13 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar.
3. Masonry cement will not be acceptable for use in mortar

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site. Products shall comply with ASTM C1714 and C270.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S or Type N.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and for other applications where another type is not indicated, use Type S.
5. For interior non-load-bearing partitions, Use Type N or Type S.

D. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Carbon black shall not exceed 2 percent by weight of mortar.
3. Mix to match Architect's sample.
4. Application: Use pigmented mortar for exposed mortar joints with the following units:

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:

F. Grout for Unit Masonry: Comply with ASTM C476.

1. Portland Cement: ASTM C150 Type I, gray color; waterproof, low soluble salt content type.
2. Hydrated Lime: Type S of ASTM C207.
3. Quicklime: Nonhydraulic type per ASTM C5.
4. Aggregates: Course and fine type(s) per ASTM C404.
5. Water: Clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.
6. Proportions by volume:

    a. Fine Grout: 1 part Portland cement; 0-1/10 part hydrated lime quicklime; fine aggregate, 2-1/4 - 3 times the sum of the volumes of the cementitious materials.
    b. Coarse Grout: 1 part Portland cement; 0-1/10 part hydrated lime quicklime; fine aggregate, 2-1/4 - 3 times the sum of the volumes of the cementitious materials; coarse aggregate 1-2 times the sum of the volumes of the cementitious materials.

7. Admixtures: No additives will be permitted.
8. Strength of grout, tested in accordance with ASTM C1019 shall be equal to compressive strength of unit masonry, but in no case less than 2,000 psi.
9. Thoroughly machine mix grout ingredients, in quantities needed for immediate use. Hand mixing will not be permitted.
10. Mixed grout slump shall be between 8 inches and 11 inches.
11. Place grout within 1-1/2 hours from time of introducing water in the mixture and prior to initial set.
12. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1-/ASCE 6-/TMS 602 for dimensions of grout spaces and pour height.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond to match adjacent existing building; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.

2. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Apply air barrier to face of backup wythe to comply with Division 07 Section "Fluid-Applied Membrane Air & Vapor Barrier (AVB)."

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, and attach with fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Part Two “Horizontal and Vertical Reinforcement, Anchors and Ties.”
2. Fill cracks and open gaps in insulation with spray foam crack sealer compatible with insulation and masonry.
3. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
4. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

3.7 INSTALLING MASONRY-JOINT REINFORCEMENT

A. General: Perform reinforcement work in accordance with TMS 602- and as follows. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Provide cavity and single wythe walls with horizontal masonry reinforcing at 16 inches o.c. maximum. Embed free end of cavity wall reinforcing in every sixth mortar joint of brick veneer.
2. For masonry walls with vertical reinforcement and grout, provide horizontal reinforcing in every mortar joint.
3. Place horizontal masonry reinforcing in first and second joints above and below openings. Place continuous in first joint below top of walls.
4. Lap horizontal masonry reinforcing splices minimum 6 inches.
5. Embed wall ties for face brick at maximum 16 inches on center vertically and 16 inches on center horizontally. Place at maximum 8 inches away from perimeter of openings or edge.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners per anchor.
2. All anchors shall be gasketed to reduce heat transfer to the metal studs.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, 16 inches o.c. vertically and 16 inches o.c. horizontally, with not less than 1 anchor for each 1.77 sq. ft. of wall area, unless noted otherwise. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Construct joint with sash blocks spaced 3/8 inch apart, utilizing PVC shear key inserted in sash slots and 5/16 inch thickness hardboard strips to maintain spacing and to keep joint free of mortar. Remove hardboard strips after wall is laid up. Backer rod and caulking shall be provided under Division 07 Section “Joint Sealants”.
2. Locate joints as indicated on drawings but no greater than as indicated below:

a. Nominal 8 inches high by 16-24 inches long by 4 inches deep concrete masonry veneer at 20 feet on center maximum with (2) 0.114 (AWG) inch (9 ga.) stainless steel bars horizontal at 16 inches vertical.
b. Nominal 4 inches high by 12-24 inches long by 4 inches deep concrete masonry veneer at 10 feet on center maximum with (2) 0.114 (AWG) inch (9 ga.) stainless steel bars horizontal at 8 inches vertical.
c. Nominal 8 inch by 16 inch interior concrete masonry walls and concrete masonry installed as veneer backup on the exterior at 24 feet maximum on center. Reinforce walls as indicated.

3. Install bond breaker between courses of brick and concrete masonry veneer in wall where brick and concrete block are banded.

C. Form interior and exterior control joint (C.J.) in face brick as follows:

1. Construct joint with brick spaced 3/8 inch apart, utilizing 5/16 inch thickness hardboard strip to maintain spacing and to keep joint free of mortar. Remove hardboard strip after wall is laid up and insert compressible filler. Backer rod, and sealant shall be provided under Division 07; Section "Joint Sealants."
2. Locate joints as indicated on drawings or at 24 feet on center maximum distance.
3. Interior: Construct as detailed and dimensioned on drawings by laying in a strip of compressible filler compressed 50%. Compressible filler shall be full width of the interior wythe, but held back from the interior wall face a sufficient depth to allow for backer rod and sealant provided under Division 07 Section “Joint Sealants.”
4. Exterior: Construct interior wythe with corner blocks spaced as indicated on drawings. Fill joint with compressible filler compressed 50%. Compressible filler shall be held back from interior face of wall a sufficient depth to allow for backer rod and sealant provided under Division 07 Section “Joint Sealants”.

D. Expansion Joints

1. Refer to Division 07 Section “Expansion Control” for product and installation information related to expansion joints in masonry walls.

E. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/4 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete and masonry lintels where shown and where openings of more than 8 inches for brick-size units and 16 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

D. The edge of lintels shall be a minimum 12 inches from nearest control joint.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or as recommended by flashing manufacturer.
2. At masonry-veneer walls, extend stainless steel flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge secured with fasteners to structural substrate and tucked under air and vapor barrier (AVB) self-adhering transition, lapping the full 8 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.
3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

    a. Install backer rod and butyl sealant beneath stainless steel flashing.

4. Install stainless steel flashing termination at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of stainless steel flashing termination.

    a. Install two (2) rows of butyl sealant beneath stainless steel flashing.

5. Flashings shall be turned up and dammed at expansion joints and sealed to joint material to assure a watertight installation.
6. Flashing splices: Splice stainless steel flashing over minimum 6 inch wide splice plate below. Splice place shall have a minimum of two 1/2 inch beads each side of joint. Joint shall be tight. Use Pecora BA-98 non-curing butyl sealant or approved equal.

C. Install stainless steel single-wythe CMU flashing in bed joints of CMU walls where indicated.

1. Where face of wall is not exposed, install flashing turned up 2 inches.
2. Where face of wall is exposed to exterior view, install flashing with drip edge or sealant stop unless indicated otherwise.
3. Where face of wall is exposed to the interior, turn flashing back on itself ½ inch inboard of the face of masonry.
4. Provide weeps at 32 inches on center above flashing.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/cavity vent products to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.

F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level II in TMS 402.

1. Begin masonry construction only after inspectors have verified proportions and type of mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof with a minimum of three tests.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 04 20 00

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.
3. Shear stud connectors.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.
4. Division 9 Painting Sections for painting requirements.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
2. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Prefabricated building columns.
7. Shop primer.
8. Galvanized-steel primer.
9. Etching cleaner.
10. Galvanized repair paint.
11. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer fabricator professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

F. Survey of existing conditions.

G. Source quality-control reports.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU.

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs for the seismic lateral force resisting system have been completed and connections indicated on the Drawings.

2. Option 3 and 3B: Design connections not part of the seismic lateral force resisting system and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

a. Use Load and Resistance Factor Design; data are given at factored-load level.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles, M-Shapes: ASTM A572/A572M, Grade 50 (Grade 345).

C. Channels, Angles, S-Shapes: ASTM A572/A572M, Grade 50 (Grade 345).

D. Plate and Bar: ASTM A572/A572M, Grade 50 (Grade 345).

E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

F. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: Standard.
2. Finish: Black except where indicated to be galvanized.

G. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with plain finish.

B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.
2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with mechanically deposited zinc coating finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain and Mechanically deposited zinc coating at exterior locations.

D. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: As indicated on the structural drawings.

1. Configuration: Straight.
2. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
5. Finish: Plain, provide Hot-dip zinc coating, ASTM A153/A153M, Class C at exterior locations.

B. Threaded Rods: As indicated on the structural drawings.

1. Nuts: ASTM A63 (ASTM A563M) heavy-hex carbon steel.
2. Washers: ASTM A36/A36M carbon steel.
3. Finish: Plain, provide Hot-dip zinc coating, ASTM A153/A153M, Class C at exterior locations.

2.5 PRIMER

A. Steel Primer:

1. Comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

2.6 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 3.

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.

H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened Pretensioned or Slip critical where noted.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels located in exterior walls.

2.10 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces unless indicated to be painted.
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 3.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E165/E165M.
b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Ultrasonic Inspection: ASTM E164.
d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Pretensioned or Slip critical where indicated.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting."

C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 05 12 00

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Roof deck
2. Composite floor deck
3. Accessories including fasteners, closures, sump pans and pourstops
4. Bearing plates and angles

B. Related Sections include the following:

1. Division 01 Section “Quality Requirements” for independent testing agency procedures and administrative requirements
2. Division 03 Section "Cast-in-Place Concrete" for concrete fill
3. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors
4. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes
5. Division 09 painting Sections for repair painting of primed deck

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, pans, cut deck openings and associated reinforcement, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of steel deck, signed by product manufacturer.

B. Welding certificates.

C. Qualification Data:

1. Provide evidence that the structural steel fabricator has a minimum of five (5) years of experience in designing, detailing and fabricating projects constructed in the USA.
2. Provide evidence that the structural steel erector has a minimum of five (5) years of experience in the installation of structural steel for similar projects constructed in the USA.

D. Field quality-control test and inspection reports.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Powder-actuated mechanical fasteners

F. Research/Evaluation Reports: For steel deck.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. Submit letter certifying that metal deck meets UL design certification number for fire ratings.

C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

D. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings. Provide letter certifying that metal deck complies with FM Global requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steel Deck:

a. ASC Profiles, Inc.
b. Nucor Corp.; Vulcraft Division
c. Roof Deck, Inc.
d. Verco Manufacturing Co.

2.3 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Galvanized Steel Sheet: ASTM A653, Structural Steel (SS), Grade 40 minimum, G60 zinc coating.

2. Roof Deck Types

a. 1 ½ inch galvanized metal roof deck, 20 gauge, Type B.

3. Span Condition: Double span or more.
4. Side Laps: Overlapped.

2.4 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:

1. Galvanized Steel Sheet: ASTM A53, Structural Steel (SS), Grade 40 minimum, G60 zinc coating.
2. Composite Floor Deck Types

a. 2 inch galvanized composite metal deck, 20 gauge.

3. Span Condition: Double span or more.

2.5 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws. All fasteners shall be driven flush and at 90 degrees to the metal deck support substrate.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 20 gauge, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi and minimum 16 gauge, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Recessed Sump Pans: Single-piece steel sheet, 14 gauge minimum, of same material and finish as deck, with 3-inch wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

I. Flat Sump Plate: Single-piece steel sheet, 14 gauge minimum, of same material and finish as deck. For drains, cut holes in the field.

J. Bearing Plates: Angles: ASTM A36 steel.

K. Galvanizing Repair Paint: ASTM A780.

L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Take total responsibility to verify that the deck will support wet concrete loads and construction loads on the decking during and after installation. Provide, at no additional cost, any and all shoring required during concrete pouring and for other purposes consistent with concrete construction methods employed.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work. Reinforce openings over 12 inches in size in accordance with structural framing details indicated on the drawings. Reinforce deck openings from 6 to 12 inches in size with 2x2x1/4 inch steel angles on each side of opening. Place angles perpendicular to flutes; extend minimum two flutes each side of opening and weld to deck.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions. Fasteners shall have equivalent or greater working capacity than 5/8 inch diameter puddle welds for floor decks and ¾ inch diameter for roof decks.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated as follows:

1. Weld Diameter: 3/4 inch, nominal.
2. Weld Spacing: See plans.

B. Side-Lap Fastening: Fasten side laps of panels between supports with self-drilling, No. 10 diameter or larger, carbon-steel screws, at intervals not exceeding 12 inches.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches on steel members or 3 inches on masonry, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Roof Sump Pans and Sump Plates: Install sump pans, 14 gauge minimum, over openings provided in roof deck and mechanically fasten flanges to top of deck. Weld or fasten at each deck flute.

1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

E. Ceilings, light fixtures, ducts or other utilities shall not be supported by roof deck.

F. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. mechanically fasten to substrate to provide a complete deck installation.

1. Weld 6 inch wide cover plates at changes in direction of roof-deck panels. Fasten each side at 12 inches on center, maximum.

G. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: 5/8 inch, nominal.
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds a maximum of 12 inches apart.

B. Side-Lap Fastening: Fasten side laps of panels between supports with self-drilling, No. 10 diameter or larger, carbon-steel screws, at intervals not exceeding 12 inches.

C. Perimeter Edge Fastening: Fasten perimeter edges of panels as follows:

1. Weld or fasten the edge rib of decking or forms which are spanning parallel to spandrel beams and beams around stair, mechanical, and elevator shafts at 9 inch centers.

2. Weld or fasten each rib of decking which are supported by spandrel beams and beams around stair, mechanical, and elevator.

D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches on steel members or 3 inches on masonry, with end joints as follows:

1. End Joints: Butted.

E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

F. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and

sides of deck. Install sheet steel strip closures at floor edge upturned to thickness of slab to contain wet concrete. Provide closures of sufficient strength to remain in place without distortion.

G. Pipes over 3 inches in diameter, mechanical units, or any point load in excess of 100 pounds shall not be supported by floor deck, regardless of concrete thickness above deck. Ductwork, ceiling and lights may be supported off floor deck provided the attachment is designed and supplied by the respective contractor.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements. Contractor shall be responsible for errors in fabrication and/or proper fitting of members shown on shop drawings.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

F. Replace units damaged during construction activity.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

C. Damaged and rough or unsightly work will be rejected by the Architect.

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior non-load-bearing wall framing
2. Ceiling joist framing

B. Related Sections include the following:

1. Division 04 Section "Unit Masonry"
2. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections
3. Division 07 Section "Thermal Insulation"
4. Division 07 Section "Water Damage Class PB Exterior Insulation and Finish System (EIFS)"
5. Division 07 Section "Metal Wall Panels”
6. Division 07 Section "Joint Sealants"
7. Division 09 Section "Gypsum Board Systems" for interior non-load-bearing, metal-stud-framed assemblies

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. Shop Drawings: Provide shop drawings prepared by the cold-formed metal manufacturer.

1. Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing, fabrication, fastening and anchorage details, including mechanical fasteners.
2. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Submit signed and sealed Shop Drawings in accordance with Division 01 Section “Submittal Procedures”.

4. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, design loads, support points and tie backs.
5. The design shall be in accordance with the aesthetic design intent of the project with the Architect having final authority in reference to aesthetic matters.

C. Design Criteria

1. Conform to local and state codes.
2. Provision for Movements in Structural Frame: Detail metal stud curtain wall and supports to provide for movement in structural frames as indicated on the Drawings.
3. Structural Criteria

    a. Support conditions for the metal stud curtainwall system shall be as indicated on the structural drawings.
    b. Design to withstand the secondary architectural wind and seismic loads shown on the structural drawings.
    c. Deflection of metal framing members in a direction normal to the plane of the wall shall not exceed L/360 of the clear span of member or 0.75 inch (19 mm), whichever is least.
    d. Sheathing board shall be neglected for diaphragm action. Diagonal straps and bridging shall be designed to accommodate all loading conditions.
    e. The metal stud curtainwall system shall be designed to support all exterior wall construction that is framed to the metal stud system, including the weight of that construction and any lateral forces transmitted from that construction to the metal stud curtainwall system.
    f. Design for most stringent structural criteria listed above.

1.5 INFORMATIONAL SUBMITTALS

A. Design Data for Delegated Design Elements

1. All design calculations, which shall bear the seal and signature of the cold-formed design engineer indicating compliance with the requirements of the design criteria and appropriate codes, shall be provided to the Architect concurrent with the submittal of shop drawings. Shop drawings submitted without corresponding Design Data will be returned as “Not Reviewed”.

B. Welding certificates

C. Qualification Data:

1. For professional engineer
2. For testing agency
3. For fabricator
4. For erector

D. Submit manufacturer's literature for installation of materials specified.

E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet
2. Expansion anchors
3. Power-actuated anchors
4. Mechanical fasteners
5. Vertical deflection clips
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories

F. Research/Evaluation Reports: For cold-formed metal framing.

1.6 QUALITY ASSURANCE

A. Qualifications for Fabricator and Erector:

1. The fabricator shall have a minimum of 5 years of experience in the fabrication of metal stud curtain wall systems and shall have successfully fabricated a minimum of 5 projects similar to this project.
2. The erector shall have a minimum of 5 years of experience in the erection of metal stud curtain wall systems and shall have erected a minimum of 5 projects similar to this project.

B. Delegated Design Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct the testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.

E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

F. AISI Specifications and Standards: Comply with AISI's S100 "North American Specification for the Design of Cold-Formed Steel Structural Members" and its S200 "Standard for Cold-Formed Steel Framing - General Provisions."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Material shall be delivered in original unopened packages, fully identified as to manufacturer, brand or other identifying data, and bearing the proper Underwriters Laboratories, Inc., or other approved agency, labels for fire hazard and fire-resistance classification.

B. Material shall be stored above ground, under cover and in a dry location until ready for use. All containers that have been exposed to water before use shall be found unsuitable for use and discarded. Stock of material is to be rotated and used prior to its expiration date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cold Formed Metal Panels:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ClarkDietrich, West Chester, Ohio.
b. Marino/Ware Industries, South Plainfield, New Jersey
c. The Steel Network, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated. Refer to the structural drawings for general notes and for the required support conditions and connection types to the primary structure.

1. Design Loads: As indicated
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 1/600 of the wall height.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

a. Upward and downward movement of 3/4 inch.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

B. Cold-Formed Steel Framing Standards: Design according to AISI's "Standard for Cold-Formed Steel Framing – General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Delegated Design: Design cold-formed metal-framing, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25.

B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G60 (Z180), G90 (Z275).

C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G90 (Z275).

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Steel Thickness: 0.0538 inch (1.37 mm).
2. Minimum Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base- Steel Thickness: Matching steel studs.
2. Minimum Flange Width: 1-1/4 inches.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base- Steel Thickness: 0.0538 inch (1.37 mm).
2. Minimum Flange Width: 1-5/8 inches.

2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base- Steel Thickness: 0.0538 inch.
2. Minimum Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base- Steel Thickness: Matching steel studs.
2. Minimum Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780.

B. Cement Grout: Portland cement, ASTM C150, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1-part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C1107, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, non-leaching.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

1. Basis of Design: Subject to compliance with requirements, provide H-B, Inc.; NS – Closed Cell Neoprene Sponge, or approved equal.

2.7 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-

resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations at exterior non-gravity load bearing walls only.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to ASTM C1007, AISI's S200 "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Install Cold Formed Framing at 16 inches on center maximum, or closer, as required by design requirements.

J. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

K. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Tolerance shall be maintained to comply with the requirements of the Division 07 Section “Metal Wall Panel” manufacturer.

3.4 INSTALLATION

A. Stud System

1. Install tracks at floor and structure above and secure with powder driven fasteners maximum spacing of 16 inches (400 mm) o.c. (medium duty). At track butt joints, securely anchor abutting pieces of track to a common structural element; reinforce joint with a section of stud nested in track and screw fastened at track flanges. Studs shall be one piece (no splicing), spaced 16 inches (400 mm) o.c. maximum, and shall extend from floor to within 1 inch (25 mm) of underside of structure. Fasten bottom of studs to track, one screw in each flange; do not fasten top of studs to secured top track. Interrupt top and bottom tracks at control joints. Where bottom track is set on concrete, provide 1/4 inch (6mm) continuous compressible filler between track and concrete.
2. Provide 1-1/2 inch (38 mm) cold rolled channel bracing, one row at midpoint of height or maximum 6 feet (1800 mm) above bottom track, and one row at top (first opening below top of stud) inserted in stud cutouts or as directed by the Engineer of Record. If design of cutouts is such that 1-1/2 inch (38 mm) channel cannot be friction-fit for rigidity, weld each flange of channel (both sides) to studs or screw attach to 1-1/2 inch (38 mm) x 2 inch (50 mm) x 16 gauge clip angle with four screws, two into each member.
3. Provide horizontal bracing to support wall mounted fixtures, casework, guard rails, other equipment.
4. Install members true to lines and levels to provide surface flatness with maximum variation of 1/8 inch (3 mm) in a 4 foot (1200 mm) radius at any location.
5. Attach runners, studs, bracing, or any other component of partition system only to building floors, walls or structural framing.
6. Door Opening Framing: Install double studs at door frame jambs with minimum of three "U" shaped strap anchors to join studs together. Run the double studs from floor to underside of structure above. Install runners at frame head height between jamb studs. Perform work per recommendations of GA 219 for heavyweight doors.

3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Maximum stud spacing as follows:

1. Stud Spacing: 16 inches (406 mm).

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Connect vertical deflection clips to bypassing studs and anchor to building structure.
2. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection. Install bridging within 12 inches of unsecured wall studs at head of wall and engaged in deep leg /deflection track.

1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Steel framing and supports for countertops.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections
3. Elevator machine beams and hoist beams
4. Steel shapes for supporting elevator door sills
5. Slotted channel framing.
6. Structural-steel door frames
7. Miscellaneous steel trim including steel edgings, support angle for elevator doorsill
8. Metal pipe crossovers.
9. Metal bollards
10. Metal floor plate and supports
11. Elevator pit sump covers.
12. Abrasive metal nosings, treads, and thresholds.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry
3. Division 05 Section "Structural Steel Framing"
4. Division 05 Section "Metal Stairs and Railings”
5. Division 05 Section "Decorative Metal"
6. Division 09 sections Interior Painting and Exterior Painting for primers used on metal fabrications.
7. Division 12 Section "Site Furnishings" for bicycle racks.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes
2. Fasteners.
3. Metal nosings and treads.
4. Shop applied primer and paint products.
5. Shrinkage-resisting grout.
6. Slotted channel framing.
7. Metal pipe crossovers.
8. Metal bollards.

B. Shop Drawings: Show fabrication and installation details for all metal fabrications. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1. Steel framing and supports for countertops.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Elevator machine beams, hoist beams.
5. Steel shapes for supporting elevator door sills.
6. Metal pipe crossovers.
7. Metal floor plate and supports.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim including steel angle corner guards and steel edgings.
11. Metal bollards.
12. Loose steel lintels.
13. Provide templates for anchors and bolts specified for installation under other Sections.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Design Data for Delegated Design Elements: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for

calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as “Not Reviewed”

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel"
2. AWS D1.2, "Structural Welding Code--Aluminum"
3. AWS D1.3, "Structural Welding Code--Sheet Steel"
4. AWS D1.6, "Structural Welding Code--Stainless Steel"

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 to conduct the testing indicated.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design slotted channel framing, pipe railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3, except provide for the enhanced single concentrated live load of 300 lbf for each rung.

1. Provide delegated design of connections to structure to meet performance requirements.
2. Member sizes indicated on details are minimums and subject to delegated design as required to meet performance requirements.

C. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of 50 lbf/ ft. applied in any direction.
2. Concentrated load of 200 lbf applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

D. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Slotted Channel Framing: Provide calculations for framing and connections for supporting hangers, equipment, etc. Include supporting data from framing manufacturer. Refer to Structural drawings or notes for specific loading criteria.

F. Unless member sizes are shown on the structural drawings, all elements shall be considered delegated-design elements. All member sizes shown on the architectural drawings are minimum sizes that are required to be designed by the contractor’s qualified professional engineer licensed in the project state.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 316L.

C. Stainless-Steel Bars and Shapes: ASTM A276, Type 316L.

D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A793.

F. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface.

1. Subject to requirements, provide products manufactured by one of the following:

    a. Harsco Industrial IKG, a division of Harsco Corporation
    b. Ross Technology Corporation
    c. W S Molnar Company

G. Steel Tubing: ASTM A500, cold-formed steel tubing.

H. Steel Pipe: ASTM A53/A53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

I. Slotted Channel Framing ("Unistrut"): Cold-formed metal channels with continuous slot complying with MFMA-3.

1. Size of Channels: As indicated or required.
2. Material: Galvanized steel complying with ASTM A653/A653M, Grade 33, with G90 coating; 12G 0.108-inch nominal thickness.
3. Material: Steel complying with ASTM A1008/A1008M, Grade 33; 12G 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel or hot-dip galvanized after fabrication.

J. Cast Iron: ASTM A48/A48M, Class 30, unless another class is indicated.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F593 for bolts and ASTM F594 for nuts, Alloy Group 2).

E. Anchor Bolts: ASTM F1554, Grade 36

1. Provide hot-dip, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Eyebolts: ASTM A489

H. Machine Screws: ASME B18.6.3

I. Lag Bolts: ASME B18.2.1

J. Wood Screws: Flat head, ASME B18.6.1

K. Plain Washers: Round, ASME B18.22.1

L. Lock Washers: Helical, spring type, ASME B18.21.1

M. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations and in pressure treated lumber: Alloy Group 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

N. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

O. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts,

complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Low Emitting Materials:

1. Products listed shall have a minimum VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

    a. Architectural Sealants: 250 g/L.
    b. Sealant Primers for Nonporous Substrates: 250 g/L.
    c. Sealant Primers for Porous Substrates: 775 g/L.

C. Shop Primers: Provide primers that comply with Division 09 painting Sections.

D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

1. Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain

structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for glazed openings head stiffening, and masonry partition stiffening from continuous structural steel members of sizes indicated with attached bearing plates, anchors, and braces as indicated, with holes where indicated on Shop Drawings of individual products.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.8 LOOSE LINTELS

A. Fabricate loose lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc rich primer.

2.9 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Provide steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize exterior steel frames.

2.10 INDUSTRIAL PIPE RAILINGS

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Configuration:

a. Handrail: Schedule 40 Pipe with an outside diameter not less than 1.32 inches.
b. Top, Bottom and Intermediate Guardrails and Posts: Schedule 40 Pipe with an outside diameter not less than 1.9 inches. Space intermediate rails not more than 21 inches clear between.
c. These pipe railings shall be included only where noted on the drawings and are not to be used in lieu of decorative rails or metal stair rails specified in other sections.

2.11 PIPE CROSSOVERS

A. Provide metal pipe crossovers where indicated. Fabricate of open-type construction with channel stringers, pipe railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.

1. Fabricate pipe crossovers, including railings from steel.
2. Fabricate treads and platforms from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 3/4 inch in least dimension.
3. Fabricate treads and platforms from abrasive-surface floor plate.
4. Comply with applicable requirements in Division 05 Section "Metal Stairs" for railings.

2.12 METAL FLOOR PLATE

A. Fabricate from rolled-steel floor abrasive-surface floor plate of thickness indicated below:

1. Thickness: 3/8 inch or as indicated.

B. Provide grating sections where indicated fabricated from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 3/4 inch in least dimension.

C. Provide steel angle supports, angle stiffeners, and fixed and removable sections as indicated.

D. Provide flush bar drop handles for lifting removable sections, one at each end of each section in material to match plate.

2.13 ELEVATOR PIT SUMP COVERS

A. Fabricate from 3/16-inch rolled-steel floor plate with four 1-inch-diameter holes for water drainage and for lifting.

B. Fabricate from welded or pressure-locked steel bar grating Limit openings in gratings to no more than 1/2 inch in least dimension.

C. Provide steel angle supports as indicated.

D. Plate and support angles to be galvanized.

2.14 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Prime interior miscellaneous steel trim with zinc rich primer.

2.15 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe 1/4-inch wall-thickness rectangular steel tubing.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all 4 corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe with 1/4-inch-thick, steel or stainless-steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Prime interior bollards with primer specified in Division 09 Section "Interior Painting."

2.16 ABRASIVE METAL NOSINGS TREADS

A. Cast-Metal Units: Cast iron with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Safety Tread Co., Inc.
b. Balco Inc.
c. Barry Pattern & Foundry Co., Inc.
d. Ross Technology Corporation.
e. Safe-T-Metal Company, Inc.
f. Wooster Products Inc.

2. Nosings: Cross-hatched units, 4 inches wide with 1-inch lip, for casting into concrete steps.
3. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches, for casting into concrete curbs.
4. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.

1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

D. Apply bituminous paint to concealed surfaces of cast-metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.17 METAL DOWNSPOUT COVER

A. Source Limitations: Obtain downspout boots from single source from single manufacturer.

B. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: Vertical, to discharge into pipe. Horizontal, to discharge into pipe at 35 degrees from horizontal, to discharge onto splash block or pavement.

C. Prime cast-iron downspout boots with zinc-rich primer.

2.18 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.19 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.20 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A123/A123M, for galvanizing steel and iron products
2. ASTM A153/A153M, for galvanizing steel and iron hardware
3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.21 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Bright, Directional Satin Finish: No. 4.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.22 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with expansion anchors, anchor bolts through bolts. Provide four 3/4-inch bolts at each bollard, unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete or in formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete or formed or core-drilled holes not less than 8 inches deep and 3/4 inch larger than OD of sleeve. Fill annular space around internal sleeves solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.

F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

G. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

H. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.4 INSTALLING INDUSTRIAL PIPE RAILINGS

A. Installation, General

1. Fit exposed connections together to form tight, hairline joints.

2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

    a. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
    b. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
    c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

3. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

    a. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

B. Railing Connections

1. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
2. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

C. Anchoring Posts

1. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.
4. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

    a. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

D. Attaching Railings

1. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
3. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:

    a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
    b. For hollow masonry anchorage, use toggle bolts.
    c. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.

3.5 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Install per manufacturer’s written instructions.

D. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 Section "Joint Sealants" to provide a watertight installation.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION 05 50 00

SECTION 05 51 00 - METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Channel stringer fabricated steel stairs with concrete-filled treads.
2. Industrial-type stairs with abrasive diamond plate landings, risers, and treads.
3. Pipe railings attached to metal stairs.
4. Pipe handrails attached to walls adjacent to metal stairs.
5. Railing gates at the level of exit discharge.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section "Metal Fabrications" for metal treads and nosings installed at locations other than in metal stairs.
3. Division 06 Section "Miscellaneous Rough Carpentry" for blocking for anchoring railings.
4. Division 09 Section "Gypsum Board Systems” for blocking for anchoring railings and for gypsum drywall products applied to stairs.
5. Division 09 Flooring Sections for flooring materials installed on metal stairs.
6. Division 10 Section "Wire Mesh Partitions" for wire mesh security partitions and doors.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Prefilled metal-pan stair treads
2. Woven-wire mesh.
3. Handrail wall brackets
4. Nonslip aggregates and nonslip-aggregate finishes
5. Abrasive nosings
6. Shop primer products
7. Paint products
8. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, design loads, support points and tie backs.
4. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
5. Include plan at each level.
6. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

C. Samples for Verification: For the following products.

1. For each type and finish of nosing.
2. Nonslip aggregates and nonslip-aggregate finishes

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Design Data for Metal Stairs and Railings: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as “Not Reviewed”.

C. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
2. Statement that the Professional Engineer is fully experienced in the design of metal stairs and railings.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer’s signature and seal shall appear on all design calculations.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.

1. Test railings according ASTM E894 and ASTM E935.

F. Welding certificates

1.5 CLOSEOUT DOCUMENTS

A. Maintenance and care instructions for inclusion in the Maintenance Manuals.

B. Fully executed warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1. The fabricator shall have a minimum of 5 years of experience in the fabrication of successfully completed metal stairs and railings and shall have successfully fabricated a minimum of 5 projects similar to this project.
2. The erector shall have a minimum of 5 years of experience in the erection of metal stair and railings and shall have erected a minimum of 5 projects similar to this project.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel"
2. AWS D1.3, "Structural Welding Code--Sheet Steel"

1.7 COORDINATION

A. Schedule installation of railings and guards so wall attachments are made only to completed walls.

1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

B. Coordinate installation of anchorages for metal stairs.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

D. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

B. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Top Rails of Guards:

    a. Uniform load of 50 lbf/ ft. applied in any direction.
    b. Concentrated load of 200 lbf applied in any direction.
    c. Uniform and concentrated loads need not be assumed to act concurrently.

3. Infill of Guards:

    a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
    b. Infill load and other loads need not be assumed to act concurrently.

4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

    a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Seismic Performance: Provide metal stairs capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" and information provided on the Structural drawings.

D. The design shall be in accordance with the aesthetic design intent of the project, possibly requiring structural profiles different from the minimum structural requirements. The Architect shall have final authority in reference to these aesthetic matters.

1. All proposed deviations from the specification and drawings must be so noted on the submittal drawings.
2. Approval of the submittals does not constitute approval of changes to the design intent without proper notification of same.

E. Delegated Design: Manufacturer's responsibilities include using a qualified professional engineer to prepare comprehensive structural calculations for metal stair and railing members and connections, using performance requirements and design criteria indicated.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alfab, Inc.
2. American Stair, Inc.
3. Worthington Metal Fabricators
4. Pacific Stair Corporation
5. McGregor Industries, Inc.
6. Specialized Stair Systems

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.4 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M

B. Steel Tubing: ASTM A500 (cold formed)

1. Provide galvanized finish for exterior installations and where indicated.

C. Steel Pipe for Railings: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

1. Hot dipped galvanized finish raised pattern (diamond) floor plate for exterior stair treads, risers, and landings.

E. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface.

F. Steel Bars for Grating Treads: ASTM A36/A36M.

1. Wire Rod for Grating Crossbars: ASTM A510 (ASTM A510M).

G. Iron Castings: Either gray or malleable iron, unless otherwise indicated.

1. Gray Iron: ASTM A48/A48M, Class 30, unless another class is indicated or required by structural loads.
2. Malleable Iron: ASTM A47/A47M.

H. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.

I. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.

J. Galvanized Steel Sheet: ASTM A653/A653M, G90 (Z275) coating, structural steel, Grade 33 (Grade 230), unless another grade is required by design loads.

K. Woven-Wire Mesh: Intermediate-crimp, square pattern, 2-inch woven-wire mesh, made from 0.135-inch nominal diameter wire complying with ASTM A510 (ASTM A510M).

2.5 NONFERROUS METALS

A. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6

B. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F

2.6 ABRASIVE NOSINGS – NON-HIGH RISE

A. Extruded Units: Extruded-aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.

1. Basis of design: Wooster Products Inc. Spectra WP3 WP3G
2. Other acceptable manufacturers, subject to compliance with requirements.

a. American Safety Tread Co., Inc.
b. Amstep Products
c. Armstrong Products, Inc.
d. Balco, Inc.
e. Granite State Casting Co.
f. Nystrom, Inc.
g. Upnovr, Inc.

3. Provide solid-abrasive-type units without ribs.
4. Nosings: Square-back units, 3 inches wide, without lip for concrete, with lip for steel pan.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply bituminous paint to concealed bottoms, sides, and edges of cast-metal units set into concrete.

2.7 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs, stairs indicated to be galvanized.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F593, and nuts, ASTM F594 (ASTM F836M).

E. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ASTM F568M, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

F. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

G. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

H. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

I. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

J. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Alloy Group 2 (A4) stainless-steel bolts complying with ASTM F593 (ASTM F738M) and nuts complying with ASTM F594 (ASTM F836M).

2.8 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Shop Primers: Provide primers that comply with Division 09 painting sections.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

F. For galvanized reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.9 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces shall be ground smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

    a. Where flush welds are noted on the drawings, prepare balusters for complete or partial joint penetration welds as required and grind/smooth so weld is not visible after finishing

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Castings shall be sound and free from warp, holes and other defects that impair their strength or appearance. Exposed surfaces shall have a smooth finish and sharp, well-defined lines and arises.

Machined joints where required, shall be milled to a close fit. Provide necessary rabbets, lugs and brackets so that work can be assembled in a neat and substantial manner.

J. Supply components required for anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

2.10 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Commercial Service Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of 12-inch-deep steel channels with a flange size of 3 inches.

2. Fabricate stringers of steel channels.

   a. Provide closures for exposed ends of channel stringers.

   b. For flange mounted railing posts minimum channel flange width is 3.
   c. Finish: Shop primed, Galvanized.

3. Construct platforms of steel plate and channel headers, as indicated, and miscellaneous framing members as needed to comply with performance requirements indicated.

   a. Provide closures for exposed ends of channel and rectangular tube framing.
   b. Finish: Shop primed, Galvanized.

4. Weld stringers to headers; weld framing members to stringers and headers.
5. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or posts to support landings from floor construction above or below. Locate hanger rods and posts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
6. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 12G .1046-inches.

1. Fabricate treads and landing subplatforms of exterior stairs so finished walking surfaces slope to drain.
2. Steel Sheet: Uncoated cold -rolled steel sheet.
3. Steel Sheet: Galvanized steel sheet.
4. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
5. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
6. Shape metal pans to include nosing integral with riser.

7. Attach abrasive nosings to risers.
8. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 12G .1063-inch.

1. Steel Sheet: Uncoated hot-rolled steel sheet, unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.11 PIPE RAILINGS

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Configuration: Interior Stair

2. Configuration: Exterior Stair

a. Handrail: Schedule 40 Pipe with an outside diameter not less than 1.32 inches.
b. Top and Bottom Guardrails and Balusters: 1-1/2-inch by ½-inch bar, spaced no more than 4-inches clear between.
c. Posts: 1-1/2-inch square with 1-inch by 1-inch by 1-inch spacer, centered on top.

B. Gates: Form gates from pipe of same size as noted above, with infill to match. Provide with self-closing spring hinges and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

C. Rails shall be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.

D. Welded Connections: Fabricate railings with welded connections.

1. Fabricate connections that are exposed to weather in a manner that excludes water.

a. Provide weep holes where water may accumulate internally.

2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
3. Weld all around at connections, including at fittings.
4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
5. Obtain fusion without undercut or overlap.
6. Remove flux immediately.

7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint as shown in NAAMM AMP 521.

E. Form changes in direction of railings as follows:

1. As detailed, by bending.

F. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

G. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

H. Connect posts to stair framing by direct welding unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For non-galvanized railings, provide non-galvanized prime painted ferrous-metal fittings, brackets, fasteners, and sleeves, except provide galvanize anchors embedded in exterior masonry and concrete construction.
4. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 2-1/4-inch clearance from inside face of handrail to finished wall surface.

J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.12 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A123/A123M, for galvanizing steel and iron products
2. ASTM A153/A153M, for galvanizing steel and iron hardware
3. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
4. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:

1. Exterior Stairs (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"
2. Interior Stairs (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning"
3. Interior Stairs (SSPC Zone 1A): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates.

a. Clean bottom surface of plates.
b. Set plates for structural members on wedges, shims, or setting nuts.
c. Tighten anchor bolts after supported members have been positioned and plumbed.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

a. Where flush welds are noted on the drawings, prepare balusters as required and grind/smooth so weld is not visible after finishing

G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.
2. Center nosings on tread width.

H. Install precast concrete treads with adhesive supplied by manufacturer.

I. Install precast concrete treads with adhesive supplied by manufacturer.

3.3 INSTALLING STEEL RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints.

1. Space posts at spacing indicated.
2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
4. Secure posts and rail ends to building construction as follows:

a. Anchor posts to steel by welding directly to steel supporting members.
b. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with post-installed anchors and bolts.

B. Install railing gates level, plumb, and secure for full opening without interference.

1. Attach hardware using tamper-resistant or concealed means.
2. Adjust hardware for smooth operation.

C. Attach handrails to wall with wall brackets.

1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
2. Secure wall brackets to building construction as follows:

a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed fire-retardant wood blocking using wood screws of size and type required to support structural loads.

D. Install guardrails and handrails in accordance with the latest approved shop drawings. The design and detailing of all guardrails and handrails is the responsibility of the contractor's qualified licensed professional engineer. All connections must comply with the Design Criteria listed in this section and all applicable building codes.

3.4 REPAIR

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION 05 51 00

SECTION 05 75 00 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Beam wraps.
2. Closures and trim.
3. Filler panels at demountable partitions and between dissimilar construction.
4. Lighting coves.
5. Metal base.
6. Mullion cladding.
7. Pipe system covers.
8. Pockets for window treatment.
9. Exterior fins.
10. Exterior sunshades.
11. Exterior window covers.

B. Related Requirements:

1. Division 07 Section "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
2. Division 07 Section "Roof Specialties" for items made of formed metal for parapets and copings.

1.3 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

D. Samples for Verification: For each type of exposed finish required, prepared on 6-inch-square Samples of metal of same thickness and material indicated for the Work.

1.6 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

C. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: To include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units.

B. Coating Applicator Qualifications: A firm experienced in successfully applying organic- anodic-powder-coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

C. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Installer Qualifications: Fabricator of products.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups for the following types of decorative formed metal:

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design decorative formed metal, including attachment to building construction.

B. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind Loads on Exterior Items: As indicated on Drawings

C. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and information provided on the documents.

1. Component Importance Factor: 1.0.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METAL

A. General: Fabricate products from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Aluminum Sheet: Flat sheet complying with ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties of not less than Alloy 5005-H32.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 coating, either commercial steel or forming steel.

D. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 316, stretcher-leveled standard of flatness.

2.3 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain airtight and weathertight; as recommended in writing by decorative formed metal manufacturer.

1. ASTM D1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.

B. Sealants, Exterior: Elastomeric sealant complying with Division 07 Section "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

C. Sealants, Interior: Nonsag, paintable sealant complying with Division 07 Section "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

D. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

E. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated or exposed fasteners are unavoidable or are the standard fastening method.
2. Provide tamper-resistant square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

F. Structural Anchors: For applications indicated to comply with certain design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.

G. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.

H. Anchor Materials:

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

I. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

J. Backing Materials: Provided or recommended by decorative formed metal manufacturer.

K. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal, will prevent telegraphing and oil-canning, and is compatible with substrate and noncombustible after curing.

L. Isolation Coating: Manufacturer's standard epoxy coating.

2.4 PAINTS AND COATINGS

A. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Shop Primers: Comply with Division 09 Section "Exterior Painting." and Division 09 Section "Interior Painting."

D. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

F. Shop Primer for Galvanized Steel: Water-based galvanized metal primer complying with MPI#134.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch-wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

1. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

2.6 BEAM WRAPS

A. Manufacturers

1. Subject to compliance with requirements, acceptable manufacturers include, but are not limited to:

a. Hi-Tech Metals, Inc.
b. Industrial Louvers, Inc.
c. Metal Sales and Service, Inc.
d. MM Systems Corporation
e. SAF (Southern Aluminum Finishing Company, Inc.).
f. Southwest Metalsmiths

B. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

1. Aluminum Sheet: 0.063 inch or as Thickness required to comply with performance requirements.

a. Finish: Baked enamel or powder coat.

C. Fabricate with calk stop angle to retain backer rod and sealant.

2.7 CLOSURES AND TRIM

A. Manufacturers

1. Subject to compliance with requirements, acceptable manufacturers include, but are not limited to:

a. Fry Reglet Corporation.
b. Pittcon Industries

B. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.

1. Aluminum Sheet: 0.063 inch or as Thickness required to comply with performance requirements.

    a. Finish: Baked enamel or powder coat.

2. Galvanized-Steel Sheet: 0.052 inch or as Thickness required to comply with performance requirements.

    a. Finish: Factory primed, Baked enamel or Powder coat.

3. Steel Sheet: 0.048 inch or as Thickness required to comply with performance requirements.

    a. Finish: Factory primed, Baked enamel or Powder coat.

4. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.

C. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.

D. Drill and tap holes needed for securing closures and trim to other surfaces.

E. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.

F. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.8 FILLER PANELS

A. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as **[partitions] [mullions]** unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.

1. Galvanized-Steel Sheet: 0.064 inch.

    a. Finish: Factory primed, Baked enamel or Powder coat.

2. Steel Sheet: 0.060 inch.

    a. Finish: Factory primed, Baked enamel or Powder coat.

3. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.

C. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch-square material, unless otherwise indicated, set approximately 1/4 inch into channeled edge of filler panel.

D. Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.

E. Do not mechanically fasten filler panels to mullions.

2.9 POCKETS FOR WINDOW TREATMENT

A. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.

1. Aluminum Sheet: 0.063 inch.

a. Finish: Baked enamel or powder coat.

2. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

B. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.

C. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

2.10 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Match Architect's sample or As selected by Architect from full range of industry colors and color densities.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: Match Architect's sample selected by Architect from manufacturer's full range

2.12 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

D. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Color and Gloss: Match Architect's sample As selected by Architect from manufacturer's full range.

F. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: Match Architect's sample As selected by Architect from manufacturer's full range.

2.13 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

D. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Color and Gloss: Match Architect's sample As selected by Architect from manufacturer's full range

E. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

1. Color and Gloss: Match Architect's sample As selected by Architect from manufacturer's full range.

2.14 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Directional Satin Finish: No. 4.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

F. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

3.3 ADJUSTING AND CLEANING

A. Unless otherwise indicated, clean metals by washing thoroughly with water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

D. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Sections "Exterior Painting" and "Interior Painting."

E. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05 75 00

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rooftop equipment bases and support curbs.
2. Wood blocking, cants, and nailers.
3. Wood furring and grounds.
4. Wood sleepers.
5. Plywood backing panels.

B. Related Requirements:

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.

B. Maximum Moisture Content of Lumber: 19 percent for 2-inch nominal thickness or less, no limit for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Inorganic boron (SBX) products shall be used only for interior construction not exposed to moisture.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat items indicated on Drawings, and wood installed on the exterior side of the weather barrier, including but not limited to:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

E. Application: Treat items indicated on Drawings, and wood installed in the interior side of the weather barrier, including but not limited to:

1. Framing for raised platforms.
2. Concealed blocking.
3. Roof framing and blocking.
4. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
5. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.

B. For concealed board blocking, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
4. Eastern softwoods, No. 2 Common grade; NELMA.
5. Northern species, No. 2 Common grade; NLGA.
6. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 2, Exposure 1, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
2. Seismic Requirement: Where fasteners are required to secure ceilings, partitions and other architectural components, as indicated in the trade sections, select wood and sheet metal screws appropriate to the seismic shear and withdrawal loads indicated.

    a. Drywall screws are not acceptable except to fasten gypsum drywall to metal studs.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 and ICC-ES AC193 as appropriate for the substrate.

2.7 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

D. Provide blocking as indicated and as required to support facing materials, casework/millwork, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. ICC-ES evaluation report for fastener.

H. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 06 16 00 – SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Parapet sheathing.

B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Division 07 Section "Air and Vapor Barrier (AVB)" for water-resistive barrier applied over wall sheathing and testing requirements.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

1.5 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

B. Product Certificates: From air-barrier and water-resistant glass-mat gypsum sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.

C. Product Test Reports: For each air-barrier and water-resistant glass-mat gypsum sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.

D. Evaluation Reports: For the following, from ICC-ES:

1. Air-barrier and water-resistant glass-mat gypsum sheathing.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of glass-mat gypsum sheathing.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

C. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

a. CertainTeed Corp.; GlasRoc Sheathing.
b. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
c. Continental; Weather Defense Platinum Sheathing Type X
d. National Gypsum Company; Gold Bond, e(2)XP.
e. USG Corporation; Securock Glass Mat Sheathing.

2. Type and Thickness: Type X, 5/8 inch thick.
3. Size: 48 by 120 inches for vertical installation.

2.3 PARAPET SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

a. CertainTeed Corporation.
b. Georgia-Pacific Gypsum LLC.
c. National Gypsum Company.
d. USG Corporation.

2. Type and Thickness: Type X, 5/8 inch thick.
3. Size: 48 by 96 inches for vertical installation.

a. Custom Building Products.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
2. For parapet and wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.

B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

C. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

D. Coordinate wall and parapet sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GLASS-MAT GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Vertical Installation: Install vertical edges centered over studs. Attach at perimeter and within field of panel to each stud.

1. Erect glass faced gypsum sheathing board vertically with ends and edges butted, edges occurring over firm bearing, and edge joints staggered in successive courses, in accordance with GA 253. Interrupt sheathing at control joints.
2. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels or as directed by the CFMF Design Engineer and in accordance with ASTM C1002.

3. Apply elastomeric sealant to joints and fasteners, apply tape and seal penetrations and openings as directed in Division 07 sections Air and Vapor Barrier (AVB) and Vapor Permeable Barrier (AIB).

3.3 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

1. Sheathing to be installed and tested in conjunction with air barriers per Division 07 sections Air and Vapor (AVB) and Vapor Permeable (AIB) Barriers.

B. Testing and Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Inspections: Sheathing to be tested in conjunction with air barriers per Division 07 sections Air and Vapor (AVB) and Vapor Permeable (AIB) Barriers.

END OF SECTION 06 16 00

SECTION 06 41 00 - ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plastic laminate faced cabinets
2. Solid surface material countertops
3. Cabinet hardware and accessories
4. Wood shims and hanging strips for installing architectural cabinets.

B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking concealed within other construction required for installing cabinets.
2. Division 12 Section “Laboratory Casework” for HPDL acid resistant tops.

1.3 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO Plywood: Plywood with a medium-density overlay on the face.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product, including high pressure decorative laminates, countertop materials and adhesives, cabinet hardware and accessories and finishing materials and processes.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples for Initial Selection:

1. Thermoset decorative panels.
2. Each type of high pressure laminate.
3. Each type of solid surface material.

D. Samples for Verification:

1. Thermoset decorative panels, 8 by 10 inches, for each color, pattern, and surface finish, with edge banding on one edge.
2. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.

    a. Provide one sample applied to core material with specified edge material applied to one edge.

3. Solid surface material countertops, 8 by 10 inches, for each type, color, pattern, and surface finish, with specified edge treatment applied to one edge.
4. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator and installer.

B. Product Certificates: For the following:

1. Thermoset decorative panels.
2. Adhesives.
3. High pressure decorative laminate.
4. Each type of solid surface material.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: AWI Certified shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar operations that could damage cabinets have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural cabinets can be supported and installed as indicated.

1.11 WARRANTY

A. Products provided under the scope of this Section shall be of specified materials, quality workmanship and be free from defects that would render them unserviceable for the use intended, including flaws in appearance. The fabricator and installer agree, for a period of two years after date of Substantial Completion, to repair or replace without charge to the Owner, any product that is defective within the meaning of this warranty.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINETS, GENERAL

A. Quality Standard (Current Edition): Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural cabinets indicated for construction, finishes, installation, and other requirements.

1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.2 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Grade: Custom.

B. Type of Construction: Frameless.

C. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.

D. Cabinet Door and Drawer Front:

1. Core Thickness: 11/16 inch.
2. Maximum Door Height: 80 inches.

E. Panel Product for Exposed and Semi-Exposed Surfaces and Shelves: 3/4 inch thick medium density fiberboard (MDF).

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

1. Manufacturers: See Finish Legend for user-approved laminate(s). Subject to compliance with requirements, provide other products by one of the following:

a. Abet Laminati, Inc.
b. Formica Corporation.
c. Lamin-Art, Inc.
d. Panolam Industries International, Inc.
e. Wilsonart , Inc.
f. Pionite Decorative Surfaces

G. Laminate Cladding for Exposed Surfaces:

1. Vertical Surfaces: Grade VGS .
2. Edges: Self-Edged with edges applied first, prior to faces.
3. Pattern Direction: As indicated.

H. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies and Shelves: Thermoset decorative panels.

a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Thermoset decorative panels.

I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

J. Shelf Construction: 3/4 inch thick MDF substrate with top and bottom surfaces of high-pressure decorative laminate, NEMA LD 3, Grade HGS (0.048-inches).

1. Four edges: Self Edged.

K. Case side, base and bottom panels: 3/4 inch MDF.

L. Case Back Panels: 1/2 inch thick medium density fiberboard (MDF).

M. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on Finish Schedule.

2.3 SOLID-SURFACE-MATERIAL COUNTERTOPS

A. Solid surface material: Mineral-filled polymer composition that is solid and nonporous, with color and pattern extending through its entire thickness.

B. Grade: Premium

C. Configuration: Provide countertops with 4” high backsplashes and side splashes when located beside a wall.

D. Countertops: 1/2-inch-thick, solid surface material laminated to 3/4-inch- thick marine plywood with exposed edges built up with solid surface material.

1. Prepare plywood sheet substrate in accordance with solid-surface material manufacturer’s written instructions prior to bonding solid-surface material.

E. Unless otherwise indicated build up countertop thickness to 1-1/4 inches at front, back, and ends with additional layers of substrate material laminated to top.

F. Provide additional support cleats along the sides of each individual base cabinet.

G. Backsplashes and sidesplashes: 1/2-inch- thick, solid surface material fabricated and installed as indicated.

H. Fabrication: Fabricate tops in one piece with shop-applied edges unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.
2. Sink Bowls: Comply with ISSFA-2 and ANSI Z124.3, Type 5 or Type 6, without a precoated finish.

a. Bowl shall be "integral" inconspicuous flush seamed undermount bowl.

1) Stainless steel sinks for seamless undermount.
2) Increase thickness of solid surface material around sink openings to allow for screw fasteners.

b. Sink shall be undermount incorporating bowls specified in Division 22.

3. Faucet, drain, plumbing, trim, etc., by Division 22.
4. Coordinate required openings with Division 22.

I. Solid Surface Material:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avonite Surfaces
b. E. I. du Pont de Nemours and Company
c. Formica Corporation
d. LG Chemical, Ltd.
e. Samsung Chemical USA, Inc.
f. Wilsonart

2. Colors and Patterns: As indicated on Finish Legend and Schedule.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, and B 01612, self-closing.

1. Basis of Design: Blum, Inc.: 71T Series hinges

a. 170°: All doors, except as noted.
b. 110°: For installation on cabinet doors abutting inside corner surfaces.

Door Height	Hinges per Door
0-36 inches	2
37 – 62 inches	3
63 – 80 inches	4

C. Continuous Hinges: BHMA A156.9, B01491, Bright nickel plated, 14 gauge steel.

1. Basis of Design: The Stanley Works, 314 Series.

D. Flip Up Counterbalance:

1. Assembly providing neutral balance through 90 degrees of countertop travel, such that the counter will stay in place if released anywhere within this range, utilizing modular torsion spring device.
2. Modular torsion spring device.
3. Finish: Black anodized.
4. Basis of Design: CounterBalance; Counter-A-Syst CAS Series.
5. Install per manufacturer's written instructions.

E. Door and Drawer Pulls: BHMA A156.9, B02011, back mounted, solid stainless steel, 5-3/8 inches long, 1-3/8 inches deep, and 5/16 inch in diameter.

1. Basis of Design: Sugatsune SWF 650 satin stainless steel (ADA compliant).

F. Catches: Magnetic catches, BHMA A156.9, B03141. Minimum 5 pound pull (ADA compliant).

1. Basis of Design: Stanley CD 46.

G. Adjustable Shelf Supports: BHMA A156.9, B04013.

1. Steel, nickel-plated.
2. Basis of Design: Hettich International, #052096.

H. Shelf Securing Studs

1. Flexible, translucent plastic.
2. Basis of Design: Hettich International, #1005082.

I. Shelf Standards and Brackets: BHMA A156.9, B04102 and B04112.

1. Twelve gauge steel, stainless steel finish.
2. Provide matching shelf rests for anchoring the shelf to the bracket.
3. Basis of Design: Knape and Vogt Mfg. Co., #87 and #187.

J. Drawer Slides: BHMA A156.9, B05111.

1. File Drawers: Telescoping with full extension, three hundred fifty (350) lbs. load capacity, steel ball bearings and zinc-plated finish.

   a. Basis of Design: Accuride, Model 7957

2. Box Drawers: Telescoping with full extension, one hundred fifty (150) lbs. load capacity, steel ball bearings and zinc-plated finish.

   a. Basis of Design: Accuride, Model 3634C

3. Keyboard Drawers: Telescoping with full extension, one hundred (100) lbs. load capacity, steel ball bearings and zinc-plated finish.

   a. Basis of Design: Accuride, CBERGO-TRAY 200.

K. Locks: Locks are required on 50%of cabinet drawers and doors in the Breakrooms. All drawers and doors installed in the same room are to be keyed alike.

1. Cabinet Locks: ANSI A156.11, Grade 1.

a. Pin tumbler, grooved key type, master keyed as directed by the Owner.
b. Manufacturer's standard finish as selected by the Architect.
c. Provide strike box keeper on inactive leaf at pair of doors.
d. Basis of Design: Olympus Lock, Inc., #500 DR, with Keeper #2SPD-KEPR.

2. Drawer Locks: ANSI A156.11, Grade 1.

a. Dead bolt, pin tumbler, grooved key type, master keyed as directed by the Owner.
b. Manufacturer's standard finish as selected by the Architect.
c. Basis of Design: Olympus Lock Inc., #600 DW.

L. Door and Drawer Silencers: BHMA A156.16, L03011.

1. Clear polyurethane, 8 mm diameter, self-adhesive.
2. Provide on all cabinet doors and drawers.
3. Basis of design: Häfele America Co., #356.21.428.

M. Counter Support Brackets:

1. Materials: 6063-T6 extruded aluminum, welded and ground smooth.
2. Size: 75% of counter depth, minimum.
3. Finish: Powder coat, Off-White.
4. Basis of Design: Rangine Corporation, Rakks Bracket EH Series, Flush Mount.

N. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

O. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Shims and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.6 FABRICATION

A. Fabricate cabinets to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of Cabinets: 1/16 inch unless otherwise indicated.
2. Exposed cut metal edges: 1/16 inch ground or sanded smooth.

B. Unless otherwise indicated, use substrate panel thicknesses that comply with referenced quality standard.

C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shelf Support Holes: Provide 0.20 inch holes spaced 1.25 inches on center. Locate holes no less than 1 inch or greater than 3 inches from the front and back of the cabinet. Unless noted otherwise, extend holes to within 6 inches of the cabinet top and bottom.

E. Attach hinges per manufacturer's written instructions.

F. Countertops: Layout surface to minimize joints and avoid L-shaped pieces.

G. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

B. Before installing cabinets, examine shop-fabricated work for completion including backpriming and complete work as required, including removal of packing.

3.2 CABINET INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with same quality standard grade as item to be installed.

B. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.

C. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails for exposed fastening, countersunk and filled flush with cabinet surface.

1. For shop finished items use filler matching finish of items being installed.

F. Install cabinets without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
3. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
4. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

G. Touch up finishing work specified in this Section after installation of cabinets. Fill nail holes with matching filler where exposed.

3.3 SOLID SURFACE COUNTERTOP INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet.

B. Tools: Cut and polish with water cooled powered tools or as recommended by the manufacturer.

C. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.

D. Fasten countertops with silicon adhesive applied per top manufacturer’s written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

1. Install backsplashes and sidesplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
2. Seal edges of cutouts in particleboard subtops by saturating with varnish.

E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Cutouts:

1. Cutouts shall have a minimum of 3/8 inch radius.
2. Where edges of cutouts will be exposed in finished work, ease corners and polish edges.

G. Laminate layers of surfacing material as required to create built up edges following procedures recommended by the manufacturer.

3.4 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity shall prepare and submit report of inspection.

3.5 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 41 00

SECTION 06 82 00 - GLASS-FIBER-REINFORCED PLASTIC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Fiberglass reinforced polyester panel system for adhesive mounting.

B. Moldings, adhesive, and joint sealers.

C. Related sections include the following:

1. Section 06200 - Finish Carpentry
2. Section 09260 - Gypsum Wallboard Systems

1.3 ACTION SUBMITTALS

A. Submit Product Data in accordance with Section 01 33 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Marlite

2.2 PANEL SYSTEM

A. Plastic Panel System: Factory finished panels, trim, sealant, and accessories.

B. Panels: Marlite FRP Panels; fiberglass reinforced polyester, USDA approved for incidental food contact.

1. Thickness: 3/32-inch, nominal
2. Width: 48 inches
3. Height: 96 inches
4. Height: 108 inches
5. Height: 120 inches
6. Surface Burning Characteristics: Flame spread index of 200 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84 (Class C/III).
7. Flexural Strength: 17,000 psi, when tested in accordance with ASTM D790.
8. Flexural Modulus: 600,000 psi, when tested in accordance with ASTM D790.
9. Tensile Strength: 8,000 psi, when tested in accordance with ASTM D638.
10. Tensile Modulus: 9,430 psi, when tested in accordance with ASTM D638.
11. Barcol Hardness: 40, when tested in accordance with ASTM D2583.
12. Impact Resistance: 7 ft-lb/in, when tested in accordance with ASTM D256, Izod method.
13. Coefficient of Thermal Expansion: 0.0000157 in/in/degree F, measured in accordance with ASTM D696.
14. Water Absorption: 0.17 percent, when tested in accordance with ASTM D570.
15. Specific Gravity: 1.53, when tested in accordance with ASTM D792.
16. Surface Texture: Gently pebbled, high-gloss.
17. Color: As selected by Architect from manufacturer's standard selection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Take panels out of cartons and allow to acclimatize to room conditions for at least 48 hours prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

D. Protect existing surfaces from damage due to installation.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use the adhesives recommended by the panel manufacturer unless prohibited by local regulations; obtain manufacturer's approval of alternative adhesives.

C. Install continuous bead of silicone sealant in each joint and trim groove and between trim and adjacent construction, maintaining 1/8 inch expansion space.

D. Avoid contamination of panel faces with adhesives, solvents, or cleaners; clean as necessary and replace if not possible to repair to original condition.

E. Protect installed products until completion of project.

F. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION 06 82 00

SECTION 07 13 26 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Modified bituminous sheet waterproofing system for application below grade to vertical surfaces
2. Preparation of substrate
3. Cants at all interior corners
4. Termination bar and tape
5. Various accessory materials
6. Prefabricated drainage system
7. Protection board
8. Independent inspection program

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Approximately 7 days in advance of installation of waterproofing, arrange a conference at the job site for the purpose of physically viewing all waterproofing locations, to review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs; coordination of these activities; and satisfying any conditions which might interfere with proper application.
2. Conference shall be attended by the Contractor, Waterproofing Subcontractor, the specific waterproofing foreman for the project, the representative for the manufacturer of waterproofing materials, the independent inspection firm, the concrete subcontractor, the excavation subcontractor, and the Architect.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.

2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC AC380.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
2. Installing company shall have at least five (5) years' experience in work of the type required by this section.

B. Manufacturer Qualifications: Waterproofing membranes and all accessory products shall be provided by a single manufacturer with a minimum of 30 years' experience in the direct production and sales of waterproofing systems. Manufacturer shall be capable of providing field service representation during and after construction, approving acceptable installers, recommending appropriate installation methods and providing backup remediation field services during the warranty period.

C. Independent Inspection: Owner shall make all arrangements and payments for an independent inspection service to monitor waterproofing material installation in compliance with the project contract documents and manufacturer's published literature and site-specific details. Independent Inspection Firm shall be an approved company participating with the waterproofing manufacturer's Certified Inspection Program. Inspection service shall produce reports and digital photographs documenting each inspection. Reports shall be made available to the Contractor, waterproofing installer, waterproofing material manufacturer, and Architect. Inspections shall include substrate examination, beginning of waterproofing installation, additional inspections at periodic intervals, and final inspection prior to concrete or backfill placement against the waterproofing. Independent inspection firm shall provide final sign-off prior to issuance of the warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing.

B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.

C. Remove and replace materials that cannot be applied within their stated shelf life.

D. Store rolls according to manufacturer's written instructions.

E. Protect stored materials from direct sunlight.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.
2. Do not apply waterproofing to surfaces unacceptable to manufacturer.
3. Verify that items penetrating through surfaces to receive waterproofing are rigidly installed.
4. Verify that surfaces are free of anything which may be detrimental to successful installation.
5. Starting work of this Section indicates acceptance of substrate and site conditions.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.9 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Failure includes, but is not limited to, failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate not exceeding 1/16 inch in width.
2. Warranty Period: Manufacturer shall provide a 5-year labor and material warranty for the installation. Any failure of the waterproofing system, including leaks, which develop during this period, shall be repaired by the waterproofing manufacturer.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, and molded-sheet drainage panels from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Rubberized Asphalt Sheet: Self-adhering rubberized asphalt waterproofing membrane consisting of 56 mils of rubberized asphalt laminated to a 4-mil high density cross-laminated polyethylene sheet to provide a total 60 mil membrane. The membrane shall be fabricated with a silicone release paper which shall be removed prior to application of the membrane. The membrane system shall include primers, mastics, flashing and termination accessories, as provided by the system manufacturer. The membrane shall conform to the following criteria:

1. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
2. Puncture Resistance: 40 lbf minimum; ASTM E154/E154M.
3. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.
4. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D5385.
5. Peel adhesion (ASTM D903) - 9 lb./in.
6. Lap adhesion (ASTM D1876) - 5 lb./in. (min.)
7. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C836/C836M
8. Water Vapor Permeance: 0.05 perm (2.9 ng/Pa x s x sq. m) maximum; ASTM E96/E96M, Water Method
9. Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D412, Die C, modified.
10. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D1970/D1970M

B. Manufacturer:

1. Acceptable Products subject to compliance with requirements:

    a. Carlisle Coatings & Waterproofing, Inc.; CCW Mira DRI 860/861
    b. CETCO Building Materials Group; Envirosheet
    c. GCP Applied Technologies.; Bituthene 4000
    d. Henry Company; Blueskin WP 200
    e. Soprema, Inc.; COLPHENE 3000
    f. Or equal.

2. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of sheet waterproofing material.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.

D. Liquid Membrane: Elastomeric, single-component liquid, cold fluid applied, trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Trowel Grade Detailing Mastic: single-component, elastomeric waterproofing mastic.

G. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch thick, predrilled at 8-inch centers.

H. Protection Board: Expanded-polystyrene board insulation, ASTM C578, Type I, 0.90-lb/cu. ft. minimum density, 2-inch minimum thickness; 40 psi minimum compressive strength.

2.4 PREFABRICATED DRAINAGE COMPOSITE

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing, Inc.
b. CETCO, a Minerals Technologies company.
c. GCP Applied Technologies, Inc.

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft.

1. Manufacturers: Subject to compliance with requirements, provide products by the following or equal:

    a. Carlisle Coatings & Waterproofing, Inc.
    b. CETCO, a Minerals Technologies company.
    c. GCP Applied Technologies, Inc.
    d. Soprema, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D4263.
3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D4258.

1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.

F. Bridge and cover isolation joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.

G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D6135 and manufacturer's instructions.

1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.

H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing with the mastic per manufacturer's instructions.

3.3 SHEET WATERPROOFING APPLICATION

A. Install modified bituminous waterproofing membrane according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D6135.

B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.

D. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

E. Seal edges of sheets at terminations under metal counterflashings, ending in reglets or termination bars with mastic.

F. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing/flashing materials.

G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.

H. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

I. Do not cover waterproofing membrane until Owner’s field quality control inspections are complete.

J. Install protection board with butted joints over waterproofing membrane, with adhesive spots.

3.4 PREFABRICATED DRAINAGE COMPOSITE INSTALLATION

A. Place and secure prefabricated drainage composite panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. Install prefabricated drainage composite over insulation protection board per detail on drawings, down onto footing. Wrap ends of PDC panels with additional geotextile to prevent soil from contaminating the cores. Lap panels 4 inches and snap dimples. Install geotextile continuously overlaps.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests, and to furnish reports to Architect.

B. Testing agent will inspect substrate conditions; surface preparation; membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

3.6 PROTECTION, REPAIR AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed board insulation and prefabricated drainage composite from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 26

SECTION 07 16 19 - METAL OXIDE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes metal-oxide waterproofing.

B. Related Requirements:

1. Division 03 Section "Cast-in-Place Concrete" for elevator pit and the finishing of concrete walls and slabs to receive waterproofing.

1.4 ACTION SUBMITTALS

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Applicator.

B. Product Certificates: For each type of waterproofing, patching, and plugging material.

C. Product Test Reports: For each product formulation, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm experienced in applying metal-oxide waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit metal-oxide waterproofing to be performed according to manufacturer's written instructions.

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F or above during work and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

A. Metal-Oxide Waterproofing Compound: A product specifically formulated for waterproofing concrete and masonry substrates and containing pulverized iron and a chemical oxidizing agent to cause the iron particles to rust and grow in size in the presence of water.

1. Basis of Design: Anti-Hydro International, Inc.; A-H Metallic Waterproofing
2. Manufacturers: Subject to compliance with requirements, other manufacturers offering products that may be incorporated into the Work include:

    a. Euclid Chemical Company (The); an RPM company.
    b. Metalcrete Industries.
    c. or equal.

2.2 ACCESSORY MATERIALS

A. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.

B. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.

C. Portland Cement: ASTM C150/C150M, Type I.

D. Sand: ASTM C144.

E. Water: Potable.

2.3 MIXES

A. Metal-Oxide Coats: Add metal-oxide waterproofing compound and other mix components, if any, to water according to manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency for each coat.

B. Protection Coat: Measure, batch, and mix portland cement and sand in the proportion of 1:2-1/2 and water. Blend together with mechanical mixer to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

A. Comply with manufacturer's written instructions.

B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.

C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.

D. Stop active water leaks with plugging compound.

E. Repair damaged or unsatisfactory substrate with patching compound.

1. At holes and cracks 1/16 inch wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch deep. Fill reveal with patching compound flush with surface.

F. Surface Preparation: Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

1. Clean concrete surfaces according to ASTM D4258.

a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution according to ASTM D4260.
b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning according to ASTM D4259.

2. Concrete Joints: Clean reveals.

3.3 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
2. Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:

    a. Onto every substrate in areas indicated for treatment, including pits and and similar offsets and features.

3. Number of Metal-Oxide Coats: Two.
4. Application Method: Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids. Brush each subsequent coat into full contact with previous coat.
5. Dampen surface between coats.
6. Allow each coat to set for 24 hours between coats.

B. Protection Coat: Immediately after metal-oxide coats have set, apply protection coat on walls to a thickness of 1/8 inch.

1. Finish: Smooth.

D. Curing: Moist-cure waterproofing for three days immediately after installation has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.

D. Curing: Moist-cure waterproofing for three days immediately after installation has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed application of waterproofing.

B. Prepare test and inspection reports.

END OF SECTION 07 16 19

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Glass-Fiber Board Insulation
2. Mineral-Wool Board Insulation
3. Glass-Fiber Batt/Blanket Insulation
4. Mineral-Wool Batt/Blanket Insulation
5. Accessories
6. Fasteners

B. Related Sections:

1. Division 01 Section “Temporary Facilities and Controls” for moisture and mold field quality control procedures.
2. Division 04 Section “Unit Masonry” for insulation and drainage board installed in masonry cavity wall construction.
3. Division 07 “Roofing” and “Waterproofing” sections for insulation installed as part of roofing and waterproofing construction.
4. Division 07 Section “Firestopping” for insulation installed as part of a fire-resistive penetration or perimeter joint system.
5. Division 09 Section “Gypsum Board Systems" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BOARD INSULATION

A. Products: Subject to compliance with requirements, provide one of the following:

1. Owens Corning; 700 series FSK
2. CertainTeed Corporation; CertaPro Commercial Board FSK.
3. Johns Manville; Insul-Shield FSK.

B. Foil-Faced, Glass-Fiber Board Insulation: ASTM C612, Type IA; faced on one side with foil-scrim-kraft (FSK) vapor barrier, with maximum flame-spread and smoke-developed index of 25 per ASTM E84, with a maximum permeance 0.05 per ASTM C1136.

1. Provide Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.2 MINERAL-WOOL BOARD INSULATION

A. Products: Subject to compliance with requirements, provide one of the following:

1. Johns Manville; a Berkshire Hathaway company; CladStone Water & Fire Block
2. Thermafiber, Inc.; an Owens Corning company; RainBarrier
3. Rockwool International; Cavityrock

4. Nominal density of 4 lb/cu. ft., Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.3 GLASS-FIBER BATT/BLANKET INSULATION

A. Products: Subject to compliance with requirements, provide one of the following:

1. Johns Manville; Fiberglass Insulation.
2. Knauf Insulation; EcoBatt Thermal/Acoustical Insulation.

3. Owens Corning; EcoTouch Pink Fiberglass Insulation.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

C. Thermal Resistivity in accordance with ASTM C518

2.4 MINERAL-WOOL BATT/BLANKET INSULATION

A. Products: Subject to compliance with requirements, provide products by one of the following:

1. Johns Manville; a Berkshire Hathaway company; Mineral Wool Batts.
2. Rockwool International; AFB
3. Thermafiber, Inc.; an Owens Corning company; Ultra-Batt.

B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 per ASTM E84; passing ASTM E136 for combustion characteristics.

2.5 SHEET VAPOR BARRIER

A. Flame-retardant insulation facing vapor barrier: lightweight aluminum foil, fiberglass yarn reinforcing and natural kraft paper laminated with a flame-retardant adhesive. Compliant with ASTM E84: flame spread <25 / smoke developed < 50. Product shall have a maximum permeance of 0.05 perms per ASTM E96. Product provided in rolls 50 in. wide by 600 ft. long.

1. Sheet Vapor Barrier: Subject to compliance with requirements, provide the following or an equivalent product by another manufacturer: Johns Manville; FSK 25 Cap Sheet.

2.6 ACCESSORIES

A. Adhesive for bonding insulation: Product compatible with insulation and air and vapor barrier (AVB) materials and with demonstrated capability to bond insulation securely to substrates without damaging insulation or substrates.

B. Vapor-Barrier Tape: Four-inch-wide pressure-sensitive tape of type FSK as recommended by vapor-barrier manufacturer for sealing joints and penetrations in vapor barrier.

C. Vapor-Barrier Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

D. Single-Component Nonsag Urethane Sealant: ASTM C920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates. Sealant shall have demonstrated capability to bond vapor barrier to substrates indicated.

2.7 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AGM Industries, Inc.; TACTOO Insul-Hangers.
b. Gemco; Insulation Hangers.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030-inch thick by 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Gemco; 90-Degree Insulation Hangers.

2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AGM Industries, Inc.; SC150.
b. Gemco; S-150.

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

a. Ceiling plenums.
b. Mechanical or Electrical Rooms
c. Where indicated.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Gemco; Clutch Clip.

E. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AGM Industries, Inc.; TACTOO Adhesive.
b. Gemco; Tuff Bond Hanger Adhesive.

PART 3 - EXECUTION

3.1 PREPARATION

A. With installer present, examine substrates and conditions for compliance with the requirements of Sections in which substrates and related work are specified and for other conditions which may adversely affect performance, including temperature and humidity restrictions for the installation of foam insulation products. Do not proceed with this work until all substrates have been prepared as required.

B. Clean substrates of substances that are harmful to insulation or vapor barriers, including removing projections capable of puncturing vapor barriers, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 VAPOR BARRIER INSTALLATION, GENERAL

A. Vapor Barrier Continuity: The Contract Documents indicate a continuous vapor barrier as part of the building enclosure design.

1. Maintain continuity of building vapor barrier by forming an airtight seal at the perimeter of areas indicated to receive vapor barriers, to adjacent construction and to vapor barrier products specified as the work of other sections by applying vapor barrier tape, by overlapping or as otherwise indicated.

2. At openings in exterior walls, including doors, window systems and louvers, extend the vapor barrier into the rough opening and terminate with vapor barrier tape or as otherwise indicated.
3. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor barriers with vapor-barrier tape to create an airtight seal between penetrating objects and vapor barriers.
4. Repair tears or punctures in vapor barriers immediately before concealment by other work. Cover with vapor-barrier tape or another layer of vapor barrier.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Glass-Fiber or Mineral-Wool Batt/Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
5. Vapor-Barrier-Faced Batt/Blankets: Tape joints and ruptures in vapor-barrier facings and seal each continuous area of insulation to ensure airtight installation.

    a. Exterior Walls: Set units with facing placed toward interior of construction.
    b. Interior Walls: Set units with facing placed toward areas of high humidity**.**

3.5 INSULATION INSTALLED IN JOINTS, CRACKS AND VOIDS

A. Mineral Wool Batt Insulation: Provide un-faced mineral wool compression fit into voids and spaces around window and door openings and where indicated. Completely fill joints, cracks and voids. Recess mineral wool sufficiently to allow the installation of backer rod and sealant where indicated.

1. Compact mineral wool to approximately 40 percent of normal maximum volume.

B. Spray-Applied Polyurethane Foam: Install spray-apply insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. Completely fill joints, cracks and voids. After insulation is applied, make flush with face of void by using method recommended by insulation manufacturer.

1. Verify selected product is compatible with application substrate per manufacturer’s technical data.

3.6 INSTALLATION OF BOARD INSULATION ON MASONRY AND CONCRETE SUBSTRATES

A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
3. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
4. Where insulation will not be covered by other building materials or will received an applied vapor barrier, apply capped washers to tips of spindles.

3.7 INSTALLATION OF SHEET VAPOR BARRIERS

A. Sheet vapor barrier shall be applied after un-faced insulation has been installed.

B. Place vapor barriers on side of insulation indicated on Drawings. Extend vapor barriers to extremities of areas to protect from vapor transmission. Secure vapor barriers in place with vapor barrier tape or other anchorage system as indicated. Extend vapor barriers to cover miscellaneous voids in insulated substrates, including those filled with spray foam insulation.

C. Tape joints and ruptures in vapor barrier and seal each continuous area of insulation to ensure airtight installation.

3.8 MOISTURE AND MOLD FIELD QUALITY CONTROL

A. Reference Division 01 Section “Temporary Facilities and Controls” for moisture and mold field testing and remediation procedures applicable to the work of this section.

3.9 PROTECTION

A. Protect installed insulation and vapor barriers from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 41 13.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Vertical rib standing seam metal roof panel.
2. Underlayments.
3. Flashings, curbs and accessories.
4. Thermal Insulation and Substrate and Cover Board.

B. Related Sections:

1. Division 07 Section “Insulated Metal Wall Panels” for adjoining cladding and interfacing construction.
2. Division 07 Section “Sheet Matal Flashing and Trim” for miscellaneous flashings required from insulated metal panels to standing-seam metal roof panels.

1.3 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, substrate boards, underlayment and accessories necessary for a complete weathertight roofing system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.

B. Shop Drawings:

1. Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

2. All shop drawings must be signed and sealed by a qualified professional engineer licensed in the state where the work will be performed.
3. Furnish shop drawings prepared by the product manufacturer, (not the roof contractor), complete with details of all major interfaces and periphery conditions.
4. Shop drawings shall specify and indicate all materials furnished as well as finishes to be applied.
5. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, design loads, support, support points, tie backs, and other elements pertinent to the design.
6. These shop drawings shall also serve as field installation drawings and be complete with specific instructions for the application of the products, periphery trim, and all sealants, lapstrips, etc., to insure a weathertight installation.
7. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

    a. Flashing and trim.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Roof Panels: 12 inches long by actual panel width. Include fasteners, clips**,** battens**,** closures, and other metal roof panel accessories.
2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Design Data for Metal Roof Panel System: Design metal roof panel system under direct supervision of the manufacturer employed Engineer. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as “Not Reviewed”.

B. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
2. Statement that the Professional Engineer is fully experienced in the design of metal roof systems.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
5. Statement that the design shall be in accordance with the aesthetic design intent of the project with the Architect having final authority in reference to aesthetic matters.
6. Statement that the Professional Engineer will submit an additional signed and sealed letter at the conclusion of the work related to this section stating that the fabrication and installation of the metal roof system has been performed in accordance with the Professional Engineer's design.

C. Coordination Drawings: Roof plans, drawn to scale, on which the following are shown and coordinated with each other, based on input from installers of the items involved:

1. Roof panels and attachments.
2. Purlins and rafters.
3. Roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.

D. Qualification Data for manufacturer, erector/installer and professional engineer.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

F. Field quality-control reports.

G. Warranties: Samples of special warranties.

1.6 RECORD SUBMITTALS

A. Final Certification Letter from Delegated-Design Professional: After construction of the metal roof system is complete, submit a signed and sealed Certification Letter from the responsible design professional stating that the fabrication and installation of the metal roof system has been performed in accordance with the Professional Engineer's design.

1.7 CLOSEOUT DOCUMENTS

A. Maintenance Data: For metal roof panels to include in maintenance manuals.

B. Warranties: Final warranties to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: The product manufacturer shall have a minimum of 10 years of experience in the manufacturer of exterior metal roof system and shall have successfully manufactured a minimum of 5 projects similar to this project.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer. Metal roof system installer shall have completed a minimum of five metal roof panel projects similar in material, design and extent to that indicated for this project with a record of successful in-service performance.

C. Professional Engineer's Qualifications: A Professional Engineer, who is legally qualified to practice in the state where the work will be performed, and who is experienced in providing engineering services of the kind indicated.

D. System Engineering: Engineering (shop drawings) shall only be acceptable from the product manufacturer. Shop drawings from metal roof system contractor are NOT acceptable. Shop drawings for all roof panels, shall be submitted by one manufacturer at one time as a complete submittal package.

E. Statement of Specification Compliance: Both the metal roof system contractor and manufacturer shall submit and sign a statement that all materials supplied for this project shall only be manufactured by the specified manufacturer. It is the intent of this section that the metal roof system be provided as a complete system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof panels with rain drainage work, flashing, trim, and construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies including all trim, substrate board, underlayment, insulation, gutters, etc. that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including rupturing, cracking, or puncturing.
    b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Hunter units when tested according to ASTM D2244
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for low-slope roof products.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

G. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A90.
2. Hail Resistance: MH.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips inside laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Basis-of-Design Product: CENTRIA Architectural Systems, ADP-100 roof panels.
2. Other Acceptable Manufacturers subject to compliance with requirements.

    a. Advanced Architectural Products.
    b. AEP Span; A BlueScope Steel Company.
    c. Architectural Building Components.
    d. Architectural Metal Systems.
    e. Berridge Manufacturing Company.
    f. Merchant and Evans.

3. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 0.040 inch.
    b. Exterior Finish: Two-coat fluoropolymer containing not less than 70% PVDF resin in color and topcoat complying with AAMA 2605.
    c. Color: Match Insulated Metal Wall Pael finish.

4. Aluminum Sheet: Coil-coated sheet, ASTM B209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

    a. Thickness: 0.040 inch.
    b. Surface: Smooth, flat finish.
    c. Exterior Finish: Two-coat fluoropolymer containing not less than 70% PVDF resin in color and topcoat complying with AAMA 2605.
    d. Color: Match Insulated Metal Wall Pael finish.
    e.

5. Clips: One-piece fixed or two-piece floating to accommodate thermal movement.

    a. Material: 0.064-inch-nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

b. Material: 0.062-inch-thick, stainless-steel sheet.

6. Panel Coverage: 12 inches.
7. Panel Height: 1 inch.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
3. Products:

a. Basis of Design: Carlisle Coatings & Waterproofing, Inc., Div. of Carlisle Companies, Inc.; CCW WIP 300HT
b. Other Acceptable Manufacturers subject to compliance with requirements:

1) Grace Construction Products; a unit of Grace, W. R. & Co.; Ultra
2) Henry Company; Blueskin PE200 HT

B. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 SUBSTRATE BOARD AND COVER BOARD

A. Glass-Mat Gypsum Board: ASTM C1177/C1177M; 5/8-inch-thick type X.

1. Product: Subject to compliance with requirements, provide Dens-Dek by Georgia-Pacific Corporation or equal.

B. Substrate Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

A. Faced, Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 2 felt or glass-fiber mat, Grade 3, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.

2.6 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed metallic-coated steel sheet, ASTM A653/A653M**,** G90, hot-dip galvanized. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Fasteners for Miscellaneous Metal Framing: Self-tapping screws designed to withstand design loads of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch-wide and 1/8 inch-thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

F. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. All fasteners shall be 300 series stainless steel. Exposed fasteners are not permitted.

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. End Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.8 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

E. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support and soffit members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing/substrate board/insulation to verify that joints are supported by framing or blocking, and that installation is within flatness tolerances required by metal roof panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

C. Cover Board and Roof Insulation Installation: Install cover boards over roof insulation on entire roof surface. Attach with substrate-board fasteners.

1. Install cover board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt boards together.
2. Comply with UL and FMG requirements for fire-rated construction.
3. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

3.3 UNDERLAYMENT INSTALLATION

A. Breathable Synthetic Underlayment: Comply with written instructions of underlayment manufacturer for installation. Apply at locations indicated below and, on the drawings, wrinkle free, in shingle fashion to shed water.

1. Apply over the entire roof surface.
2. Apply on the roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering underlayment not less than 3-inches, in shingle fashion to shed water.

B. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below and on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.
2. Apply over the roof area indicated below:

    a. Roof perimeter for a distance up from eaves of 36 inches beyond interior wall line.
    b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
    c. Rake edges for a distance of 18 inches.
    d. Hips and ridges for a distance on each side of 18 inches.
    e. Roof to wall intersections for a distance from wall of 18 inches
    f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.

C. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.4 METAL ROOF PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.

4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Provide metal roof panels of full length from eave to ridge.

C. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.

1. Point of Fixity: Fasten each panel along a single line of fixing located by the panel manufacturer's design and engineering to best suit the roof configuration.
2. Do not attach accessories or items through roof panels in a manner that will inhibit thermal movement, unless specifically indicated by the manufacturer.

D. Fasteners:

1. Steel Roof Panels: Use stainless-steel fasteners.
2. Aluminum Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or stainless-steel fasteners for surfaces exposed to the interior.
3. Copper Panels: Use copper, stainless-steel, or hardware-bronze fasteners.

E. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

F. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.

G. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

H. Joint Sealers: Install gaskets, joint fillers, and sealants within system where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.

I. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

J. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13.16

SECTION 07 42 13.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

B. Related Requirements:

1. Division 05 Section "Cold-Formed Metal Framing" for support framing, including girts, studs, and bracing.
2. Division 06 Section “Sheathing” for substrate.
3. Division 07 Section “Fluid-Applied Membrane Air and Vapor Barrier (AVB)”
4. Division 07 Section "Formed Metal Wall Panels" for foamed metal wall panels.
5. Division 07 Section "Sheet Metal Flashing and Trim" for flashing and other sheet metal work that is not part of metal wall panel assemblies.

1.3 DEFINITION

A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.

5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Distinguish between factory-, shop- and field-assembled work.
3. System Engineering: Engineering (shop drawings) shall only be acceptable from the product manufacturer for the metal wall panel and support system. Shop drawings from metal wall system contractor will not be acceptable. Shop Drawings shall be signed and sealed by a qualified professional engineer licensed in the state where the work will be performed.

    a. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, design loads, support, support points, tie backs and other pertinent structural information.
    b. Coordinate with Division 01 Section “Project Management and Coordination” for building enclosure coordination drawing requirements.

4. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Manufacturer/Fabricator.

B. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:

1. Wall panels and attachments.
2. Girts, Stud framing.
3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

C. Design Data for Metal Wall Panel System: Design metal wall panel system under direct supervision of the manufacturer employed Engineer. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as "Not Reviewed".

D. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
2. Statement that the Professional Engineer is fully experienced in the design of metal wall systems.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
5. Statement that the design shall be in accordance with the aesthetic design intent of the project with the Architect having final authority in reference to aesthetic matters.
6. Statement that the Professional Engineer will submit an additional signed and sealed letter at the completion of the work related to this section stating that the fabrication and installation of the metal wall system has been performed in accordance with the Professional Engineer's design.

E. Product Test Reports: For each product, tests performed by a qualified testing agency.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

1.7 RECORD SUBMITTALS

A. Final Certification Letter from Delegated-Design Professional: After construction of the metal wall system is complete, submit a signed and sealed Certification Letter from the responsible design professional stating that the fabrication and installation of the metal wall system has been performed in accordance with the Professional Engineer’s design.

1.8 CLOSEOUT DOCUMENTS

A. Maintenance Data: For metal panels to include in maintenance manuals.

B. Warranties: Executed warranties to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Manufacturer/Fabricator Qualifications: A firm experienced in the manufacturing of products or systems similar to those indicated for this project and with a record of successful in-service performance, as well as sufficient production capacity to produce the required units. All formed metal panels specified in this section shall be supplied by a single manufacturer with a minimum of ten years of demonstratable experience.

B. Installer Qualifications:

1. An entity that employs installers and supervisors who are trained and approved by manufacturer.
2. Metal wall system installer shall have completed a minimum of five metal wall panel projects similar in material, design and extent to that indicated for this project with a record of successful in-service performance. The metal wall system installer shall also be able to show a minimum of ten years of experience.

C. Professional Engineer's Qualifications: A Professional Engineer, who is legally qualified and licensed to practice in the State where the project is located, who is employed by the manufacturer, and who is experienced in providing engineering services of the kind indicated.

D. Source Limitations: Metal wall panel system shall be obtained from a single source, from a single manufacturer, including all accessories.

E. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly as shown on Drawings <**Insert size**>, including corner, soffits, supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.12 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.
c. Weather tightness, including air and water infiltration.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of the design loads and stresses within limits and under conditions indicated, based on testing according to ASTM E1592:

1. Dead Loads: Account for weight of storefront window system at conditions where window system bears on metal wall panel assembly.
2. Wind Loads: Determine loads based on the following minimum design wind pressures:

a. Uniform pressure as indicated on the Structural Drawings.
b. Account for wind loads from storefront window system where connections are made to metal wall panel assembly.

3. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 or 3/4 inch maximum, whichever is less, of the span.
4. Movement of Structural Frame: Design components and connections to accommodate movement of structural frame as listed below:

a. Story Drift

1) Accommodate design displacement of adjacent stories equal to 1/400 of span between supports.

b. Deflection at midspan of supporting members

1) Accommodate vertical downward deflection of 1/720 of the span with a maximum of 0.5 inches under live load conditions.

5. Tolerances

a. Connections and anchorage shall be designed to provide adjustability for final alignment.
b. The maximum allowable girt steel deviation from a theoretical girt plane is ± 1/2 inch. In any 20-foot length horizontally or vertically, this deviation cannot vary more than 1/4 inch. Transition areas such as corners and soffits shall have girt steel ± 1/8 inch of the theoretical girt plane.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E119.
2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.

4. Potential Heat: Acceptable level when tested according to NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

F. Design exterior metal wall and support system and connections to accommodate, by means of expansion joints, movement in structure and between cladding elements and structure without permanent distortion, damage to components, wracking of joint connections or breakage of seals.

G. Fatigue Test: There shall be no evidence of metal/foam interface delamination when the panel is tested by simulating wind loads of 20 psf, positive and negative, for two million alternate cycles. Test results must be verified by an independent testing facility.

H. Rain Screen Test for Horizontal Panels: With liner side seal broken, there shall be no water rise in the horizontal joint cavity under 10 psf and in accordance with ASTM E331.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

    a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
    b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.
    c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.
    d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.

B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Basis-of-Design Product: CENTRIA Architectural Systems, Formawall Dimension Series.
2. Other Acceptable Manufacturers: Subject to compliance with requirements, products by the following comparable manufacturers or equal may be provided:

    a. Kingspan.
    b. MBCI, a division of NCI Building Systems, L.P.
    c. Metl-Span LLC.

3. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 0.034 inch.
b. Exterior flat and profiled insulated wall panels.
c. Panel face finish: Embossed.

4. Tongue and groove, shiplap side joint design with fasteners concealed within side joint. Concealed design shall fully capture face and liner sheets.
5. Module tolerance plus 1/16 inch or minus 1/8 inch adjustment feature.
6. Interior female joints factory caulked.
7. Horizontal application face design shall have nominal 1/2 inch capillary break and sloped drain shelf to create the rain screen effect and a pressure equalization chamber. The nominal gutter height shall be 2-1/4 inches.
8. Where so indicated on drawings, trimless or closed end panels shall be factory fabricated and utilize a field installed recessed, dry gasket in lieu of exposed wet sealants or battens. Field fabrication of trimless end on horizontal panels will NOT be accepted.
9. Trim shown on the architectural drawings, including sill and reveal trim, and copings shall be made of extruded aluminum: Trim shall be painted to match adjacent panels unless indicated to be a different color on the architectural drawings. All trim splice joints are to be clearly shown on the manufacturer's submittal drawings, and it is the design intent that splice joints are only to occur at vertical panel joints.
10. Concealed fasteners and clip assemblies shall be provided in type as recommended and furnished by the manufacturer.
11. All panel corners shall be trimless, and factory made by the metal wall panel manufacturer, not the metal wall panel contractor.
12. Panel Coverage and Orientation: As indicated on drawings.
13. Panel Thickness: 3.0 inches.
14. Thermal-Resistance Value (R-Value): 21 according to ASTM C 1363.

C. Exterior Finish: Two-coat fluoropolymer.

1. Color: As selected by Architect from manufacturer's full range to match Architect’s Sample.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Formed from same material and gauge as wall panels, zinc-coated, G90 (galvanized) steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels. Provide manufacturer's standard extruded aluminum trim pieces, including at jambs, sills, copings, etc., finish to match wall panels, indicated on the drawings, at insulated metal/panels and interlocking profile panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Panels shall be fabricated foamed in place wall panels between metal facer and backer sheets. Insulated panels shall be fabricated with a double tongue and groove lap joint and butt side joints whereby a capillary break and pressure equalized joint design is achieved.

F. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

G. Extruded Panel Trim: Fabricate trim and accessories from extruded aluminum, for panel systems where indicated, and where required as part of manufacturer's standard system.

H. Manufacture exterior metal wall system to ensure similarity of dimension and finish throughout.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION, GENERAL

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Apply pre-formed silicone tape continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.

8. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
9. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners: Use stainless-steel fasteners for all panel attachment to substrate.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.

3.4 INSULATED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.

B. Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Metal wall panels will be considered defective if they do not pass test and inspections.

E. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13.19

SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleaning substrate.
2. Adhered polyvinyl-chloride (PVC) roofing system.
3. Roof cover board.
4. Roof insulation.
5. Vapor barrier and primer
6. Roof walkway pads.
7. Flashing and sealing membrane to curbs, termination, etc.
8. Installation of roof drains furnished under Division 22.
9. Installation of prefabricated curbs furnished under Division 23.
10. Inspection by membrane manufacturer.

B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.Division 06 Section "Sheathing" for wood-based, structural-use roof deck panels.
2. Division 07 Section "Thermal Insulation" for insulation beneath the roof deck.
3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Division 07 Section "Manufactured Roof Expansion Joints" for proprietary manufactured roof expansion-joint assemblies.
5. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
6. Division 22 Section "Plumbing Systems" for roof drains
7. Division 23 – HVAC for mechanical penetrations.
8. Division 26 – Electrical for electrical penetrations.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in the Technical Dictionary of NRCA’s “Roofing Manual: Architectural Metal Flashing and Condensation and Air Leakage Control” apply to Work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.
10. Determine whether Owner will require additional testing.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:

1. Base flashings and membrane terminations.
2. Layout and thickness of insulation, including slopes.
3. Flashing details at penetrations.
4. Insulation fastening patterns.
5. Tie-in with air & vapor barrier.

C. Samples for Verification: For the following products:

1. Sheet roofing, of color required.
2. Aggregate surfacing material in gradation and color required.
3. Walkway pads or rolls, of color required.

D. Submit manufacturer's instructions for surface conditioner compatibility, elastic flashing, joint cover sheet, and joint and crack sealants, with temperature range for application of roofing membrane.

E. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Product Data: For adhesives and sealants, indicating VOC content.
3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
4. Environmental Product Declaration: For each product.

B. Qualification Data: For Installer and manufacturer.

C. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

D. Installer Certificates: Signed by roofing installer certifying that the system installed meets all identified code and insurance requirements as required by this Section.

E. Product Test Reports: For components of roofing system, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

G. Field Test Reports:

1. Concrete internal relative humidity test reports.

H. Field quality-control reports.

I. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT DOCUMENTS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

C. Warranties: Sample warranties to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. FMG certified roofing installer.

C. There shall be no deviation made from the Project Specification or the approved shop drawings without prior written approval by the Architect and Manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.

1. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
2. Adhesives shall be stored at temperatures between 40-degree F and 80-degree F.
3. Flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow storage precautions supplied by material manufacturer/supplier.

D. Place all materials on pallets and fully protect from moisture.

E. Membrane rolls shall be stored lying down on pallets and fully protected from the weather with clean canvas tarpaulins. Unvented polyethylene tarpaulins are not acceptable.

F. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Perform inspection prior to membrane installation in presence of representative of membrane manufacturer.

1. Verify that drains, sleeves, curbs and other penetrations which pass through surfaces to receive roofing are rigidly installed.
2. Verify that surfaces are free of cracks, depressions, waves or projections which may be detrimental to successful installation. Remove foreign materials.
3. Starting work of this Section indicates acceptance of substrate and site conditions.

C. Only as much of the new roofing as can be made weathertight each day, including all flashing and detail work, shall be installed daily. All seams shall be heat welded before leaving the job site that day.

D. Surfaces to receive new insulation, membrane or flashings shall be dry. Should surface moisture be present, the Installer shall provide the necessary equipment to dry the surface prior to application.

E. The Applicator is cautioned that certain PVC membranes are incompatible with asphalt, coal tar, heavy oils, roofing cements, creosote and some preservative materials. Such materials shall not remain in contact with PVC membranes. The Applicator shall consult the manufacturer regarding compatibility, precautions and recommendations.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, roof pavers, vapor barriers and other components of roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, roofing accessories, roof pavers, vapor barriers, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain components including roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, vapor barriers, and walkway products for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D3746 or ASTM D4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. Roofing System Design: Per ASCE 7 and the information provided on the structural drawings.

D. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures provided on the structural drawings when tested according to FM Approvals 4474, UL 580, or UL 1897:

E. FM Approvals' RoofNav Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings. Roof system shall meet the following criteria.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail-Resistance Rating: SH.

F. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 or initial SRI not less than 82 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

G. Energy Star Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

H. Energy Performance: Roofing system shall have an initial solar reflectance index of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

I. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 PVC ROOFING

A. PVC Sheet: ASTM D4434/D4434M, Type III, fabric reinforced and fabric backed.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Sarnafil
    b. Carlisle SynTec Incorporated.
    c. Duro-Last Roofing, Inc.
    d. Flex Membrane International Corp.
    e. GAF.
    f. Johns Manville; a Berkshire Hathaway company.
    g. Versico Roofing Systems.

2. Thickness: 60 mils, nominal.
3. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

2. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.

C. Deck Primers

1. Provide solvent or water-based primer where system manufacturer recommends application.

D. Bonding Adhesive: Manufacturer's standard, water based.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.

G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

H. VAPOR RETARDER

1. Self-Adhering-Sheet Vapor Retarder: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
2. Temporary Construction Roof: Vapor barrier intended for use as a temporary construction roof by the Contractor shall be product approved in writing by the membrane manufacturer for this purpose.

    a. The Contractor shall arrange for the roofing system manufacturer's technical personnel to inspect the vapor retarder and recommend required repairs before proceeding with the installation of the permanent roof over the temporary.

2.5 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by PVC roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2 or Type II, Class 1, Grade 3, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with membrane manufacturer’s requirements, provide products by one of the following or an alternate manufacturer approved by the membrane manufacturer:

    a. Atlas Roofing Corporation
    b. Carlisle SynTec Incorporated
    c. Dyplast Products
    d. Firestone Building Products
    e. GAF Materials Corporation
    f. Hunter Panels
    g. Insulfoam LLC; a Carlisle company
    h. Johns Manville
    i. Rmax, Inc.

2. Compressive Strength: 20 psi.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.

2. Minimum Thickness: 1/4 inch.
3. Slope:

    a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
    b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated and as required to avoid obstructions and create positive slope to drains.

2.6 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread spray-applied, low-rise, two-component urethane adhesive.

1. Adhesives and sealants shall comply with the following limits for VOC content:

    a. Plastic Foam Adhesives: 50 g/L.
    b. Gypsum Board and Panel Adhesives: 50 g/L.
    c. Multipurpose Construction Adhesives: 70 g/L.
    d. Fiberglass Adhesives: 80 g/L.
    e. Contact Adhesives: 80 g/L.
    f. PVC Welding Compounds: 510 g/L.
    g. Other Adhesives: 250 g/L.
    h. Single-Ply Roof Membrane Sealants: 450 g/L.
    i. Nonmembrane Roof Sealants: 300 g/L.
    j. Sealant Primers for Nonporous Substrates: 250 g/L.
    k. Sealant Primers for Porous Substrates: 775 g/L.

2. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 COVER BOARD:

A. ASTM C1177/C1177M, glass-mat, mold and water-resistant gypsum substrate, 5/8 inch thick.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corporation; GlasRoc Roof Board.
    b. Georgia-Pacific Corporation; Dens Deck.
    c. National Gypsum Company; Dexcell FA Glass Mat Roof Board

d. USG Corporation; Securock Glass Mat Roof Board.

2.8 ASPHALT MATERIALS

A. Roofing Asphalt: ASTM D312/D312M, Type III or Type IV.

B. Asphalt Primer: ASTM D41/D41M.

2.9 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

1. Size: Approximately 36 by 60 inches.
2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer when tested according to ASTM F2170.

   a. Test Frequency: One test probe per each 1000 sq. ft., or portion thereof, of roof deck, with no fewer than three test probes.
   b. Submit test reports within 24 hours of performing tests.

5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

E. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

F. Installation shall be in accordance with UL and FMG requirements.

3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Division 07 Sections Air and Vapor Barriers.

3.4 VAPOR-RETARDER INSTALLATION

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.5 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Insulation Installation.:

1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows and end joints staggered not less than 12 inches in adjacent rows.

    a. Adhesively adhered boards shall be 48 inches square.
    b. Install insulation in two or more layers under area of roofing to achieve required thickness, where overall insulation thickness is 2 inches or greater. Install insulation with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    f. Trim insulation so that water flow is unrestricted.
    g. Fill gaps exceeding 1/4 inch with insulation.
    h. Cut and fit insulation within 1/4 inchof nailers, projections, and penetrations.
    i. Adhere base layer of insulation to vapor retarder according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

        1) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
        2) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.

    a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
    d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    e. At mechanical equipment units or other obstructions wider than 24 inches (610 mm), provide crickets on the upslope side.
    f. Trim insulation so that water flow is unrestricted.
    g. Fill gaps exceeding 1/4 inch with insulation.
    h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
    i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
2) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

3.7 ADHERED ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roofing and allow to relax before retaining.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owner's testing and inspection agency.

D. Accurately align roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed roof membrane.

G. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.

H. Apply roofing with side laps shingled with slope of roof deck where possible.

I. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.8 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings.

3.9 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.

1. Install flexible walkways at the following locations:

    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform the following test:

1. Low-Voltage Electrical Conductance Testing: Testing agency shall survey entire roof area and flashings to locate discontinuity in the roof membrane using an exposed metal electrical loop to create an electrical field tested with handheld probes.

    a. Perform tests before overlying construction is placed.
    b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

        1) Cost of retesting is Contractor's responsibility.

    c. Testing agency shall prepare survey report indicating locations of initial discontinuities, if any.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.1 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: SNHD.
2. Address: 280 S. Decatur Blvd., Las Vegas, NV 89107
3. Building Name/Type: New Laboratory Building
4. Address: 700 South M. L. K. Blvd., Las Vegas, NV 89106Area of Work: Roof of Building.
5. Acceptance Date: _____.
6. Warranty Period: 2 Years.
7. Expiration Date: _____.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding as indicated on Structural drawings.
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 54 19

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Formed or manufactured through-wall flashing.
2. Formed or manufactured reglets with counterflashing.
3. Formed roof-drainage sheet metal fabrications.
4. Formed low-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.
6. Formed equipment support flashing.
7. Formed overhead-piping safety pans.

B. Related Sections:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers and sheathing installed in support of flashings.
2. Division 04 Section “Unit Masonry” for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry
3. Division 06 Section “Sheathing” for substrate.
4. Division 07 Section “Fluid-Applied Membrane Air and Vapor Barrier (AVB)” for installing sheet metal flashing and trim which interfaces with air barriers.
5. Division 07 Sections "Polyvinyl-Chloride (PVC) Roofing" for installing sheet metal flashing and trim integral with low-slope roofing.
6. Division 07 Section "Formed Metal Wall Panels" for sheet metal flashing and trim integral with steep-slope metal roof panels.
7. Division 07 Section "Insulated Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
8. Division 07 Section "Roof Accessories" for equipment supports, roof hatches, pipe and vents, and other manufactured roof accessory units.
9. Division 07 Section "Expansion Control" for manufactured sheet metal expansion-joint covers
10. Division 23 "HVAC" for set-on type curbs and equipment supports.
11. Division 26 "Electrical" for set-on type curbs and equipment supports.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
5. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6. Review requirements for insurance and certificates if applicable.
7. Review sheet metal flashing observation and repair procedures after flashing installation.
8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Sheet metal materials.
2. Underlayment materials.
3. Elastomeric sealant.
4. Butyl sealant.
5. Epoxy seam sealer.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.

5. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Details of termination points and assemblies, including fixed points.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
8. Include details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
10. Details of special conditions.
11. Details of connections, transitions and interfacing with adjoining work.
12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Evaluation Reports: For copings and roof edge flashing, from ICC-ES showing compliance with ANSI/SPRI/FM 4435/ES-1.

E. Sample Warranty: For special warranty.

1.7 CLOSEOUT DOCUMENTS

A. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

B. Executed Warranties

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal

2. Finish Warranty Period: 10 years from date of Substantial Completion

B. Provide Owner with a written warranty from Subcontractor stating that metal flashings will properly shed water and protect base flashings from physical damage for a minimum period of 2 years, and that all work will be repaired to satisfaction of Owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in

construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Flashing and Trim Standard: Comply NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. FM Approvals Listing: Manufacture and install copings and roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60 Identify materials with name of fabricator and design approved by FM Approvals.

E. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Structural Drawings.

F. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. Surface: Smooth, flat.

2. Exposed Coil-Coated Finishes:

a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: Match Architect's sample.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.

1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled) or where indicated ASTM A480/A480M, No. 4 (polished directional satin).

    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
    b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

        1) Run grain of directional finishes with long dimension of each piece.
        2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D226/D226M for Type I and Type II felts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

    a. Atlas Roofing Corporation; Summit.
    b. Intertape Polymer Group.
    c. Kirsch Building Products, LLC; Sharkskin Comp.
    d. SDP Advanced Polymer Products Inc.; Palisade.

2. Source Limitations: Obtain underlayment from single source from single manufacturer.

C. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

    a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT
    b. GCP Applied Technologies, Inc. (formerly Grace Construction Products); Ice & Water Shield HT
    c. Henry Company; Blueskin PE200 HT

2. Thermal Stability: ASTM D1970; stable after testing at 240 deg F.
3. Low-Temperature Flexibility: ASTM D1970; passes after testing at minus 20 deg F.
4. Source Limitations: Obtain underlayment from single source from single manufacturer.

D. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of sheet metal.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
    b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
4. Fasteners for Zinc-Coated (Galvanized) Sheet: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329 or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2-inch-wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

H. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.5 SHEET METAL FLASHING AND TRIM

A. Through-Wall, Smooth, Sheet Metal Flashing: Manufacture or form through-wall sheet metal flashing for embedment in masonry. Manufacture or form through-wall flashing with interlocking counterflashing on exterior face, of same metal as flashing.

B. Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high end dams.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

    a. Cheney Flashing Co.
    b. Hohmann & Barnard, Inc.
    c. Keystone Flashing Co.

2. Stainless Steel: 0.016 inch thick.
3. Source Limitations: Obtain flashing from single source from single manufacturer.

C. Flashing and Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions with interlocking counterflashing on exterior face, of same metal as reglet.

1. Products: Subject to compliance with requirements, provide one of the following or equal:

    a. Cheney Flashing Co.
    b. Fry Reglet Corporation
    c. Hickman, W. P. Company
    d. Hohmann & Barnard, Inc.
    e. Keystone Flashing Company, Inc.

2. Material: Stainless steel, 0.016 inch thick.
3. Source Limitations: Obtain reglets from single source from single manufacturer.
4. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
6. Accessories:

    a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

7. Finish: With manufacturer's standard color coating. Exposed flashing accessories shall match flashing materials.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated.

1. Fabricate items at the shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

F. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

G. Do not use graphite pencils to mark metal surfaces.

H. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch (0.477 mm) thick.

I. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim. Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. .

J. Splash Pans: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch (0.477 mm) <Insert dimension> thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edges of external leg and interior leg. Miter corners, watertight. Shop fabricate interior and exterior corners.

1. Coping Profile: As indicated on the drawings in accordance with SMACNA's "Architectural Sheet Metal."
2. Joint Style: Butt, with 12-inch-wide concealed backup plate and continuous beads sealant each side (not exposed).
3. Fabricate from the following materials:

a. Aluminum: 0.050 inch thick.

B. Roof to Wall Transition and Fascia Cap Transition Expansion-Joint Cover: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Stainless Steel: 0.0250 inch thick.

C. Base Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.

D. Counterflashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.

E. Flashing Receivers: Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch thick.

F. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.

G. Roof-Drain Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0156 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high end dams.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.016 inch (thick.

C. Wall Expansion-Joint Cover: Fabricate from the following materials:
   1. Stainless Steel: 0.019 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

   1. Stainless Steel: 0.019 inch thick
   2. Galvanized Steel: 0.028 inch thick

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

   1. Stainless Steel: 0.025 inch thick

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.

   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

3.2 INSTALLATION OF UNDERLAYMENT

A. General: Install underlayment as indicated on Drawings.

B. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim.

   1. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

C. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than 4 inches.
2. Lap end joints not less than 12 inches.

D. Self-Adhering Sheet Underlayment:

1. Install self-adhering sheet underlayment, wrinkle free.
2. Apply primer if required by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches.
6. Roll laps with roller.
7. Cover underlayment within 14 days.

E. Apply slip sheet, wrinkle free, directly on substrate before installing sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lapp joints not less than 4 inches.

3.3 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
2. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
3. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
4. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
5. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
6. Space cleats not more than 12 inches apart unless indicated to be continuous. Anchor each cleat with two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
8. Install sealant tape where required within laps and joints to provide watertight condition.
9. Torch cutting of sheet metal flashing and trim is not permitted.
10. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating.

1. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install self-adhering sheet underlayment.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection.
2. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws. Substrate shall be not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as shown and as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

    a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant.
    b. Form joints to completely conceal sealant.
    c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    d. Adjust setting proportionately for installation at higher ambient temperatures.

        1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
2. Do not solder aluminum sheet.
3. Do not use torches for soldering.
4. Heat surfaces to receive solder and flow solder into joint.

    a. Fill joint completely.

    b. Completely remove flux and spatter from exposed surfaces.

5. Stainless-Steel Soldering:

    a. Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux.
    b. Promptly remove acid flux residue from metal after tinning and soldering.
    c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

H. Rivets: Rivet joints in uncoated aluminumwhere necessary for strength.

3.4 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Parapet Scuppers:

1. Install scuppers where indicated through parapet.
2. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
3. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper.
4. Loosely lock front edge of scupper with conductor head.
5. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

C. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints a minimum of 4 inches in direction of water flow.

3.5 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

    a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
    b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches over base flashing.
3. Lap counterflashing joints minimum of 4 inches.
4. Secure in waterproof manner by means of interlocking folded seam or blind rivets and sealant unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section "Unit Masonry

C. Reglets: Installation of reglets is specified in Division 03 Section "Cast-in-Place Concrete

D. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.7 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 62 00

SECTION 07 71 29 - MANUFACTURED ROOF EXPANSION JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Extruded bellows roof expansion joints.

B. Related Requirements:

1. Division 06 Section "Miscellaneous Rough Carpentry" for wooden curbs or cants for mounting roof expansion joints.
2. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated sheet metal expansion-joint systems, flashing, and other sheet metal items.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For roof expansion joints.

1. Include plans, elevations, sections, and attachment details.
2. Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
3. Provide isometric drawings of intersections, terminations, changes in joint direction or planes, and transition to other expansion joint systems depicting how components interconnect with each other and adjacent construction to allow movement and achieve waterproof continuity.

C. Samples: For each exposed product and for each color specified, 6 inches in size.

1.5 INFORMATIONAL SUBMITTALS

A. Design Submittals:

2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

B. Qualification Data: For Installer.

C. Product Test Reports: For each fire-barrier provided as part of a roof-expansion-joint assembly, for tests performed by a qualified testing agency.

D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installer of roofing membrane.

1.7 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof expansion joints that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Fire-Resistance Rating: Comply with ASTM E1966 or UL 2079; testing by a qualified testing agency to resist the spread of fire and to accommodate building thermal and seismic movements without impairing its ability to resist the passage of fire and hot gases. Identify products with appropriate markings of applicable testing agency.

2.2 EXTRUDED BELLOWS ROOF EXPANSION JOINTS

A. Extruded Bellows Roof Expansion Joint: Manufactured, continuous, waterproof, joint cover assembly; consisting of primary and secondary, single-layered, elastomeric seals; secured along each edge with extruded-aluminum retainers for fastening to substrate.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

    a. Balco; a CSW Industrials Company.
    b. MM Systems Corporation.

2. Joint Movement Capability: Plus and minus As indicated on Structural Drawings.
3. Primary Seal: Silicone extrusion; color: As selected by Architect from manufacturer's full range.
4. Secondary Seal: EPDM, or manufacturer's standard elastomeric seal.
5. Drain-Tube Assemblies: Equip secondary seal with drain tubes and seals to direct collected moisture to exterior-wall expansion joint cover.
6. Corner, Intersection, and Transition Units: Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints.

B. Materials:

1. Aluminum: ASTM B221 for extrusions; mill finish, with temper to suit forming operations and performance required.

    a. Apply manufacturer's standard protective coating on aluminum surfaces in contact with cementitious or preservative-treated wood materials.
    b. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

        1) Two-Coat Fluoropolymer: System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

2. Silicone Extrusions: ASTM D2000, UV stabilized, and that does not propagate flame.
3. EPDM Membrane: ASTM D4637, type standard with manufacturer for application.

2.3 MISCELLANEOUS MATERIALS

A. Adhesives: As recommended by roof-expansion-joint manufacturer.

1. Adhesives shall have a VOC content of 70 g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.

1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.

C. Mineral-Fiber Blanket: ASTM C665.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joint openings, substrates, and expansion-control joint systems that interface with roof expansion joints, for suitable conditions where roof expansion joints will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.

1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
2. Install roof expansion joints true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
3. Provide for linear thermal expansion of roof expansion joint materials.
4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
5. Provide uniform, neat seams.
6. Install roof expansion joints to fit substrates and to result in watertight performance.

B. Directional Changes: Install factory-fabricated units at directional changes to provide continuous, uninterrupted, and watertight joints.

C. Transitions to Other Expansion-Control Joint Assemblies: Coordinate installation of roof expansion joints with other exterior expansion-control joint assemblies specified in Section 079513.16 "Exterior Expansion Joint Cover Assemblies" to result in watertight performance. Install factory-fabricated units at transitions between roof expansion joints and exterior expansion-control joint systems**.**

D. Splices: Splice roof expansion joints to provide continuous, uninterrupted, and waterproof joints.

1. Install waterproof splices and prefabricated end dams to prevent leakage of secondary-seal membrane.

E. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

END OF SECTION 07 71 29

SECTION 07 81 00 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Preparation of surfaces to receive fire-resistant materials.
2. Sprayed fire-resistant materials (SFRM).
3. Repair of fire-resistant materials damaged or removed after initial installation.

1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistant material.

B. Cementitious: The term cementitious as defined by ASTM and Underwriters Laboratories Inc. applies to all fireproofing that is wet mixed and then pumped as a slurry. Cementitious does not refer to portland cement content.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Conference shall be scheduled at least 2 week prior to the start of installation.
2. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, application parameters and other performance requirements.
3. Conference shall be attended by Architect, Owner’s Representative, Owner’s Inspection Agent, Contractor, Manufacturer and Installer.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. SFRM

a. Provide framing plans, based on approved erection drawings, and accompanying schedules indicating the following:

1) Extent of fireproofing for each construction and fire-resistance rating.
2) Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3) Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4) Treatment of fireproofing after application.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Manufacturer’s written installation instructions for each product specified.

C. Provide certification that the UL Designs selected for the project are not load restricted.

D. Product Certificates: For each type of fireproofing.

E. Evaluation Reports: For fireproofing, from ICC-ES.

F. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

B. Pre-Installation Conference: Prior to the beginning of installation, conduct conference at Project Site.

1. Conference shall be scheduled at least 2 week prior to the start of installation.
2. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, application parameters and other performance requirements.
3. Conference shall be attended by Architect, Owner’s Representative, Owner’s Inspection Agent, Contractor, Manufacturer and Installer.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

1.9 WARRANTY:

A. Special Warranty: Provide warranty in which installer agrees to repair or replace components of applied fireproofing system that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Evidence of corrosion.
b. Installation failures including cracking, spalling and delamination.
c. Evidence of excessive air erosion.
d. Evidence of fungal growth.

2. Warranty Period: 2 years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

1. Fireproofing assemblies shall be based on the Load and Resistance Factor Design (LRFD) or Allowable Stress Design Method.
2. Assemblies shall not require a “load restricted” design or use the Working Stress Design Method.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. Asbestos: Provide products containing no detectable asbestos.

2.2 SPRAYED FIRE-RESISTANT MATERIALS

A. SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application

B. Medium Density Portland Cement Based Cementitious Products:

1. Basis of Design: GCP Applied Technologies; Monokote Z106 series
2. Other Acceptable Products: Subject to compliance with requirements, the following equivalent products may be provided:

a. Isolatek International; Cafco 400
b. Southwest Fireproofing Products Co.; Type 5MD

C. SFRM Performance:

1. Bond Strength:

a. Standard Density (structures 0-74 feet in height): Minimum 150-lbf/sq. ft..
b. Medium Density (structures greater than 74 feet and up to 420 feet in height): 430-lbf/sq. ft.
c. High Density (structures greater than 420 feet in height): 1000-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E736.

2. Density:

a. Standard Density as specified in the indicated fire-resistance design, according to ASTM E605: 15 lb/cu. ft. minimum
b. Medium Density as specified in the indicated fire-resistance design, according to ASTM E605: 22 lb/cu. ft. minimum
c. High Density as specified in the indicated fire-resistance design, according to ASTM E605: 40 lb/cu. ft. minimum

3. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E605, whichever is thicker, but not less than 0.50 inch.
4. Combustion Characteristics: ASTM E136.
5. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 10 or less.
b. Smoke-Developed Index: 10 or less.

6. Compressive Strength (according to ASTM E761):

a. Standard Density: 10 lbf/sq. in. minimum
b. Medium Density: 100 lbf/sq. in. minimum
c. High Density: 300 lbf/sq. in. minimum

7. Corrosion Resistance: No evidence of corrosion according to ASTM E937.
8. Deflection: No cracking, spalling, or delamination according to ASTM E759.
9. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E760.
10. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours according to ASTM E859.
11. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.
12. Finish: Spray-textured finish

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Where required by the manufacturer for substrates indicated or included in the UL design, provide primers approved by fireproofing manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.

C. Bonding Agent: Where required by the manufacturer for substrates indicated or included in the UL design, provide bonding agent approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:

1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Verify that concrete work on steel deck has been completed before beginning fireproofing work.

C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fireproofing work.

D. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Clips, hangers, support sleeves and other attachments by other trades penetrating the SFRM shall be installed prior to application of the cementitious materials.

3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Metal Decks:

1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, has been completed.
2. Do not apply fireproofing to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fireproofing.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

F. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

G. Extend fireproofing in full thickness over entire area of each substrate to be protected.

H. Install body of fireproofing in application thicknesses recommended in writing by fireproofing manufacturer.

I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.

J. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.

K. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

L. Cure fireproofing according to fireproofing manufacturer's written recommendations.

M. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

N. Finishes: Where indicated, apply fireproofing to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.

3.4 APPLIED FIREPROOFING SCHEDULE

A. Medium Density SFRM Products:

1. Provide medium density products as follows:

   a. Surfaces which are exposed and where a specific fireproofing finish has been specified.
   b. Surfaces which are exposed in elevator shafts and elevator machine rooms.
   c. Surfaces which are located in horizontal and vertical air plenums.
   d. Surfaces located in high humidity areas such as pools and greenhouses.
   e. Surfaces which are installed on exposed interior columns located in areas subject to foot traffic.

2. Medium Density products shall not be applied where bond strength does not meet IBC minimum requirements based on building height.
3. Medium Density products shall not be applied where density does not meet minimum IBC and approved fire-restive design requirements per ASTM E605.
4. Medium Density products shall not be applied where a higher density product has been specified.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Testing and inspection as required by the IBC, Chapter 17 Structural Tests and Special Inspections and Division 01 Section “Testing and Laboratory Services”.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Coordinate performance of the work with tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

D. Fireproofing will be considered defective if it does not pass tests and inspections.

1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

E. Prepare test and inspection reports.

3.6 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

1. Patch and original material shall be the same product.
2. Remove loose and damaged material prior to patching.
3. Hand mixed and applied material limited to 144 sq. in.; areas greater than 144 sq. in. shall be sprayed.
4. There are no provisions in the code or this specification which allow for a percentage of exposed steel to remain unprotected.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer’s recommended trowel-applied product.

END OF SECTION 07 81 00

SECTION 07 84 13 – FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Firestop systems for joints and penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

B. Related Sections include the following:

1. Division 07 Section "Joint Sealants" for non-fire-resistive joint sealants.
2. Division 21 Sections specifying fire-suppression piping penetrations.
3. Division 22 and 23 Sections specifying duct and piping penetrations.
4. Division 26, 27, and 28 Sections specifying cable and conduit penetrations.

1.3 FIRESTOPPING RATINGS:

A. F-ratings indicate that the firestopping withstood the fire test for the rating period without the following taking place: flames passing through openings, flaming of any element on the unexposed side of the firestopping system, and any openings developing that permit water from the hose stream to project beyond the unexposed side.

B. T-ratings signify that heat transmitted through the firestopping during the rating period did not raise the temperature of any thermocouple on the unexposed firestopping system surface or on any penetrating item by more than 325 deg F above its initial temperature.

C. L-ratings indicate the amount of air leakage through the firestopping during testing and indicate how well systems resist the passage of smoke.

D. W-ratings evaluate a firestop system’s ability to restrict water migration. To qualify as a Class 1 rated system, the firestop assembly must withstand a 3-ft head of water for 72 hours with no leakage.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, fire resistive joint system, and perimeter fire resistive joint system, show each type of construction condition, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop and fire resistive joint system configuration for construction and penetrating items.
2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

C. Firestop System Schedule: Indicate locations of each firestop system, along with the following information:

1. Types of penetrating items.
2. Types of construction conditions at each penetration or joint, including fire-resistance ratings and, where applicable, thicknesses of construction.
3. Firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
4. Firestop System Schedule Nomenclature:

    a. Designation System for Through-Penetration Firestopping Systems. Alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
    b. Designation System for Joints in or between Fire-Resistance-Rated Constructions: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHBN.
    c. Designation System for Joints at the Intersection of Fire-Resistance-Rated Floor or Floor/Ceiling Assembly and an Exterior Curtain-Wall Assembly: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHDG.

5. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For firestop system products, signed by product manufacturer.

C. Listed Systems: From a qualified testing agency indicating firestop system complies with requirements, based on comprehensive testing of current products.

D. Field quality-control test reports.

E. Research/Evaluation Reports: For each type of firestopping system.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors" or
2. A firm that has been qualified under UL's Qualified Contractor Program or
3. A firestop specialty contractor qualified under a Firestop manufacturer's training program

B. Installer Qualifications: A firm experienced in installing firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Installation Responsibility: Assign installation of firestop systems in project to a single qualified installer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop or fire resistive joint systems when ambient or substrate temperatures are outside limits permitted by through-

penetration firestop of fire resisting joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items and joints to ensure that firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Coordinate sizing of joints to accommodate fire-resistive joint systems.

D. Notify Owner's inspecting agency at least seven days in advance of firestop system installations; confirm dates and times on days preceding each series of installations.

E. Do not cover up firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Subcontractor or manufacturer shall review all penetrating items and rated penetrated construction, construction joint conditions, and perimeter firestopping conditions and select a UL listed system that provides the required protection for each application. Submittal shall list system and product provided to meet the system test requirements. Provide through-penetration firestop systems, fire resistive joint systems, and perimeter fire resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. T-Rated Systems: Provide through-penetration firestop systems with T-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
3. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L-ratings of not more than 3.0 cfm/sq. ft at both ambient temperatures and 400 deg F.

4. W-Rated Systems: Provide through penetration firestop systems with Class 1 W Ratings where water tight ratings for floor penetrations are indicated. W Ratings to be determined in accordance with water leakage test per UL 1479.

C. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

1. Sealant shall have a VOC content of 250 g/L or less.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.

F. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities indicated as determined by UL 2079 or ASTM E1966.

1. Load-bearing capabilities as determined by evaluation during the time of test.

G. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

H. Continuity Head-of-Wall Joint Systems: For joints between fire-rated walls and non-rated floor or roof decks, provide systems with F Ratings equaling or exceeding the fire-resistance ratings of the wall assembly as determined by ASTM E2837.

I. Sound Attenuation: Firestop systems installed at joints and penetrations must restore/maintain wall assembly STC rating to its originally designed value using ASTM E90 test data.

J. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL in its "Fire Resistance Directory."
        2) Intertek Group in its "Directory of Listed Building Products."
        3) FM Global in its "Building Materials Approval Guide."

2.2 MANUFACTURERS

A. Products

1. Basis of Design: Hilti Construction Chemicals Inc. , Tulsa, Oklahoma

2. Other Acceptable Manufacturers subject to compliance with requirements

    a. 3M Fire Protection Products, St. Paul, Minnesota
    b. Nelson Firestop Products, Tulsa, Oklahoma
    c. STI (Specified Technologies, Inc.)

3. All fire stopping, for each kind of construction condition indicated, shall be from the same manufacturer.

2.3 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience. Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of < 1 as determined by ASTM G21.

G. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated. Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-/rock-wool-fiber insulation
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state
    c. Fire-rated form board
    d. Fillers for sealants

2. Temporary forming materials
3. Substrate primers
4. Collars
5. Steel sleeves

2.4 FILL MATERIALS

A. General: Provide firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule as required to comply with Part 1 “Performance Requirements” by referencing the types of materials described in this Article. Fill materials are

those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.5 MIXING

A. For those products requiring mixing before application, comply with firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required),

type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configuration, opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

1. Remove from surfaces foreign materials that could interfere with adhesion of firestop systems.
2. Clean opening substrates to produce clean, sound surfaces capable of developing optimum bond with penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 FIRESTOP SYSTEM INSTALLATION

A. General: Install firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Provide Hilti Speed Sleeve or Modular Sleeve system (or equivalent retrofittable) fire rated pathway system for data cable penetrations in size, location, and quantity indicated on Drawings.

3.4 IDENTIFICATION

A. Identify firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:

1. The words "Warning - Firestop System - Do Not Disturb. Notify Building Management of Any Damage”
2. Contractor's name, address, and phone number
3. Firestop system designation of applicable testing and inspecting agency; including system UL Number.
4. Date of installation
5. Firestop system manufacturer's name
6. Installer's name

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E2174 or ASTM E2393 requirements including those related to qualifications, conducting inspections, and preparing test reports.

B. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.

1. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

C. Keep areas of work accessible until inspection by applicable authorities.

D. Remove and replace firestop systems where inspections indicate that they do not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements herein.

G. Proceed with enclosing firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestop systems immediately and install new materials to produce systems complying with specified requirements.

3.7 THROUGH-PENETRATION FIRESTOP SYSTEMS SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestopping with no penetratrants:

1. UL-Classified Systems: C-AJ- and W-L-0001-0999

C. Firestopping for metallic pipes:

1. UL-Classified Systems: C-AJ- and W-L-1001-1999

D. Firestopping for plastic pipes:

1. UL-Classified Systems: C-AJ- and W-L-2001-2999

E. Firestopping for Electrical Cables:

1. UL-Classified Systems: C-AJ- and W-L-3001-3999

F. Firestopping for Cable Trays with Electric Cables:

1. UL-Classified Systesms: C-AJ- and W-L-4001-4999

G. Firestopping for Insulated Pipes:

1. UL-Classified Systesms: C-AJ- and W-L-5001-5999

H. Firestopping for Miscellaneous Electrical Penetrants:

1. UL-Classified Systesms: C-AJ- and W-L-6001-6999

I. Firestopping for Miscellaneous Mechanical Penetrants:

1. UL-Classified Systesms: C-AJ- and W-L-7001-4999

J. Firestopping for Grouping of Penetrants:

1. UL-Classified Systesms: C-AJ- and W-L-8001-8999

K. Fire resistant Joints at floor to wall:

1. UL-Classified Systesms: HW-D-0001 -0999

3.8 JOINT SYSTEMS SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

B. Floor-to-Floor, Joint Firestopping Systems:

1. UL-Classified Systems: FF-D 0001-4999

C. Wall-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: WW-D-0001-4999

D. Floor-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: FW-D-0001-4999

E. Head of Wall, Joint Firestopping Systems:

1. UL-Classified Systems: HW-D-0001-4999

F. Bottom of Wall, Joint Firestopping Systems:

1. UL-Classified Systems: BW-D-0001-4999

3.9 THROUGH-PENETRATION FIRESTOP AND JOINT SYSTEMS SCHEDULE

A. See FireStopping Systems Key and Fire Resistant Joint Systems Key, below.

FireStopping Systems Key										
PENETRANT	**SIZES**	**1 HR Shaftwall**	**2 HR Shaftwall**	**1 HR Gypsum Wall**	**1 HR SMOKE BARRIER Gypsum Wall**	**2 HR Gypsum Wall**	**2 HR SMOKE BARRIER Gypsum Wall**	**1 HR CMU Wall**	**2 HR CMU Wall**	**2 HOUR CONCRETE FLOOR SLAB**
NO PENETRATING ITEM										
Blank opening	**Max 6"**	**EJ**	**EJ**	**WL0030**	**WL0030**	**WL0030**	**WL0030**	**CAJ 0090**	**CAJ 0090**	**CAJ 0090**
Speed Sleeve -(For Future Cables)	**Max 4"**	**EJ**	**EJ**	**WL 3334**	**WL3334**	**WL 3334**	**WL3334**	**WJ 3167**	**WJ 3167**	
Cast In Place Floor Device	**Max 6"**									**FA 0005**
INSULATED METALLIC PIPE - FIBERGLASS										
Steel Pipe/Cast Iron/Ductile Iron Pipe	**Max 8"**	**WL 5240**	**WL 5240**	**WL 5029**	**WL 5029**	**WL 5029**	**WL 5029**	**CAJ 5091**	**CAJ 5091**	**CAJ 5091**
Steel Pipe/Cast Iron/Ductile Iron Pipe	**Max 12"**			**WL 5029**	**WL 5029**	**WL 5029**	**WL 5029**		**CAJ 5091**	**CAJ 5091**
Copper pipe/tubing	**Max 4"**	**WL 5240**	**WL 5240**	**WL 5029**	**WL 5029**	**WL 5029**	**WL 5029**			
Copper pipe/tubing	**Max 6"**	**EJ**	**EJ**	**WL 5029**	**WL 5029**	**WL 5029**	**WL 5029**	**CAJ 5091**	**CAJ 5091**	**CAJ5091**
CAST IN PLACE FLOOR DEVICE - Steel /Copper pipe/copper tubing	**Max 4"**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**FA 5017 / FA 5018**	**FA 5017 / FA 5018**	**FA 5017 / FA 5018**
INSULATED METALLIC PIPE - AB/PVC										
Steel Pipe	**Max 4"**	**EJ**	**EJ**	**WL 5028**	**WL 5028**	**WL 5028**	**WL 5028**	**CAJ 5090**	**CAJ 5090**	**CAJ 5090**
Copper pipe	**Max 1"**	**WL 5143**	**WL 5143**	**WL 5028**	**WL 5028**	**WL 5028**	**WL 5028**	**CAJ 5090**	**CAJ 5090**	**CAJ 5090**
Copper pipe/tubing	**Max 2"**	**EJ**	**EJ**	**WL 5028**	**WL 5028**	**WL 5028**	**WL 5028**	**CAJ 5090**	**CAJ 5090**	**CAJ 5090**
Copper pipe	**Max 4"**	**EJ**	**EJ**	**EJ**	**EJ**	**EJ**	**EJ**	**CAJ 5090**	**CAJ 5090**	**CAJ 5090**
CAST IN PLACE FLOOR DEVICE - Steel /Copper pipe/copper tubing	**Max 4"**									**FA 5015**
UNINSULATED METALLIC PIPE										
Steel Pipe/Cast Iron/Ductile Iron Pipe	**Max 8"**	**WL 1380**	**WL 1380**	**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1067**	**CAJ 1067**	**CAJ 1226**
Steel Pipe/Cast Iron/Ductile Iron Pipe	**Max 30"**			**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1067**	**CAJ 1067**	**CAJ 1226**
Copper pipe/tubing	**Max 4"**	**WL 1380**	**WL 1380**	**WL 1054**	**WL 1054**					
Copper pipe/tubing	**Max 6"**			**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1226**	**CAJ 1226**	**CAJ 1226**
Steel conduit	**Max 6"**	**WL 1380**	**WL 1380**	**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1226**	**CAJ 1226**	**CAJ 1226**
Steel conduit	**Max 4"**	**WL 1380**	**WL 1380**	**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1226**	**CAJ 1226**	**CAJ 1226**
EMT	**Max 4"**	**WL 1380**	**WL 1380**	**WL 1054**	**WL 1054**	**WL 1054**	**WL 1054**	**CAJ 1226**	**CAJ 1226**	**CAJ 1226**

FireStopping Systems Key										
PENETRANT	**SIZES**	**1 HR Shaftwall**	**2 HR Shaftwall**	**1 HR Gypsum Wall**	**1 HR SMOKE BARRIER Gypsum Wall**	**2 HR Gypsum Wall**	**2 HR SMOKE BARRIER Gypsum Wall**	**1 HR CMU Wall**	**2 HR CMU Wall**	**2 HOUR CONCRETE FLOOR SLAB**
CAST IN PLACE FLOOR DEVICE - Steel/Cast Iron/Conduit/Copper Pipe	**Max 6"**									**FA 1016**
CAST IN PLACE FLOOR DEVICE - EMT	**Max 4"**									**FA 1016**
PLASTIC PIPE										
PVC/CPVC	**Max 4"**	**WL 2217**	**WL 2217**							
PVC/CPVC	**Max 2"**	**EJ**	**EJ**	**WL 2244**	**WL 2244**	**WL2244**	**WL 2244**			
PVC/CPVC	**Max 10"**			**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**			
PVC/CPVC/ABS/FRPP	**Max 6"**	**EJ**	**EJ**	**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**	**CAJ 2271**	**CAJ 2271**	**CAJ 2271**
PVC/CPVC/ABS/FRPP	**Max 4"**			**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**	**CAJ 2342**	**CAJ 2342**	**CAJ 2342**
ABS	**Max 6"**			**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**	**CAJ 2109**	**CAJ2109**	**CAJ2109**
FRPP	**Max 6"**			**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**			
PVDF	**Max 4"**			**WL 2078**	**WL 2078**	**WL 2078**	**WL 2078**	**CAJ 2217**	**CAJ 2217**	**CAJ 2217**
CAST IN PLACE FLOOR DEVICE										
PVC/CPVC/RNC	**Max 6"**									**FA 2053**
ABS	**Max 4"**									**FA 2065**
FRPP	**Max 6"**									**FA 2065**
HVAC DUCT (WITHOUT DAMPERS)										
UNINSULATED										
Round	**Max 6"**	**WL7068**	**WL 7068**	**WL 7042**	**WL 7042**	**WL 7042**	**WL 7042**	**CAJ 7084**	**CAJ 7084**	**CAJ 7084**
Round Spiral	**Max 20"**			**WL 7042**	**WL 7042**	**WL 7042**	**WL 7042**	**CAJ 7084**	**CAJ 7084**	**CAJ 7084**
Round Sheet Metal	**Max 12"**			**WL 7042**	**WL 7042**	**WL 7042**	**WL 7042**	**CAJ 7084**	**CAJ 7084**	**CAJ 7084**
Square	**Max 7"x7"**	**WL 7069**	**WL 7069**	**WL 7069**	**WL 7069**	**WL 7069**	**WL 7069**	**WJ 7039**	**WJ 7039**	**CAJ 7192**
Rectangular	**Max 24x48"**			**WL7040**	**WL7040**	**WL7040**	**WL7040**	**WJ 7021**	**WJ 7021**	**CAJ 7154**
Rectangular	**Max 32"x32"**			**WL 7155**	**WL 7155**	**WL 7155**	**WL 7155**			**CAJ 7046**
INSULATED										

FireStopping Systems Key										
PENETRANT	**SIZES**	**1 HR Shaftwall**	**2 HR Shaftwall**	**1 HR Gypsum Wall**	**1 HR SMOKE BARRIER Gypsum Wall**	**2 HR Gypsum Wall**	**2 HR SMOKE BARRIER Gypsum Wall**	**1 HR CMU Wall**	**2 HR CMU Wall**	**2 HOUR CONCRETE FLOOR SLAB**
Rectangular	**Max 24x48"**			**WL 7151**	**WL 7151**	**WL 7151**	**WL 7151**	**WJ 7091**	**WJ 7091**	**CAJ 7145**
Round Spiral	**Max 20"**			**WL 7153**	**WL 7153**	**WL 7153**	**WL 7153**	**WJ 7124**	**WJ 7124**	**EJ**
Round Sheet metal	**Max 12"**			**WL 7153**	**WL 7153**	**WL 7153**	**WL 7153**	**WJ 7124**	**WJ 7124**	**EJ**
ELECTRIC CABLES										
Max 4" opening	**Misc Cables**	**WL 3161**	**WL 3161**	**WL 3065**	**WL 3065**	**WL 3065**	**WL 3065**			
Max 6" Opening	**Misc Cables**	**WL 8095 or EJ**	**WL 8095 or EJ**	**WL 8079**	**WL 8079**	**WL 8079**	**WL 8079**	**CAJ 3180**	**CAJ 3180**	**CAJ 3180**
SPEED SLEEVE	**Misc Cables**			**WL 3334**	**WL 3334**	**WL 3334**	**WL 3334**	**WJ 3167**	**WJ 3167**	**CAJ 3281**
CAST IN PLACE FLOOR DEVICE	**Misc Cables**									**FA 3033**
ELECTRIC CABLE TRAY										
		NA	**NA**	**WL 4011**	**WL 4011**	**WL 4011**	**WL 4011**	**WJ 4027**	**WJ 4027**	**CAJ 4035**

NOTES:

ALL FIRESTOPPING SYSTEM NUMBERS ARE UNDERWRITERS LABORATORIES, EXCEPT FM PREFIX IDENTIFIES SYSTEM LISTED IN FM APPROVAL GUIDE

ALL EQUIPMENT LISTED AS OPTIONAL IN THE SYSTEM DESCRIPTION SHALL BE CONSIDERED MANDATORY.

HVAC DUCT PENETRATIONS OF 2 HOUR WALLS WILL GENERALLY HAVE A FIRE DAMPER. WHERE DAMPER IS PROVIDED DO NOT FIRESTOP WALL PENETRATION.

Fire Resistive Joint Systems Key										
JOINTS	**SIZES**	**1 HR Shaftwall**	**2 HR Shaft-wall**	**1 HR Gypsum Wall**	**1 HR SMOKE BARRIER Gypsum Wall**	**2 HR Gypsum Wall**	**2 HR SMOKE BARRIER Gypsum Wall**	**1 HR CMU Wall**	**2 HR CMU Wall**	**2 HOUR CONCRETE FLOOR SLAB**
TOP OF WALL										
Flat Concrete Floor	**Max Width 3/4"**			**HWD0209**	**HWD0209**	**HWD0209**	**HWD 0268**	**HWD 0268**	**HWD 0268**	**HWD 0268**
	Max 2"			**HWD0106**		**HWD0106**				
	Max Width 1"	**HWD0342**	**HWD0342**					**HWD 0268**	**HWD 0268**	**HWD 0268**
	Max Width 3 3/4"							**HWD 1009**	**HWD 1009**	
Concrete over Metal Deck		**HWD 0570**	**HWD 0570**		**HWS 0053**		**HWS 0053**			
Perpendicular to Metal Deck		**HWD 0570**	**HWD 0570**	**HWD1066**	**HWD1066**	**HWD1066**	**HWD1066**	**HWD 1037**	**HWD 1037**	
Parallel to Metal Deck		**HWD 0570**	**HWD 0570**	**HWD1067**	**HWD1067**	**HWD1067**	**HWD1067**	**HWD 0181**	**HWD 0181**	
CURTAIN WALL JOINTS										
WALL TO WALL JOINTS										
Concrete or Block Wall	**Max Width 3/4"**	**WWS 0059**	**WWS 0059**	**WWD0040**	**WWD0040**	**WWD0040**	**WWD0040**	**WWD 0032**	**WWD 0032**	**WWD 0032**
	Max Width 1"	**WWS 0059**	**WWS 0059**	**EJ**	**EJ**	**EJ**	**EJ**	**WWD 0032**	**WWD 0032**	**WWD 0032**
	Max Width 3 3/4"							**WWD1012**	**WWD1012**	**WWD1012**

END OF SECTION 07 84 13

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Polysulfide joint sealants.
4. Butyl joint sealants
5. Latex joint sealants.
6. Preformed joint sealants.
7. Acoustical joint sealants.
8. Sealant backing, primer and other accessory products

B. Related Requirements:

1. Division 04 Section "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
2. Division 07 Section "Firestopping " for sealing joints in fire-resistance-rated construction.
3. Division 08 Section "Glazing" for glazing sealants.
4. Division 32 Section "Concrete Paving Joint Sealants" for sealing joints in pavements, walkways, and curbing

1.3 DEFINITIONS

A. Sealant: Sealant as indicated on the drawings is defined to include all backing, bond breakers, primers and accessories specified herein and as necessary for a compete sealant installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and Testing Agency.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

D. Field-Adhesion Test Reports: For each sealant application tested.

E. Certification that all sealant products are compatible with surfaces with which they will come into contact.

F. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Silicone sealants: Twenty years from date of Substantial Completion
2. Warranty Period: All other sealants: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Suitability for Immersion in Liquids: Where sealants are indicated for use for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 JOINT SEALANT SCHEDULE

A. Refer to Part 3: Joint Sealant Schedule for installation locations for the sealant materials listed in this section.

2.3 SILICONE JOINT SEALANTS

A. Exterior Traffic (E/T): Single-Component, Nonsag or Self Leveling, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C920, Type S, Grade NS/SL, Class 100/50, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following products:

    a. Dow Corning Corporation; DOWSIL NS or SL Parking Structure Sealant.
    b. Pecora Corporation; 300 SL and 301 NS
    c. Tremco Incorporated; Spectrem 800 or 900 SL.

2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors..

B. Exterior Non-Traffic (E/NT): Single-Component, Non-sag, Neutral-Curing, Non-Traffic Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 100/50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Dow Corning Corporation; DOWSIL 790.
   b. Pecora Corporation; 890NST or 890FTS.
   c. Tremco Incorporated; Spectrem 1
   d. Sika Corporation; WS 290

2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors..

C. Interior Mildew-Resistant (I/M): Single-Component, Nonsag, Neutral-Curing (or Acid Curing Class 25) Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Dow Corning Corporation; DOWSIL 786 Mildew Resistant.
   b. Pecora Corporation; 898NST
   c. Sika Corporation; Sikaflex-15 LM
   d. Tremco Incorporated; Tremsil 200

2. Joint-Sealant Color: color as selected by the Architect.

D. Interior FDA (I/FDA): Single-Component, Nonsag, Acid-Curing, Non-Traffic Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Dow Corning Corporation; DOWSIL 999-A.

2. Joint Sealant Color: As selected by the architect from manufacturer’s standard colors.

2.4 URETHANE JOINT SEALANTS

A. Interior Traffic (I/T): Multi-component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C920. Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. LymTal International, Inc.; Iso-Flex 880 GB.
   b. Pecora Corporation; Urexpan NR-200.
   c. Tremco Incorporated; Vulkem 445SS.
   d. BASF Building Systems; MasterSeal SL 2.

2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

2.5 BUTYL SEALANTS

A. Butyl-Rubber-Based Joint Sealants (BS): ASTM C1311.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Henry; HE 925 BES.
   b. Pecora Corporation; BC 158.
   c. Tremco Incorporated; Butyl Sealant.

2.6 LATEX JOINT SEALANTS

A. Interior Non-Traffic (I/NT): Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP or Type C, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Pecora Corporation; AC-20+ and AC*20+ FTR (Fire rated).
   b. Tremco Incorporated; Tremflex 834.

2. Joint-Sealant Color: Where directed by the architect, provide clear or color to match surrounding surfaces.

2.7 PREFORMED JOINT SEALANTS

A. Sheet Sealant (S/PF): Pre-cured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

1. Products: Subject to compliance with requirements, provide one of the following products:

   a. Dow Corning Corporation; DOWSIL 123 Silicone Seal
   b. Pecora Corporation; Sil-Span.

B. Urethane Pre-formed U/PF: Preformed, pre-compressed, open-cell foam sealant that is manufactured from high-density urethane foam impregnated with a nondrying, water-repellent agent; is factory produced in pre-compressed sizes in roll or stick form to fit joint widths indicated; is coated on one side with a pressure-sensitive adhesive and covered with protective wrapping; develops a watertight and airtight seal when compressed to the degree specified by manufacturer.

1. Basis of Design: EMSEAL Joint Systems, Ltd.; Emseal 25V.
2. Properties: Permanently elastic, mildew resistant, non-migratory, non-staining, and compatible with joint substrates and other joint sealants.

   a. Density: 10 lb/cu. ft

2.8 ACOUSTICAL JOINT SEALANTS

A. Interior Acoustical (I/A): Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

1. Products: Subject to compliance with requirements, provide one of the following products:.

a. Accumetric LLC; BOSS 826 Acoustical Sound Sealant
b. Hilti Firestop; CP 506.
c. Pecora Corporation; AC-20 FTR
d. Tremco Incorporated; Tremflex 834
e. Specified Technologies, Inc.; Smoke and Acoustic Sealant.

2.9 JOINT SEALANT BACKING (BACKER ROD)

A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.10 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint width and configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include, but are not limited to, the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include, but are not limited to, the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C1193, unless otherwise indicated.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Installation of Preformed Silicone Sealants:

1. Over concealed stainless steel flashing where indicated.

H. Installation of Preformed Urethane Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

I. Where multiple layers of sealant are indicated, install each and allow curing per manufacturer's written instructions before proceeding with the next.

J. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings, devices and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL: SEALANTS

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

   a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application (E/T): Exterior Joints in Horizontal Traffic Surfaces.

1. Joint Locations:

a. Control and expansion joints in brick and concrete pavers.
b. Isolation and construction joints in cast-in-place concrete slabs.
c. Joints between plant-precast architectural concrete paving units.
d. Joints between paving and structures.
e. Joints in stone paving units**,** including steps.
f. Tile control and expansion joints.
g. Joints between different materials listed above.
h. Other joints as indicated.

B. Joint-Sealant Application (E/NT): Exterior Joints in Vertical Surfaces and Horizontal Non-traffic Surfaces.

1. Exterior Joint Locations:

a. Construction joints in cast-in-place concrete.
b. Joints between plant-precast architectural concrete units.
c. Control and expansion joints in unit masonry.
d. Joints in dimension stone cladding.
e. Joints in glass unit masonry assemblies.
f. Joints in exterior insulation and finish systems.
g. Joints between metal panels.
h. Exterior perimeter joints of frames of doors and louvers.
i. Exterior and interior perimeter joints of exterior window, storefront and curtainwall systems.
j. Sealant installed in conjunction with metal flashing assemblies.
k. Pipe, conduit, sleeves and other penetrations of materials listed above.
l. Control and expansion joints in ceilings and other overhead surfaces.
m. Joints between dissimilar materials.
n. Full sealant bed for sill, receptor and threshold installations.

o. Other joints as indicated.

C. Joint-Sealant Application (I/M): Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where sealant is indicated.
c. Joints between shower enclosures and fittings and other wet areas and substrate.
d. Perimeter of ceiling perimeter angles at clean room and all other ceiling systems
e. Perimeter of countertops and backsplashes to adjacent wall or millwork surfaces.
f. Other joints as indicated.

D. Joint-Sealant Application (I/FDA): FDA/USDA approved; interior joints where sealant may come into contact with food.

1. Joint Sealant Location:

a. Counter tops and shelving in contact with food products requiring sealants per FDA Guidelines.
b. Other joints as indicated

E. Joint-Sealant Application (I/T): Interior joints in horizontal traffic surfaces.

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in stone flooring.
c. Control and expansion joints in brick flooring.
d. Control and expansion joints in tile flooring.
e. Joints between dissimilar materials
f. Other joints as indicated.

F. Joint Sealant Application (BS): Exterior joints in vertical and horizontal unexposed non-traffic surfaces.

1. Joint locations:

a. Sealing stainless steel flashing in cavity and joints per Division 04 Section “Unit Masonry.”
b. Sealing Air/Vapor and Vapor Permeable Barrier, accessory and transition materials per Division 07 Sections “Fluid-Applied Membrane Air and Vapor Barrier (AVB)” and “Fluid-Applied, Vapor-Permeable Membrane Air Infiltration Barrier (AIB).”
c. Sealing Roof and Wall Flashings and joints per Division 07 Section “Sheet Metal Flashing and Trim.”

G. Joint-Sealant Application (I/NT): Interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings not otherwise specified to receive joint sealant type E/NT.
c. Vertical joints on exposed surfaces of wallsand partitions.
d. Perimeter joints between interior wall surfaces and frames of interior doors and sidelights, interior vision panels and elevator entrances.
e. Joint between interior drywall ceilings and exposed masonry walls.
f. Exposed joints between interior dissimilar materials.
g. Base of hollow metal and aluminum door frames at joint to finish floor surface.
h. Other joints as indicated.

H. Joint-Sealant Application (S/PF): Pre-formed product used in exterior joints.

1. Joint Sealant Locations:

a. Joints in sheet metal flashing where indicated
b. Other details where indicated.

I. Joint-Sealant Application (U/PF): Pre-formed product used in exterior and interior joints non-traffic horizontal and vertical applications.

1. Joint Sealant Locations:

a. Joints wider than recommended by the sealant manufacturer for gunned or poured sealants.
b. Secondary (double) seal behind a backer rod and sealant for precast concrete installation, in a vertical or horizontal application.
c. Other details where indicated.

J. Joint-Sealant Application (I/A): Interior acoustical joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Locations:

a. Top and bottom joints of nonrated interior masonry walls and gypsum board partitions that extend to underside of structure.
b. Provide around the perimeter of plumbing, mechanical and electrical devices and equipment, piping, wiring, conduit and other intrusions into and through non-fire rated walls with or without escutcheons, above and below finished ceilings.
c. Perimeter of ceiling perimeter angles at gasketed ceiling systems, except clean room.
d. Perimeter joints at dissimilar materials of interior non-fire rated gypsum board partitions.
e. Control joints in gypsum board partitions.
f. Other joints as indicated.

END OF SECTION 07 92 00

SECTION 07 95 13.16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes exterior building expansion joint cover assemblies.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section
2. Division 07 Section "Sheet Metal Roofing" for sheet metal roof joint systems
3. Division 07 Membrane Roof Sections for expansion joints included in roofing sections.
4. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal wall joint systems

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review manufacturers installation checklist, joint types, movement requirements, loads, joint terminations and transitions and performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by 6 inches long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by 6 inches long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

1. Manufacturer and model number for each expansion joint cover assembly.
2. Expansion joint cover assembly location cross-referenced to Drawings.
3. Nominal, minimum, and maximum joint width.
4. Movement direction.
5. Materials, colors, and finishes.
6. Product options.
7. Fire-resistance ratings.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers preinstallation checklist indicating locations, fire-ratings, joint widths, substrates, transitions, joint terminations, etc.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data For Owner: For each type of expansion joint cover system installed in walking surfaces, include Owner’s slip and trip -resistance maintenance requirements in maintenance manuals.

B. Executed warranty.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Installer must have attended an SWRI seminar within the past two years.

B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical expansion joint cover assembly as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Special Warranty: The Joint Manufacturer and the Approved Installer shall jointly warrant that the products supplied shall be free from manufacturing defects for a period of five (5) years from the date of installation.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and the information provided on the drawings.

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079, ASTM E 1966 by a qualified testing agency.

1. Hose Stream Test: Wall-to-wall and wall-to-soffit assemblies shall be subjected to hose stream testing.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of architectural joint systems and are based on the specific systems indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)" and ICC A117.1.

E. Expansion Joint Design Criteria:

1. Type of Movement: Thermal and Wind sway.

a. Nominal Joint Width: As indicated on Structural Drawings.

2. Type of Movement: Seismic.

a. Joint Movement: As indicated on Structural Drawings.

2.3 EXTERIOR EXPANSION JOINT COVERS

A. Exterior Compressed Foam: Weathertight assembly consisting of a silicone pre-coated, preformed, pre-compressed, self-expanding, sealant system. Expanding foam to be cellular foam impregnated with a water-based, non-drying, 100% acrylic dispersion. Seal shall combine factory-applied, low-modulus silicone and a backing of acrylic-impregnated expanding foam into a unified hybrid sealant system.

1. Basis of Design Product: EMSEAL; Colorseal
2. Other Acceptable Products: Subject to compliance with requirements, the following comparable products may be provided:

    a. Construction Specialties; VF
    b. MM Systems; SIF
    c. Nystrom; SES.

3. Application: Vertical or Horizontal; Wall to wall, wall to soffit, and parapet.
4. Installation: Recessed.
5. Color: Varies with adjacent materials; each as selected by Architect from manufacturer's complete range.

B. Exterior Seismic Elastomeric-Seal Joint Cover: Weathertight assembly consisting of elastomeric seal anchored to surface-mounted frames fixed to sides of joint gap.

1. Basis of Design Product: Watson Bowman; WSW series exterior.
2. Other Acceptable Products: Subject to compliance with requirements, the following comparable products may be provided:

    a. Architectural Art Manufacturing; R series
    b. Construction Specialties; SF series
    c. MM Systems; VSS series
    d. Nystrom; EW/EWN series

3. Application: Wall to wall.
4. Installation: Recessed.
5. Exposed Metal:

    a. Aluminum: Mill.

6. Seal: Preformed elastomeric membrane or extrusion.

    a. Color: As selected by Architect from manufacturer's full range

2.4 MOISTURE BARRIER:

A. Provide where indicated on drawings.

B. EPDM Bellows:

1. Basis of Design: Watson Bowman; EVS
2. Rubber bellows profile integrally attached to metal flanges.
3. Provide factory prefabricated transitions.
4. Install flanges over waterproofing membrane with self-adhering transition membrane.

C. Neoprene Gutter

1. Basis of Design: Watson Bowman; BOG
2. Flexible fabric reinforced neoprene gutter that satisfies the required movement criteria and compresses without damage during the full cycle of joint closure.
3. Gutter collects and drains excess amounts of moisture through a drain tube.
4. Gutter is held in place by an expansion joint anchored into a preformed block-out.

2.5 MATERIALS

A. Aluminum: ASTM B221 Alloy 6063-T5 for extrusions; ASTM B209, Alloy 6061-T6 for sheet and plate.

1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

2.6 ALUMINUM FINISHES

A. Mill finish.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

2.7 ACCESSORIES

A. Manufacturer's stainless-steel attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Compressed Foam

1. The contractor shall clean the joint opening of all contaminants immediately prior to installation of expansion joint system.
2. Repair spalled, irregular or unsound joint surfaces using accepted industry practices for repair of the substrates in question. Remove protruding roughness to ensure joint sides are smooth.
3. Ensure that there is sufficient depth to receive the full depth of the size of the Compressed Foam being installed plus at least ¼-inch (6mm) for the application of corner beads.
4. No drilling, or screwing, or fasteners of any type are permitted to anchor the sealant system into the substrate.

C. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Install frames in continuous contact with adjacent surfaces.

    a. Shimming is not permitted.

5. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.

D. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

E. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

F. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

G. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

H. Moisture Barrier Drainage: If indicated, provide drainage fitting and connect to drains.

3.4 CONNECTIONS

A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Division 07 Roofing specifications. Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.

3.5 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13.16

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior steel doors and frames.
2. Exterior steel doors and frames.

B. Related Sections:

1. Division 08 Section "Stainless-Steel Doors and Frames" for hollow-metal doors and frames manufactured from stainless steel.
2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors
3. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Shop Drawings

1. Elevations of each door design
2. Details of doors, including vertical and horizontal edge details and metal thicknesses
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses
4. Locations of reinforcement and preparations for hardware
5. Details of each different wall opening condition
6. Details of anchorages, joints, field splices, and connections
7. Details of accessories
8. Details of moldings, removable stops, and glazing
9. Details of conduit and preparations for power, signal, and control systems

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly, fire-rated borrowed-lite assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

D. Field quality control reports.

1.8 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.9 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers, subject to compliance with requirements, provide products from one of the following manufacturers:

1. Baron Metal Industries Inc.; an Assa Abloy Group company
2. Ceco Door Products; an Assa Abloy Group company
3. Concept Frames, Inc Curries Company; an Assa Abloy Group company
4. DCI Hollow Metal
5. Fleming Door Products Ltd.; Assa Abloy Group Company
6. JR Metal Frames Manufacturing, Inc.
7. Metropolitan Door Industries Corp.
8. National Custom Hollow Metal Doors & Frames
9. Pioneer Industries, Inc.
10. Republic Doors and Frames

11. Steelcraft; an Allegion company
12. Metropolitan Door Industries Corp.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch.
d. Edge Construction: Model 2, Seamless.
e. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches.
f. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
g. Core: Kraft-paper honeycomb.
h. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
i. Thermal-Rated (Insulated) Doors: All exterior doors and interior, where indicated, fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C1363. Full 1-3/4-inch-thick rigid polyurethane, adhered to inside of door faces core with waterproof adhesive for bond strength and rust prevention.

2. Frames:

a. Materials: Uncoated steel sheet.

1) Door Frames for Openings 48 Inches Wide or Less: Fabricated from 16G 0.0598-inch-thick steel sheet.
2) Door Frames for Openings More Than 48 Inches Wide: Fabricated from 14G 0.0747-inch-thick steel sheet.
3) Glazed Opening Frames: Fabricated from 16G 0.0598-inch-thick steel sheet.

b. Knocked down frames are not an acceptable substitute for welded frames.
c. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
d. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Top and Bottom Channels: Closed with continuous channels, 16G minimum 0.0598 inch thick, of same material as face sheets and spot welded to both face sheets. Seal all joints to prevent infestation of insects.

D. Hardware Reinforcement:

1. Doors shall be mortised, reinforced, drilled and tapped at the factory for fully templated hardware only, in accord with the approved hardware schedule and templates provided by the hardware supplier. Where surface-mounted hardware is to be applied, door shall have reinforcing plates only.
2. Minimum gauges for hardware reinforcing plates shall be as follows:

a. Hinge and Pivot Reinforcements: 7 gauge.
b. Reinforcements for Lock Face, Flush Bolts, Concealed Holders, Concealed or Surface-Mounted Closers: 12 gauge.
c. Reinforcements for All Other Surface-Mounted Hardware: 12 gauge.

E. Provide astragals for all pairs of doors except where specifically omitted.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch , with minimum A40 coating.

d. Edge Construction: Model 2, Seamless.
e. Edge Bevel: Bevel lock and hinge edges 1/8 inch in 2 inches.
f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
h. Core: Manufacturer's standard with Vertical steel stiffener.
i. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
b. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Hardware Reinforcements

1. Frames shall be mortised, reinforced, drilled and tapped at the factory for fully templated mortised hardware only, in accord with approved hardware schedule and templates provided by the hardware contractor. When surface-mounted hardware is to be applied, frames shall have reinforcing plates only.
2. Minimum thickness of hardware reinforcing plates shall be as follows:

D. Hinge and Pivot Reinforcements: 7 gauge, 1-1/4-inch x 10 inch minimum size.

1. Strike Reinforcements: 12 gauge.
2. Flush Bolt Reinforcements: 12 gauge.
3. Closer Reinforcements: 12 gauge.
4. Reinforcements For: Surface-mounted hardware - 12 gauge; hold-open arms - 12 gauge; surface panic devices - 12 gauge.

E. Head Reinforcement: Provide minimum 0.093-inch-thick, steel channel or angle stiffener for opening widths more than 48 inches.

2.5 BORROWED LITES

A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Full profile welded.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 16G 0.0598 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 18G 0.0478 inch thick.
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.8 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum A60 metallic coating.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

F. Grout: ASTM C476, except with a maximum slump of 4 inches, as measured according to ASTM C143/C143M.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements in Division 08 Section "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.9 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.10 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive surface-mounted door hardware.

3.3 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

1. Comply with ANSI/SDI A250.8-2023 for clearance tolerances between pairs of doors.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11 and NAAMM-HMMA 840.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8, NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.

    a. The clearance between the meeting edges of pairs of doors shall be 3/16″ (4.8 mm) ± 1/16″ (1.6 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

    a. For fire rated applications, the clearances between the meeting edges of pairs of doors shall be 1/8″ (3.2 mm) ± 1/16″ (1.6 mm).

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.5 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 11 19 - STAINLESS-STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Stainless-steel doors and frames.
2. Stainless steel panels.

B. Related Sections:

1. Division 08 Section "Door Hardware" for door hardware for stainless steel doors
2. Division 08 Section "Hollow Metal Doors and Frames" for hollow-metal doors and frames.
3. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 COORDINATION

A. Coordinate anchorage installation for stainless-steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
2. Doors: Show vertical-edge, top, and bottom construction; core construction; glazing; and hinge and other applied hardware reinforcement.
3. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

D. Product Schedule: Provide a schedule of stainless-steel, hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with a door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated stainless steel door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Field quality control reports.

D. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.7 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver stainless steel doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store stainless steel doors and frames under cover at Project site with head up. Place units on minimum 4-inch-high wood blocking.

D. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 STAINLESS-STEEL DOORS AND FRAMES

A. Basis of Design:

B. Manufacturers: Subject to compliance with requirements, provide products manufactured by the following:

1. Ceco Door Products; ASSA ABLOY.
2. Curries Company; ASSA ABLOY.
3. DCI Hollow Metal.
4. Krieger Specialty Products Company.
5. Stainless Doors, Incorporated.
6. Steelcraft; an Allegion brand

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency, acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

2.3 STAINLESS-STEEL DOORS

Construct stainless steel door and frame assemblies to comply with NAAMM-HMMA 866 for the application indicated, including materials, fabrication methods, hardware reinforcement, tolerances, and clearances, and as specified. Comply with SDI ANSI/A250.4, for Physical Performance Level A.

A. Doors and Frames for Clean Room Environments: At all BSL-3 Lab door locations as an add alternate to the specified HM doors and frames in the Door and Frame Schedule.

1. Stainless Steel Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face Sheets: Type 316 stainless steel sheet, minimum thickness 0.062 inch.
   d. Edge Construction: Continuously welded with no visible seam.
   e. Top and Bottom Edges: Closed with continuous stainless steel channels with minimum thickness of 0.062 inch, continuously welded to face sheets.
   f. Core Construction: Steel-stiffener core laminated to face sheets.
   g. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated and temperature-rise-rated doors.

2. Stainless Steel Frames:

   a. Materials: Type 316 stainless steel sheet.
   b. Door Frames for Openings 48 Inches Wide or Less: Fabricate from stainless steel sheet, minimum thickness 0.078 inch.
   c. Door Frames for Openings More Than 48 Inches Wide: Fabricate from stainless steel sheet, minimum thickness 0.078 inch.
   d. Construction: Full profile welded.

3. Hardware Reinforcement: Stainless steel sheet.

4. Finish: ASTM A480/A480M To be selected from all finishes including No. 4, Directional Satin, No. 6, Dull Satin, No. 8, Mirrorlike Reflective, Nondirectional Polish and No. 2B, Bright, Cold-Rolled, Unpolished.

2.4 MATERIALS

A. Stainless Steel Sheet: ASTM A240/A240M, austenitic stainless steel, Type 316.

B. Steel Sheet: ASTM A1008/A1008M or ASTM A1011/A1011M, commercial steel, Type B.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, commercial steel, Type B; with minimum

G60 or A60 metallic coating.

D. Mineral-Fiber Insulation: Insulation made of rock-wool fibers, slag-wool fibers, or glass fibers.

E. Inserts, Bolts, and Anchor Fasteners:

1. Stainless steel components complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 for bolts and nuts.

2.5 STAINLESS-STEEL PANELS

A. Provide stainless-steel panels of same construction, materials, and finish as specified for adjoining stainless-steel doors.

2.6 FRAME ANCHORS

A. Provide anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

B. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

C. Number and Spacing:

1. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c.
2. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
3. Compression Type: Not less than two anchors in each jamb.
4. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

D. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

1. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

E. Material:

1. Stainless steel sheet. Same type as door face.

2.7 FABRICATION

A. Stainless Steel Door Fabrication: Provide doors rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Tolerances: Fabricate doors to tolerances indicated in NAAMM-HMMA 866.
2. Stops and Moldings: Factory cut openings in doors. Provide minimum 0.038-inch-thick, stainless steel stops and moldings around glazed lites. Form corners of stops and moldings with butted or mitered hairline joints.

    a. Glazed Lites: Provide fixed stops and moldings welded on secure side of door.
    b. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

B. Stainless Steel Frame Fabrication: Provide stainless steel frames rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Tolerances: Fabricate frames to tolerances indicated in NAAMM-HMMA 866.
2. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
3. Borrowed-Lite Frames: Fabricate from 0.078-inch-thick, stainless steel sheet.
4. Sidelite Frames: Fabricate from stainless steel sheet of same thickness as adjacent door frame.
5. Mullions and Rails: Provide closed tubular members with no visible face seams or joints. Fasten members at crossings and to jambs by butt welding according to joint designs in NAAMM-HMMA 820.
6. Provide countersunk, flat-, or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
7. Door Silencers: Except on weather-stripped and gasketed frames, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

8. Stops and Moldings: Provide stops and moldings formed integrally with stainless steel frames around glazed lites and solid panels, minimum 5/8 inch high unless otherwise indicated. Form corners of stops and moldings with butted or mitered hairline joints.

    a. Loose Stops for Glazed Lites and Panels: 0.038-inch-thick, stainless steel.
    b. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
    c. Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each lite is capable of being removed independently.
    d. Coordinate rabbet width between fixed and removable stops with type of glazing or panel and type of installation.
    e. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

9. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.
10. Grouted Frames:

a. Plaster Guards: Weld guards to frame at back of hardware mortises and mounting holes in frames to be grouted.
b. Head Reinforcement: For frames more than 48 inches wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.

C. Hardware Preparation: Factory prepare stainless steel doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule, and templates.

1. Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
2. Comply with ANSI/BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.8 FINISHES

A. Stainless Steel Finishes: Remove tool and die marks and stretch lines, or blend into finish. Grind and polish surfaces to produce uniform finish, free of cross scratches. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Grain Direction: For finishes exhibiting grain, run grain vertically on door faces and frame jambs.

2.9 ACCESSORIES

A. Glazing: Comply with requirements in Division 08 Section "Glazing."

B. Grout: Comply with ASTM C476, with a slump of not more than 4 inches as measured according to ASTM C143/C143M.

C. Mineral-Fiber Insulation: Insulation made of rock-wool fibers, slag-wool fibers, or glass fibers.

PART 3 – EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation and with installation spreaders in place, adjust and securely brace stainless steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb, and perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to

plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.2 INSTALLATION

A. Install stainless steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with approved Shop Drawings and with manufacturer's written instructions.

B. Stainless Steel Frames:

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    b. Install frames with removable glazing stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.
6. Installation Tolerances: Adjust stainless steel frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb, and perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Stainless Steel Doors: Fit and adjust stainless steel doors accurately in frames within clearances specified below:

1. Non-Fire-Rated Doors: Comply with NAAMM-HMMA 841 and NAAMM-HMMA 866.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Install glazing in sidelites, transoms, and borrowed lites to comply with installation requirements in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, section 5.2

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING AND CLEANING

A. Clean grout and other bonding material off stainless steel doors and frames immediately after installation.

B. Stainless Steel Touchup: Immediately after erection, smooth any scratched or damaged areas of stainless steel; polish to match undamaged finish.

END OF SECTION 08 11 19

SECTION 08 12 16 – GLAZED INTERIOR ALUMINUM PARTITIONS, DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior aluminum frames for doors installed in gypsum board partitions.
2. Interior aluminum frames for glazing installed in gypsum board partitions.
3. Interior aluminum doors.

B. Related Sections include the following:

1. Division 06 Section “Miscellaneous Rough Carpentry”
2. Division 09 Section “Gypsum Board Assemblies”
3. Division 08 Section "Flush Wood Doors" for wood doors installed in interior aluminum frames.
4. Division 08 Section "Door Hardware" for door hardware.
5. Division 08 Section "Glazing" for glass in interior aluminum frames.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of interior aluminum frame indicated.

B. Shop Drawings: For interior aluminum frames.

1. Include elevations, sections, and installation details for each wall-opening condition.
2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
3. Include locations of reinforcements and preparations for hardware.
4. Include details of anchorages, joints, field splices, connections, and accessories.
5. Include details of moldings, removable stops, and glazing.

C. Samples for Verification: 12-inch-long framing member with factory-applied finish for each type of interior aluminum frame indicated.

D. Fabrication Sample: For each vertical-to-horizontal intersection of systems, made from 12-inch lengths of full-size components and showing details of assembly.

E. Product Schedule: For aluminum frames. Use same designations indicated on Drawings. Coordinate with door hardware schedule and glazing.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer qualifications.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For interior aluminum frames to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall demonstrate previous experience in manufacturing of interior aluminum office front framing for a period of not less than 10 years on comparable sized project.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver frames in cartons to provide protection during transit and storage at project site.

B. Inspect frames upon delivery for damage.

1. Repair minor damage to pre-finished products by means as recommended by manufacturer.
2. Replace frames that cannot be satisfactorily repaired.

C. Store frames at project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not begin installation of frames or doors until area of work has been completely enclosed and interior is protected from the elements.

B. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy. If necessary, provide temperature control and ventilation to maintain required environmental conditions.

1.10 WARRANTY

A. Warrant against defects in manufacturing of materials for a period of 2 years from date of substantial completion.

B. Warrant framing finish against defects, including cracking, flaking, blistering, peeling and excessive fading, chalking and non-uniformity in color for a period of 5 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Basis-of-Design - Wilson Partitions

B. Subject to compliance with the requirements, other acceptable manufacturers include:

1. Kawneer InFrame Interior Framing System
2. Modulex Products, Inc.
3. RACO Interior Products, Inc.
4. Wilson Partitions; a division of Acradia, Inc.

C. Single Source Responsibility: Provide aluminum frames and accessories produced by a single manufacturer for each type of product indicated.

2.2 COMPONENTS

A. Aluminum Framing, General: ASTM B221, 6063-T5 or with alloy and temper required to suit structural and finish requirements, not less than 0.062 inch thick.

B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers.

C. Glazing Frames: Extruded aluminum, for 3/8” glass thickness.

D. Doors: As specified in Section 081416 "Flush Wood Doors."

1. Door Operation: Swinging.
2. Stiles: 3-3/4 inches as indicated on drawings.
3. Rails: 6-inch top rail and 9-1/2-inch bottom rail as indicated on drawings.
4. Color: As selected by Architect from manufacturer's full range.

E. Ceiling Tracks: Extruded aluminum

F. Trim: Extruded aluminum, not less than 0.062 inch thick, with removable snap-in casing trim, glazing stops, and door stops without exposed fasteners.

2.3 ACCESSORIES

A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.

B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals in black color.

C. Smoke Seals: Intumescent strip or fire-rated gaskets in black.

D. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in black.

E. Glazing: Comply with requirements in Division 08 Section "Glazing", 3/8-inch; tempered. Hardware: Comply with requirements in Division 08 Door Hardware Sections.

2.4 FABRICATION

A. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."

1. Locate hardware cutouts and reinforcements as required by fire-rated label for assembly.

B. Components: Fabricate components for installation with concealed fastening devices and pressure-fit members that will not damage adjacent construction. Fabricate for installation with continuous seals at floor, ceiling, and other locations where partition assemblies abut fixed construction and for installation of sound attenuation insulation in partition cavities.

C. Framing:

1. Fabricate components for full-contact hairline joints.
2. Provide internal splines, clips, or reinforcements for alignment of mechanical joints.
3. Fabricate components for concealed anchorage and assembly fasteners.
4. Provide resilient stops or gaskets to prevent door contact with framing in closed position.

D. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.

1. Locate removable stops on the inside of spaces accessed by keyed doors.

E. Fabricate components to allow secure installation without exposed fasteners.

F. Glass: Fabricate glass to size before delivery.

2.5 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

1. Color: Black.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and ceilings, for conditions affecting performance of work.

1. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with frame manufacturer's written installation instructions.

B. Assemble components with full-contact, hairline joints that are accurately aligned.

C. Anchor assemblies rigidly and securely to floor and to concealed framing supports in adjacent partitions and ceilings.

D. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.

1. At fire-protection-rated openings, install fire-rated frames according to NFPA 80 and NFPA 105.

E. Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches or shorter shall be one piece.

1. Fasten to suspended ceiling grid on maximum 48-inch centers, using sheet metal screws or other fasteners approved by frame manufacturer.
2. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
3. Secure clips to extruded main-frame components and not to snap-in or trim members.
4. Do not leave screws or other fasteners exposed to view when installation is complete.

F. Glass: Install glass according to Section 088000 "Glazing" and aluminum-frame manufacturer's written instructions.

G. Door Hardware: Install according to Section 087100 "Door Hardware" and aluminum-frame manufacturer's written instructions.

H. Gasket Glazing:

1. Install gaskets with joints only at corners.
2. Install gaskets with full-contact corner joints.

I. Tape Glazing:

1. Install tape on fixed stop form continuous airtight seals. Do not stretch tapes to make them fit.
2. Butt tape corners, do not lap.
3. Install tape approximately 1/16 inch below sightline.

J. Tolerances:

1. Plumb: Within 1/8 inch in partition height.
2. Level: Within 1/8 inch in 12 ft.

3.3 ADJUSTING

A. Inspect installation, correct misalignments, and tighten loose connections.

3.4 CLEANING

A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.

B. Touch up marred frame surfaces so touchup is not visible from a distance of 48 inches as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 08 12 16

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Division 08 Section "Glazed Interior Aluminum Partitions, Doors and Frames" for aluminum door frames.
2. Division 08 Section "Door Hardware" for wood door hardware.
3. Division 08 Section "Glazing" for glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door louvers.
5. Door trim for openings.
6. Door frame construction.
7. Factory-machining criteria.
8. Factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, fire protection rating, and swing.

2. Door schedule using same reference numbers for details and openings as those on Drawings. Coordinate with hollow metal and hardware schedules.
3. Indicate door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
4. Indicate details of frame for each frame type, including dimensions and profile.
5. Indicate details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
6. Indicate dimensions and locations of blocking for hardware attachment.
7. Indicate dimensions and locations of mortises and holes for hardware.
8. Indicate clearances and undercuts.
9. Indicate requirements for veneer matching.
10. Indicate doors to be factory finished and application requirements.
11. Apply AWI Quality Certification Program label to Shop Drawings.

C. Door Schedule: Use same reference numbers for details and openings as those on Drawings. Coordinate with hollow metal and hardware schedules.

D. Samples for Initial Selection: For factory-finished doors.

E. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.
2. Plastic laminate, 6 inches square, for each color, texture, and pattern selected.
3. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.

    a. Provide samples for each species of veneer and solid lumber required.
    b. Provide samples for each color, texture, and pattern of plastic laminate required.
    c. Finish veneer-faced door samples with same materials proposed for factory-finished doors.

4. Louver blade and frame sections, 6 inches long, for each material and finish specified.
5. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT DOCUMENTS

A. Executed Special Warranty

1.7 QUALITY ASSURANCE

A. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Standards." Provide AWI Quality Certification Label or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

B. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program or WI's Certified Compliance Program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

D. Allow doors to acclimate to average prevailing humidity in installation area prior to hanging.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Delamination of veneer.
    b. Warping (bow, cup, or twist) more than 1/4-inch in a 42-by-84-inch section.
    c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards or WDMA I.S.1-A, "Architectural Wood Flush Doors."

1. Provide AWI Quality Certification or WI Certified Compliance Labels indicating that doors comply with requirements of grades specified.
2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.

2.3 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eggers Industries.
    b. Lambton Doors.
    c. Masonite Architectural; Aspira Series, Cedura Series, Graham-Maiman Series.
    d. Oshkosh Door Company.
    e. VT Industries Inc.

2. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
3. Architectural Woodwork Standards Grade: Premium.
4. Faces: Single-ply wood veneer not less than 1/50 inch thick.

    a. Species: Select white birch
    b. Cut: Rift cut.
    c. Match between Veneer Leaves: Slip match.
    d. Assembly of Veneer Leaves on Door Faces: Balance match.
    e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.

5. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.

a. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.

6. Core for Non-Fire-Rated Doors:

a. ANSI A208.1, Grade LD-1 particleboard.

1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
2) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Division 08 Section "Door Hardware."

7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Aluminum frame shop drawings will be furnished showing location and size of hardware preparation.
2. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
3. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

1. Locate hardware to comply with DHI-WDHS-3.
2. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
3. Coordinate with hardware mortises in metal door frames to verify dimensions and alignment before factory machining.
4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.

C. Openings: Cut and trim openings through doors in factory.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."
3. Louvers: Factory install louvers in prepared openings.

2.5 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Factory finish doors that are indicated on Drawings to receive transparent finish.

C. Factory finish doors where indicated in schedules or on Drawings as factory finished.

D. Transparent Finish:

1. Architectural Woodwork Standards Grade: Premium.
2. Finish: Architectural Woodwork Standards System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Open-grain finish, Filled finish or Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.

1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
2. Anchor frames to anchors or blocking built in or directly attached to substrates.

a. Secure with countersunk, concealed fasteners and blind nailing.
b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

1) For factory-finished items, use filler matching finish of items being installed.

D. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.

a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.

2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:

a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
c. Where threshold is shown or scheduled, provide1/4 inch from bottom of door to top of threshold unless otherwise indicated.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

PART 4 - SCHEDULE

END OF SECTION 08 14 16

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the access doors and frames for walls and ceilings.

B. Related Sections include the following:

1. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
2. Division 09 Section "Gypsum Board Systems" for suspended gypsum board ceilings.
3. Division 09 Section "Acoustical Ceilings" for suspended acoustical tile ceilings.
4. Division 23 Section for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of access door and frame indicated.

1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of access door(s) and frame(s) through one source from a single manufacturer.

B. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babcock-Davis.
2. Cendrex Inc.
3. JL Industries, Inc.; a division of the Activar Construction Products Group.
4. Karp Associates, Inc.
5. Larsens Manufacturing Company.
6. Maxam Metal Products Limited.
7. MIFAB, Inc.
8. Milcor; Commercial Products Group of Hart & Cooley, Inc.
9. Nystrom.
10. Williams Bros. Corporation of America (The).

B. Type shall be as required to accommodate adjacent substrate construction and shall be as least visible as possible. Doors shall be located and sized to provide appropriate access.

C. Flush Access Doors with Concealed Flanges: Fabricated from metallic-coated steel and stainless-steel sheet.

1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
2. Locations: Wall and ceiling surfaces.
3. Hinges: Continuous piano.
4. Latch and Lock: Cam latch, screwdriver operated.
5. Gasket:

a. Provide gasketed access doors in all BSL Spaces.

b. Size: 18 inches x 18 inches minimum.

D. Recessed Access Doors with Concealed Flanges Fabricated from metallic-coated steel and stainless-steel sheet.

1. Locations: Wall and ceiling surfaces.
2. Description: Door face recessed 1/2 inch for gypsum board infill; with concealed flange for gypsum board installation and concealed hinge.
3. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch , 16 gage factory finished.
4. Stainless Steel Sheet for Door: Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 or ASTM A480/A480M No. 2b finish.
5. Hinges: Concealed.
6. Latch and Lock: Cam latch, screwdriver operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Exposed Flanges: Fabricated from steel sheet.

1. Locations: Wall Ceiling Wall and ceiling surfaces.
2. Fire-Resistance Rating: Not less than that of adjacent construction.
3. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch.
5. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch-wide, surface-mounted trim.
6. Hinges: Continuous piano.
7. Automatic Closer: Spring type.
8. Latch: Self-latching device operated by ring turn with interior release.
9. Lock:

a. Prepared for cylinder lock, with interior release.
b. Prepared for mortise lock, with interior release.
c. Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware."

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.

E. Stainless Steel Flat Bars: ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.

F. Aluminum Extrusions: ASTM B221, Alloy 6063.

G. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

H. Frame Anchors: Same material as door face.

I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.

    a. Color: White.

E. Stainless Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

3.3 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Storefront framing.
2. Manual-swing entrance doors.

B. Related Sections:

1. Division 08 Section "Interior Aluminum Frames" for interior aluminum framing.

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work. Shop drawings shall be signed and sealed by the manufacturer’s structural engineer.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Include point-to-point wiring diagrams showing the following:

    a. Power requirements for each electrically operated door hardware.
    b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.6 INFORMATIONAL SUBMITTALS

A. Design Data for Aluminum-Framed Entrances and Storefronts: Design aluminum-framed entrances and storefronts under direct supervision of the manufacturer employed Engineer. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as “Not Reviewed”.

B. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
2. Statement that the Professional Engineer is fully experienced in the design of aluminum-framed entrances and storefront systems.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer's signature and seal shall appear on all design calculations and on all shop drawings.
5. Statement that the design shall be in accordance with the aesthetic design intent of the project with the Architect having final authority in reference to aesthetic matters.
6. Statement that the Professional Engineer will submit an additional signed and sealed letter at the completion of work related to this section, stating that the fabrication and installation of the aluminum-framed entrances and storefronts have been performed in accordance with the Professional Engineer's design.

C. Qualification Data: For Installer.

D. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.

E. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For special warranties.

1.7 RECORD SUBMITTALS

A. Final Certification Letter from Delegated-Design Professional: After construction of the aluminum-framed entrances and storefronts is complete, submit a Certification Letter from the responsible design professional stating that the fabrication and installation of aluminum-framed entrances and storefronts have been performed in accordance with the Professional Engineer's design.

1.8 CLOSEOUT DOCUMENTS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

C. Warranties: Final warranties to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: The product manufacturer shall have a minimum of 10 years of experience in the manufacturer of exterior metal wall panel system and shall have successfully manufactured a minimum of 5 projects similar to this project.

1. Qualified according to ASTM E699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project, with a minimum of 5 years of experience in installation of similarly sized products.

C. Professional Engineer's Qualifications: A Professional Engineer, who is licensed to practice in the state where the work will be performed, and who is experienced in providing engineering services of the kind indicated, shall seal all shop drawings, and provide calculations for wind loading for all wall system components.

D. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025.

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including, but not limited to, excessive deflection, warping, racking, joint failure, etc..
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Fluoropolymer Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite, 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches (or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E283 for infiltration as follows:

1. Fixed Framing and Glass Area:

    a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.

2. Entrance Doors:

    a. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

G. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. .

H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.

I. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Fixed glazing and framing areas as a system shall have SHGC of no greater than 0.40 as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than 55 as determined according to NFRC 500.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
b. Low Exterior Ambient-Air Temperature: 0 deg F.
c. Interior Ambient-Air Temperature: 75 deg F.

2.3 STOREFRONT SYSTEMS

A. Exterior Storefront Fixed Framing

1. Basis of Design Product: Kawneer North America; 350 Standard
2. Manufacturers: Subject to compliance with requirements, products from the following manufactures may be provided:
   a. Tubelite, Inc.
   b. Oldcastle Building Envelope.
   c. YKK AP America.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.
2. Interior Vestibule Framing Construction: Nonthermal.
3. Glazing System: Retained mechanically with gaskets on four sides.
4. Glazing Plane: Front.
5. Finish: Clear anodic finish or Color anodic finish.
6. Fabrication Method: Field-fabricated stick system.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

A. Interior Single Glazed Entrance Doors; Medium stile doors:

1. Basis of Design Product: Kawneer North America; 350 Standard Entrances Medium Stile
2. Manufacturers: Subject to compliance with requirements, products from the following manufactures may be provided:

    a. Tubelite, Inc.
    b. Oldcastle Building Envelope.
    c. YKK AP America.

B. Exterior Thermal and 1 Inch IGU Glazed Entrance Doors:

1. Basis of Design Product: Kawneer North America; 350 Standard Entrances Medium Stile
2. Manufacturers: Subject to compliance with requirements, products from the following manufactures may be provided:

    a. Tubelite, Inc.
    b. Oldcastle Building Envelope
    c. YKK AP America

C. Exterior Thermal and 1 Inch IGU Glazed Entrance Doors and Frames

1. Thermally Broken entrance Framing - High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
2. Doors: 2 inches thick for 1 inch Insulated Glass Units.
3. Non-Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
4. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposed shall be stainless steel.

a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
b. Reinforce members as required to receive fastener threads.

1. Door Design: Medium stile; 3-1/2-inch nominal width.
2. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

a. Provide nonremovable glazing stops on outside of door.

3. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

2.5 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Division 08 Section "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

D. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.

E. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.

2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

F. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

G. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

H. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

2.6 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Glazing Sealants: Comply with Division 08 Section "Glazing."

2.7 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

2.8 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A 153M requirements.

C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

D. Rigid PVC Filler.

2.9 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations
2. Accurately fitted joints with ends coped or mitered
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior
4. Physical and thermal isolation of glazing from framing members
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances
6. Provisions for field replacement of glazing
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Storefront Framing: Fabricate components for assembly using shear-block system including subsills, sill flashings, receptors, closures, etc. for a complete installation.

F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At interior and exterior doors, provide compression weather stripping at fixed stops.

G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

H. Entrance Door Hardware: Factory fabricate entrance door hardware cutouts to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Light bronze, Medium bronze, Dark bronze, or Black

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions
2. Do not install damaged components
3. Fit joints to produce hairline joints free of burrs and distortion
4. Rigidly secure nonmovement joints
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration
6. Seal joints watertight unless otherwise indicated

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
2. Alignment:

a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency who shall perform field tests and inspections.

B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements. Field testing for air infiltration and water penetration performance shall be conducted by one of the agencies listed in Paragraph 2.05.B. above.

1. Entrances and storefronts shall be tested in accordance with AAMA 5O1, AAMA 502 Test Method B and AAMA 503.
2. Testing shall occur at one typical exterior door and one typical exterior fixed glass unit including their perimeter and any special connections. The exact location and extent will be determined by the Architect. Testing shall occur after all the entrance/storefronts have been installed and sealed, but prior to installation of interior finishes. The Contractor shall schedule the testing giving both the testing agency and Architect 14 days advance notice.
3. Perform testing in accordance with the test specified herein in the presence of the Owner, the Architect and the Testing Agency and in each case evidence of satisfactory performance as specified shall be required as a condition of acceptability. Testing procedures shall include the following tests:

a. Air infiltration
b. Water penetration

4. Report results in accordance with AAMA 502 and 503.
5. If any tests are unsuccessful, the Testing Agency/Architect shall require revisions to the entrance/storefront system and/or enough additional testing/modifications to the extent to assure the entrance/storefronts meet the performance criteria of the project.
6. Installation of interior finishes in vicinity of entrance/storefronts shall not proceed until the test results are acceptable.
7. The cost of all testing, all modifications required to pass the test, subsequent modifications required to the entire system, and all retesting shall be paid for under this section.
8. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E783 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft..

    a. Test Area: One bay wide, but not less than 30 feet, by 1 story of aluminum-framed systems as indicated on the drawings.
    b. A minimum of two tests in areas indicated.

9. Water Penetration: Areas shall be tested according to ASTM E1105 at a minimum uniform static-air-pressure difference of 8.00 psf, and shall not evidence water penetration.

    a. Test Area: One bay wide, but less than 30 feet, by 1 story of aluminum-framed systems.
    b. A minimum of two tests in areas as directed by Architect.

C. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.6 ADJUSTING

A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.
2. Instruct Owner's personnel on the proper maintenance and adjusting of door systems.

END OF SECTION 08 41 13

SECTION 08 51 13 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Aluminum framed windows for exterior locations.

B. Related Sections include the following:

1. Division 08 Section "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.

B. Shop Drawings: For aluminum windows.

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of hardware and accessories involving color selection.

E. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:

1. Exposed Finishes: 2 by 4 inches.
2. Exposed Hardware: Full-size units.

F. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's warranties.

1.6 CLOSEOUT DOCUMENTS

A. Maintenance Data: For operable window sash, operating hardware, weather stripping, window system operators and finishes to include in maintenance manuals.

B. Warranty: Special warranty specified in this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: 10 years from date of Substantial Completion.
b. Glazing Units: 10 years from date of Substantial Completion.

3. Anodic Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: AW As indicated on Drawings.
2. Minimum Performance Grade: 40 As indicated on Drawings.

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.35 Btu/sq. ft. x h x deg F.

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.30.

E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.

F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

G. Sound Transmission Class (STC): Rated for not less than 30 STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.

H. Outside-Inside Transmission Class (OITC): Rated for not less than 26OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 2for basicprotection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

2.3 ALUMINUM WINDOWS

A. Basis of Design: Kaweer 1600 System 1, Kawneer North Americal, an Arconic Company

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Arcadia, Inc.
2. Bruce Wall Systems Corporation.
4. Old Building Envelope
5. USA LP.
6. Tingwall Inc.
7. Tudbelite Inc.
8. TRACOWaltek Company Limited.
9. Wausau Window and Wall Systems; Apogee Wausau Group, Inc.
10. YKK AP America Inc.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Fixed.

D. Frames and Sashes: Aluminum extrusions comply with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

E. Glass and Glazing Materials: Refer to Division 08 Section "Glazing" for glass units and glazing requirements.

F. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

G. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

C. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

D. Receptor System: Two-piece, thermally broken, extruded-aluminum receptor system that anchors windows in place.

E. Sun Control.

1. Veritcal Sunshades: Assemblies consisting of manufacturer’s standard outrigger brackets, louvers and fascia, design for attachment to curtain wall with mechanical fasteners.

a. Basis of Design: Kawneer – Sersoleil Sunshade – Single Blade System.
b. Project from Wall: As indicated on drawings with 14 inches blade.
c. Outriggers: Oval with rounded edges.
d. Fascia: As indicated on drawers.
e. Finish: Match adjacent glazed aluminum windows
f. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
g. Steel Reinfrcement: As required by manufacturer.

2. Horizontal Sunshades: Assemblies consisting of manufacturer’s standard outrigger brackets, louvers and fascia, design for attachment to structural framing as indicated on drawings with mechanical fasteners.

a. Basis of Design: Construction Specialties – Cantilevered Sunshades

b. Project from Wall: As indicated on drawings.
c. Outriggers: Oval with rounded edges.
d. Louvers in configuration as indicated on drawings:

1) Number: 5 louvres per unit.
2) Shape: Airfoil
3) Width: Varies as indicated on drawings.
4) Mounting Angle

e. Nosing: Semicircular
f. Fascia: Rectangular.
g. Finish: Match adjacent glazed aluminum windows
h. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
i. Steel Reinfrcement: As required by manufacturer.

2.5 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window unitsBow and bay window assemblies usually contain casement, double-hung, or fixed window units.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are not acceptable.

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

D. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.

1. Color: As selected by Architect from full range of industry colors and color densities

E. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

1. Color: As selected by Architect from full range of industry colors and color densities

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 INSTALLATION OF ENGINEERED TRANSITION ASSEMBLY (ETA):

A. Install ETA as specified in Division 07 sections Air and Vapor Barrier (AVB) Vapor Permeable Barrier (AIB).

1. Install ETA around the perimeter of each opening and window using recommended sealant adhesives per ETA manufacturer written instructions,

3.1 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.

2. Water-Resistance Testing:

a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
b. Allowable Water Infiltration: No water penetration.

3. Testing Extent: Three windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
4. Test Reports: Prepared according to AAMA 502.

C. Windows will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.2 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08 51 13

SECTION 08 80 00 – GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Storefront framing.
3. Glazed entrances.
4. Interior and Exterior Doors, except where noted otherwise.
5. Interior borrowed lites; including glazed openings, transoms and sidelights, except where noted otherwise.
6. Fire-resistive glazing products.
7. Glazing sealants and accessories.

B. Section includes transparent and translucent glass glazing for general and special purpose applications including; coated, float, heat-strengthened, impact resistant, insulating, low emissivity, laminated, spandrel and tempered glass.

C. Section includes the manufacture, handle, deliver and install glazing systems as shown on the architectural drawings or as otherwise specified and in accordance with the requirements of the contract documents.

D. Related Sections:

1. Division 08, Section “Hollow Metal Doors and Frames” for glazing in interior doors and interior window glazing.
2. Division 08, Section “Flush Wood Doors” for glazing in interior wood doors.
3. Division 08, Section "Glazed Interior Aluminum Partitions, Door and Frames”
4. Division 08, Section “Aluminum-Framed Entrances and Storefronts" for tempered glass doors provided by the manufacturer.
5. Division 08, Section "Aluminum Windows" for exterior insulated glazing units.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in the referenced glazing publications.

1. For this specification, manufacturer shall be defined as the firm that produces the primary glass.
2. For this specification, fabricator shall be defined as the firm that modifies the primary glass by coating, heat treating, laminating and creating insulating glass fabrications.
3. For this specification, installer shall be defined as the firm who receives the glazing products from the fabricator and installs them on the project.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.

C. IBC: International Building Code.

D. Interspace or Airspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

E. Sealed Insulating Glass Unit Surfaces & Coating Orientation:

1. Surface 1 – Exterior surface of outer pane (surface facing outdoors of outboard lite)
2. Surface 2 – Interior surface of outer pane (surface facing indoors of outboard lite)
3. Surface 3 – Exterior surface of inner pane (surface facing outdoors of inboard lite)
4. Surface 4 – Interior surface of inner pane (surface facing indoors of inboard lite)

F. Annealed Glass: Raw glass with low residual stresses which enables cutting and fabrication. Annealing is a process of slowly cooling glass to relieve internal stresses after it is formed.

G. Heat Strengthened (HS): Glass that has been heat-treated to have a surface compression between 3500 and 7500 psi and meet the requirements for ASTM C1048 kind HS. It is ~2-3 times the strength of annealed glass.

H. Fully Tempered Glass (FT): Glass that has been heat-treated to have either a minimum surface compression of 10000 psi or an edge compression not less than 9700 psi in accordance with the requirements of ASTM C1048 kind FT or meet the requirements of ANSI Z97.1 or CPSC 16 CFR 1201 safety glazing standards.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Shop Drawings: Provide elevations indicating the location and type of glazing material to be installed in each opening using the same designations on the documents.

C. Glass Samples: For each type of the following products; 12 inches (300 mm) square.

1. Each color of tinted glass.

2. Each color and type of coated glass.
3. Each type of laminated glass with colored or patterned interlayer.
4. Each type and pattern of insulating glass, including ceramic coated spandrel types.

D. Glazing Accessory Samples: For gaskets sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant samples between two strips of material representative in color of the adjoining framing system.

1. Provide each type and color of gaskets, sealants and colored spacers.

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

B. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed by an officer of the fabrication firm responsible for their preparation.

1. Submit Glass Fabricator's Submittal Review indicating compliance with glazing standards established by the Glass Association of North America (GANA). Submittal to include connection details, framing details, thermal stress analysis and structural load analysis of the proposed glass types, configuration and sizes.

C. Qualification Data: For glazing fabricator and installer.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for all glass products, fabricated glass products, glazing sealants and glazing gaskets.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

E. Submit preconstruction adhesion and compatibility test report.

F. Provide certification that roller wave or ripple distortion is within specified limits for each piece of heat-treated flat float glass.

G. Provide a copy of manufacturer's current ISO 9001Certification certificate.

H. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE.

A. Fabricator Qualifications for Insulating-Glass Units with Low-E Coatings: A qualified insulating-glass fabricator who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass and Metal (AG&M) contractors.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight. Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

B. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

C. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Field Measurement: Verify field measurements with drawing dimensions prior to fabrication of glass products.

B. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: Ten years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

1. Obtain tinted glass from single source from single manufacturer.
2. Obtain reflective-coated glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to

the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E1300 and applicable IBC code by a qualified professional engineer, using the following design criteria. Confirm glass thicknesses by analyzing Project loads and in-service conditions.

1. Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.

1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads.", based on heights above grade indicated and the information provided on the structural drawings.
2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes basic-protection testing requirements in ASTM E1996 for Wind Zone 1 when tested according to ASTM E1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.

F. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

G. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.

5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Glass shall be annealed, heat strengthened or tempered as required by codes and specified on drawings.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass (Kind HS), or fully tempered float glass (Kind FT) as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass (Kind HS)or fully tempered float glass (Kind FT) as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass (Kind FT).

F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

2.4 PRIMARY GLASS PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Cardinal Glass Industries, Inc.
2. Guardian Industries Corp.
3. Pilkington North America
4. Vitro Architectural Glass.

B. Float Glass: ASTM C1036, Type I, Quality-Q3, Class 1 (clear) or Class 2 (tinted) unless otherwise indicated.

C. Ultraclear Float Glass: ASTM C1036, Type I, Quality-Q3, Class 1, complying with other requirements specified and with visible light transmission not less than 91 percent and solar heat gain coefficient not less than 0.87.

2.5 FABRICATED GLASS PRODUCTS

A. Fabricators: Subject to compliance with requirements, provide products by one of the following or equal:

1. Cristacurva.
2. Glasswerks LA, Inc.
3. GTI; Glaz-Tech Industries.
4. Hartung Glass Industries.
5. J.E. Berkowitz
6. Northwestern Industries, Inc.
7. Oldcastle Building Envelope
8. Trulite Glass & Aluminum Solutions, LLC.
9. Viracon, Inc.

B. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) or Class 2 (tinted) unless otherwise indicated; of kind and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. Roller-Wave or Ripple: Maximum peak to valley rollerwave 0.003 inch in the central area and 0.008 inch within 10.5 inch of the leading and trailing edge for ¼ inch) thick (Electronic read out per lite is required as a submittal of this fabrication tolerance.)
3. Maximum bow and warp 1/32 inch per lineal foot or ½ of the ASTM C1048 allowable specification.
4. All tempered architectural safety glass shall conform to ANSI Z97.1 and CPSC 16 CFR 1201.
5. Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
6. For uncoated glass, comply with requirements for Condition A.
7. For coated vision glass, comply with requirements for Condition C (other coated glass).
8. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.

C. Heat Soaked Tempered Glass: Fully tempered glass shall be heat soaked to EN 14179-1:2005 European Heat Soak Standard.

1. The fully tempered glass shall be stacked in a chamber of a specially constructed oven. Its temperature shall be ramped up to 290°C (550°F) for two hours and gradually ramped down in accordance with the Standard.

D. Ceramic-Coated Vision Glass (Silk Screened Frit): ASTM C1376 and C1048, heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with

Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.

1. Shall comply with ASTM C1376 Standard for Pyrolytic and Vacuum Deposition Coatings on Glass and with ASTM C1048 Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated, Condition B.
2. Coated products to be magnetically sputtered vacuum deposition (MSVD)
3. Silk-screen pattern should be no more than 0.0625 inch off parallel from locating glass edge and no more than 0.0125 inch from edges other than locating glass edge.
4. There shall be a maximum of a 0.03125-inch variation in dot, hole or line location.

E. Ceramic-Coated Spandrel Glass: ASTM C1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.

1. Shall comply with ASTM C1376 Standard for Pyrolytic and Vacuum Deposition Coatings on Glass and with ASTM C1048 Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated, Condition B.
2. Coated products to be magnetically sputtered vacuum deposition (MSVD)
3. Silk-screen pattern should be no more than 0.0625 inch off parallel from locating glass edge and no more than 0.0125 inch from edges other than locating glass edge.
4. There shall be a maximum of a 0.03125-inch variation in dot, hole or line location.

F. Insulating-Glass Units: Shall comply with ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation and ASTM E2188 Standard Test Method of Insulating Glass Unit Performance. Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190, and complying with other requirements specified.

1. Insulated Glass: General

    a. The unit overall thickness tolerance shall be -1/16 inch/ +1/32 inch. Unit constructed with laminated glass shall be +/-1/16 inch
    b. Shall comply with ASTM E546 Standard Test Method for Frost Point of Sealed Insulating Glass Units
    c. Shall comply with ASTM E576 Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position
    d. Sealed Insulating Glass Units to be double sealed with a primary seal of polyisobutylene and a secondary seal of silicone.

        1) There shall be no voids or skips in the primary seal.
        2) Depth of secondary seal shall be as determined by the wind load analysis.
        3) Gaps or skips between primary and secondary sealant are permitted to a maximum width of 1/16 inch by maximum length of 2 inches with gaps separated by at least 18 inches. Continuous contact between the primary seal and the secondary seal is desired.

    e. Spacer: Aluminum with mill or clear anodic finish

2. Desiccant: Molecular sieve or silica gel, or blend of both.

2.6 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.

2.7 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C509, Type II, black; of profile and hardness required to maintain watertight seal.

2.8 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealant shall have a VOC content of 250 g/L or less.
4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.9 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800.

2.10 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.11 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of framing system manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces**.**

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.12 MONOLITHIC-GLASS TYPES

A. Glass Type (Interior Glazing): Clear float glass fully tempered float glass.

1. Thickness: 6.0 mm.
2. Provide safety glazing labeling.

2.13 INSULATING-GLASS TYPES

A. Glass Type IG-1: Passive solar low-e insulating glass.

1. Basis of Design Product: Viracon VE19-2M
2. Overall Unit Thickness: 1 inch
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Class 2 (tinted) float glass, heat-strengthened float glass or fully tempered float glass as required to meet or exceed performance requirements included herein.
5. Tint Color: Crystal Gray
6. Interspace Content: Air.
7. Indoor Lite: Class 1 (clear) float glass or heat-strengthened float glass as required to meet or exceed performance requirements included herein. Provide fully tempered float glass where indicated on the drawings or where required by the AHJ
8. Low-E Coating: Second surface surface.
9. Visible Light Transmittance: 50 percent minimum
10. Winter Nighttime U-Factor: 0.30 maximum.
11. Summer Daytime U-Factor: 0.26 maximum.
12. Solar Heat Gain Coefficient: 0.31 maximum

B. Glass Type IG-2: Passive solar low-e insulating glass.

1. Basis of Design Product: Viracon VE1-2M
2. Overall Unit Thickness: 1 inch
3. Thickness of Each Glass Lite: 6.0 mm
4. Outdoor Lite: Class 1 (clear) float glass, heat-strengthened float glass or fully tempered float glass as required to meet or exceed performance requirements included herein.
5. Tint Color: Crystal Gray
6. Interspace Content: Air.
7. Indoor Lite: Class 1 (clear) float glass or heat-strengthened float glass as required to meet or exceed performance requirements included herein. Provide fully tempered float glass where indicated on the drawings or where required by the AHJ
8. Low-E Coating: Second surface surface.
9. Visible Light Transmittance: 70 percent minimum
10. Winter Nighttime U-Factor: 0.30 maximum.
11. Summer Daytime U-Factor: 0.26 maximum.
12. Solar Heat Gain Coefficient: 0.38 maximum
13.
    a. ve>

2.14 FIRE-PROTECTION-RATED GLAZING TYPES

1. Provide safety glazing labeling.

B. Glass Type FRG-160-minute fire-rated glazing with 450 deg F temperature rise limitation; laminated glass with intumescent interlayers.

1. Provide safety glazing labeling.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 80 00

SECTION 08 91 19 – FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.
2. Screens and blank-off panels for louvers.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for wall vents (brick vents) for masonry.
2. Division 07 Section “Metal Panels” for louvers integral with insulated metal panels.
3. Division 23 Sections for louvers that are a part of mechanical equipment.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.

F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Design Data for Louver Systems: Design louvers under direct supervision of the manufacturer employed Engineer. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers. Design Data submittal shall be signed and sealed by a qualified professional engineer licensed in the state or district in which the project is located. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect. Design Data submission must be concurrent with the submission of corresponding Fabrication drawings. Fabrication drawings submitted without corresponding Design Data will be returned as “Not Reviewed”.

B. Initial Certification Letter from Delegated-Design Professional: Prior to the submission of Shop Drawings, Product Data, Calculations and other required submittals, submit a Certification Letter from the responsible design professional. No shop drawings will be reviewed by the Architect prior to the submission and acceptance of this Certification Letter. The Certification Letter shall include the following:

1. Signature and seal of the registered Professional Engineer (registered in the state or district in which the project is located).
2. Statement that the Professional Engineer is fully experienced in the design louver systems.
3. Statement that all calculations and shop drawings are in accordance with the Contract Documents and applicable building codes and have been prepared under the direction of the Professional Engineer.
4. Statement that the Professional Engineer’s signature and seal shall appear on all design calculations and on all shop drawings.
5. Statement that the design shall be in accordance with the aesthetic design intent of the project with the Architect having final authority in reference to aesthetic matters.
6. Statement that the Professional Engineer will submit an additional signed and sealed letter at the completion of the work related to this section stating that the fabrication and installation of the louver systems have been performed in accordance with the Professional Engineer’s design.

C. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified

testing agency, for each type of louver and showing compliance with performance requirements specified.

D. Sample Warranties: For manufacturer's special warranties.

1.6 RECORD SUBMITTALS

A. Final Certification Letter from Delegated-Design Professional: After construction of the louvers is complete, submit a signed and sealed Certification Letter from the responsible design professional stating that the fabrication and installation of the louver systems have been performed in accordance with the Professional Engineer’s design.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For louvers to include in maintenance manuals.

B. Warranties: Final warranties to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M.
2. AWS D1.3/D1.3M.
3. AWS D1.6/D1.6M.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.10 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

C. Seismic Performance: As indicated on drawings.

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F , material surfaces.

F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver LV-01:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties Inc., RSH-5700 or specified product by one of the following:

    a. Airolite Company, LLC (The); SCH-501.
    b. Ruskin Company; EME520DD.

2. Louver Depth: 5 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.075 inch for frames.
4. Louver Performance Ratings:

    a. Free Area: Not less than 7.32 sq. ft. 45.8% free area for 48-inch- wide by 48-inch-high louver.
    b. Air Performance: Not more than 0. 0.15-inch wg static pressure drop at 969-fpm free-area intake velocity.
    c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 780 fpm .

5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Mill finish unless otherwise indicated.
3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

2.5 BLANK-OFF PANELS

A. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 3 inches.
2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Insulating Core: Rigid, glass-fiber-board insulation.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Non-metallic 2-coat Kynar in color selected by Architect to match louvers.
7. Attach blank-off panels with sheet metal screws.

2.6 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B26/B26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Phillips flat-head tamper-resistant screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.7 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.

1. Semi-recessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with semirecessed mullions at corners.

G. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.9 LOUVER ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Baked-Enamel or Powder-Coat Finish: AAMA 2605 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Install louvers and accessories per approved submittals and louver manufacturer’s written instructions.

B. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

C. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

D. Form closely fitted joints with exposed connections accurately located and secured.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

H. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 19

SECTION 09 05 61.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation.

B. Related Sections include the following:

1. Division 01 Section “Summary” for explanation of contractor responsibility for the installation of a Topical Moisture Mitigation System where required.
2. Division 03 Section “Cast-In-Place Concrete” for concrete slab design, admixtures and curing requirements.
3. Division 09 Sections Flooring for flooring materials, flatness and RH requirements.

1.3 DEFINITIONS

A. MVE: Moisture vapor emission.

B. MVER: Moisture vapor emission rate.

1.4 PREINSTALLATION CONFERENCE

A. Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Shop Drawings: Include plans indicating substrates, locations, and RH test locations.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Qualification Data: For Manufacturer

C. Product Test Reports: For each MVE-control system, for tests performed by a qualified testing agency.

D. Preinstallation testing reports.

E. Field quality-control reports.

F. Sample of Manufacturer’s Warranty.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.

1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.10 WARRANTY

A. Certified applicator shall file a pre-installation checklist with the manufacturer and receive written confirmation of the approval to proceed in order to obtain the extended warranty.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:

1. MVER: Maximum 25 lb of water/1000 sq. ft. when tested according to ASTM F1869.
2. Relative Humidity: Maximum 90 percent when tested according to ASTM F2170 using in situ probes.

B. Water-Vapor Transmission: Through MVE-control system, maximum 0.10 perm when tested according to ASTM E96/E96M.

C. Tensile Bond Strength: For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D7234.

2.2 MVE-CONTROL SYSTEM

A. Products: Subject to compliance with requirements, provide products named by one of the following manufacturers:

1. Advanced Moisture Control, Inc; Vapor-Green FC.
2. ARDEX Americas; ARDEX MC RAPID One-Coat.
3. BASF Corporation; MasterTop VB 240FS.
4. Dependable, LLC; Vaporseal HM Plus.
5. Floor Seal Technology, Inc.; CustomTech TechMVC.
6. H.B. Fuller Construction Products Inc. / TEC LiquiDam.
7. KOSTER American Corporation; VAP I 2000 FS
8. LATICRETE SUPERCAP, LLC.; Moisture Vapor Control

B. MVE-Control System: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.

1. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
2. Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment products, provide MVE-control system manufacturer's primer to ensure adhesion of products to MVE-control system.

2.3 HYDRAULIC CEMENT UNDERLAYMENT

A. Hydraulic Cement-based Self-Leveling Underlayment

1. Basis of Design Product: Ardex Engineered Cements:

a. Primer: P82 Ultra Prime
b. K 15 or K 55 Microtec Premium Self-Leveling Concrete Underlayment.

2. Other Acceptable Products: Subject to compliance with requirements, comparable products manufactured by the following may be provided:

a. BASF Corporation

1) MasterTop P 150 primer
2) Mastertop 110 Plus Underlayment

b. Koster American Corporation

1) VAP I 06 Primer
2) SL Premium Underlayment

c. Laticrete

1) Drytec Levelex Primer
2) Drytek Levelex Plus Underlayment

B. WATER: Water shall be clean, potable, and sufficiently cool (not warmer than 70°F).

2.4 ACCESSORIES

A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of 3000-psi compressive strength after 28 days when tested according to ASTM C109/C109M.

B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of system indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Preinstallation Testing:

1. Testing Agency: Engage a qualified testing agency to perform tests.
2. Alkalinity Testing: Perform pH testing according to ASTM F 710. Install MVE-control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F 1869. Install MVE-control system in locations where concrete substrate MVER exceeds 3 lb of water/1000 sq. ft. in 24 hours.
    b. Internal Relative Humidity Test: Using in situ probes, ASTM F 2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.

4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. area of MVE-control system to prepared concrete substrate and test according to ASTM D 7234.

    a. Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.

B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.

1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and leveling material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.3 INSTALLATION

A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.

1. Install primers as required to comply with manufacturer's written instructions.

B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.

C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.

D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

F. Install cementitious underlayment over cured membrane in thickness required to maintain the warranty.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform installation inspections.

B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.

1. Verify that surface preparation meets requirements.
2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.

C. MVE-control system will be considered defective if it does not pass inspections.

3.5 CLEANING

A. Remove all debris resulting from water vapor reduction system installation from project site.

3.6 PROTECTION

A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION 09 05 61.13

SECTION 09 29 00 - GYPSUM BOARD SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Specialty gypsum board
3. Gypsum board shaft wall assemblies.
4. Non-load-bearing steel framing systems for interior partitions.
5. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
6. Marking and Identifying Fire and Smoke Rated Assemblies.

B. Related Sections include the following:

1. Division 01 Section “Temporary Facilities and Controls” for moisture and mold field quality control procedures.
2. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing wall studs.
3. Division 07 Section "Firestopping” for head-of-wall assemblies that incorporate gypsum board

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. System Assemblies:

1. Provide schedule of all UL approved system assembly numbers and descriptions for each UL approved wall assembly to be installed in the work.
2. Provide schedule of all STC assembly designs and descriptions for each required Sound Transmission Class wall to be installed in the work.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Delegated Design:

1. Provide load calculations for Grid Suspension System for Gypsum Board Ceilings (reference Part 2) which includes structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

a. Load calculations for system, shall include those imposed by lighting, air distribution terminals, fire suppression and all other supplementary loads on the grid system.

B. Provide Contractor's certification that all required rated assemblies are constructed in accordance with UL design tests or GA-600 including penetrations, door frames elevator doors and equipment, etc., and that all rated door openings meet ASTM E152.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Evaluation Reports: For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

1.6 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 and GA 220 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

D. Room Temperatures: For attachment of gypsum board to framing, maintain not less than 40° F. For finishing of gypsum board maintain not less than 50° F for 48 hours before application and continuously after until dry. Do not exceed 95° F when using temporary heat sources. Gypsum board shall not get wet.

E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

1.8 WARRANTY

A. Provide 2 year written product and installation warranty in accordance with Division 01 "Product Requirements."

B. Repair and/or replace any cracking, loosening, nail popping or other defects in the material or workmanship, including improper installation of framing, bracing and control joints, of the gypsum board systems during warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 GYPSUM BOARD, GENERAL

A. Panel Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific
4. Continental Building Products

5. National Gypsum Company
6. PABCO Gypsum
7. USG Corporation

B. Interior Gypsum Board Density: Lightweight panel products are not acceptable. All gypsum board products shall have a minimum weight of 2.1 pounds per square foot of 5/8 inches thick board (40.3 pounds per cubic foot).

C. Regular Type X: ASTM C1396/C1396M

1. Thickness: 5/8 inch
2. Long Edges: Tapered

D. Flexible Type: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Thickness: 1/4 inch
2. Long Edges: Tapered

E. Mold-Resistant Type: ASTM C1396/C1396M. With moisture- and mold-resistant core and surfaces.

1. Core: 5/8 inch, Type X
2. Long Edges: Tapered
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 GYPSUM SHAFTLINER

A. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Gypsum: M-BLOC Shaft Liner.
b. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
d. Continental Building Products; Firecheck Moldcheck Type X Shaftliner.
e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
f. PABCO Gypsum; Pabcore Mold Curb Shaftliner Type X.
g. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.

2. Core: 1 inch thick
3. Long Edges: Double bevel
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047. Provide longest possible lengths.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.

a. USG Corporation
b. ClarkDietrick
c. MarinoWare

2. Material: Paper-faced galvanized-steel sheet.

a. USG Corporation; Beadex or comparable products subject to compliance with requirements.

3. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. L-Bead: L-shaped; exposed long flange receives joint compound.
d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
e. Control joint: Zinc control joint.
f. Curved-Edge Cornerbead: With notched or flexible flanges
g. Bullnose Inside Corner.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers:

a. Basis of Design: Fry Reglet Corp.
b. Other Acceptable manufacturers subject to compliance with requirements:

1) Gordon, Inc.
2) Pittcon Industries

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M and GA 216.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints beveled panel edges, and damaged surface areas, use drying-type taping compound, except use setting-type for abuse resistant drywall.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type taping compound, except use setting-type for abuse resistant drywall.
3. Fill Coat: For second coat, use drying-type, sandable topping compound, except use setting-type for abuse resistant drywall.
4. Finish Coat: For third coat, use drying-type, sandable topping compound, except use setting-type for abuse resistant drywall.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: Setting mortar as recommended by backer unit manufacturer.
2. Tile Setting Mortar: Per Division 09 Section “Tiling”.

2.7 STEEL FRAMING SYSTEMS

A. Steel Stud Manufacturers Association (SSMA) nomenclature, as indicated in their Product Technical Guide, is used for identification of steel studs.

B. Framing Members, General: Comply with ASTM C754 and ASTM C1007 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 and ASTM C955 requirements for metal unless otherwise indicated.
2. Products: Subject to compliance with requirements, provide products by one of the following:

    a. ClarkDietrich Building Systems
    b. Marino/Ware
    c. Telling Industries

3. Protective Coating: Minimum ASTM A653/A653M, G40, hot-dip galvanized unless otherwise indicated.

    a. Equivalent coatings are not permitted.

C. Structural Steel Studs for Non-Load-Bearing Partition Framing:

1. 400S162-54 4” web depth stud with minimum base metal thickness of 0.054 inch, minimum flange width of 1.625” and minimum stiffening lip length of 0.375”.

    a. Other Web Depths and gauges: As indicated on Drawings.

D. Runners (Tracks):

1. Slip-Type Head Joints: Provide the following:

    a. Single Long-Leg Runner System: Top runner with minimum 2-1/2-inch-deep flanges in thickness as scheduled below, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.

        1) Stud length up to 12’0”: minimum top runner base metal thickness; match wall studs.
        2) Stud length 12’0” to 22’0”: minimum top runner base metal thickness: match wall studs
        3) Stud length up to 24’0”: minimum top runner base metal thickness: match wall studs.

2. Partition top runner which does not extend to structure: 1-1/4 inch leg of thickness and size to match studs.
3. Bottom Runner: 1-1/4 inches leg of thickness and size to match studs, typical.
4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Concealed Blocking: See requirements for concealed blocking in Part 3 of this Section.

F. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.

1. Depth: 1-1/2 inches.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

G. Blocking and Strapping: Permitted only where interferences prevent the installation of Cold Rolled Channel Bridging noted above.

1. Blocking: 0.033 inch track sections clipped to studs.
2. Strapping: 2 - 12 inches wide steel strap bracing, 0.033 inch by 10 feet.

H. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Minimum Base-Metal Thickness: 0.030 inch.
2. Depth: 7/8 inch.

I. Resilient Clips: molded rubber and steel resilient sound isolation clips to receive 7/8 inch hat channel furring.

1. Manufacturers:

    a. Basis of Design: Pliteq GenieClip Resilient Sound Isolation Clip.
    b. Other Acceptable Manufacturers subject to compliance with requirements:

        1) Acoustical Surfaces, Inc. RSIC-1
        2) Kinetics Noise Control Inc. Isomax

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.8 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated.

B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base-Metal Thickness: 0.033 inch.

C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.

1. Minimum Base-Metal Thickness: 0.033 inch.

D. Protective Coating: Minimum ASTM A653/A653M, G40, hot-dip galvanized unless otherwise indicated.

E. Elevator Hoistway Entrances: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than 0.033 inch thick.

F. Room-Side Finish: As indicated.

G. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X.

H. Concealed Blocking: See requirements for concealed blocking in Part 3 of this Section.

2.9 GYPSUM BOARD CEILING SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488 by an independent testing agency.

a. Type: Cast-in-place anchor, designed for attachment to concrete forms or post-installed, expansion anchor.

2. Powder-Actuated Fasteners: Suitable fastener for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed

by construction as determined by testing according to ASTM E1190 by an independent testing agency.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.106 inch in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges, G40 (G60 where subject to moisture) galvanized steel.

1. Depth: 1-1/2 inches.

E. Furring: G40 galvanized steel, hat channel, minimum size SSMA 150F125-33 (20 gauge structural, minimum 0.0329 inch uncoated steel thickness) or stud, minimum size SSMA 362S137-33 (20 gauge structural, minimum 0.0329 inch uncoated steel thickness).

F. In lieu of traditional carrying channel (black) iron and hat track, or stud and track suspension system, contractor may use suspended grid or "T-bar" construction. Should this option be elected, the contractor shall be responsible to provide load calculations for review and approval as required in Part 1 of this Section.

1. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Armstrong World Industries, Inc.; Drywall Grid Systems
2) Chicago Metallic Corporation; Drywall Grid System
3) USG Corporation; Drywall Suspension System

b. T-bar construction shall meet or exceed all requirements of this specification and local codes.
c. Minimum G40 hot dipped galvanized coating and .0179 steel thickness before application of protective coating.

2.10 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool. Blankets shall be the proper width and depth required to completely fill the stud/drywall cavity and prevent sag. Blankets installed where drywall is not applied on each side of the stud shall be mechanically held in place.

1. For use in non-fire rated wall and ceiling assemblies.
2. Basis of Design: Thermafiber Mineral Wool Batt
3. Other acceptable manufacturers subject to compliance with requirements;

    a. Roxul Mineral Wool Batt.
    b. Johns Manville; Fiberglass Batts for Metal Framing.
    c. Owens Corning; Fiberglass Thermal Batt for Metal Framing.

D. Fire-Resistive Blankets: ASTM C665, Type I (blankets without membrane facing); consisting of slag wool or rock wool fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics. Blankets shall be the proper width and depth required to completely fill the stud/drywall cavity and prevent sag.

1. Fire-Resistance-Rated Assemblies: Install mineral-fiber as required to comply with the requirements of the approved assembly.
2. Basis of Design: Thermafiber Mineral Wool Batt
3. Other acceptable manufacturers subject to compliance with requirements;

    a. Roxul Mineral Wool Batt.

E. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

F. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

G. Acoustical Joint Sealant: As specified in Division 07 Section "Joint Sealants"

H. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

I. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

J. Fire Safing: As specified in Division 07 Section “Firestopping”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates to which gypsum board assemblies attach or abut, including hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Commencement of installation indicates acceptance of substrate.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C840.

B. Extend gypsum board to height as indicated on drawing.

C. Protect gypsum board products from direct exposure to rain, snow, sunlight, or other excessive weather conditions.

D. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels, not less than one framing member.

E. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

F. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

G. Form control and expansion joints with space between edges of adjoining gypsum panels.

H. Cover both faces of support framing with gypsum panels in concealed spaces.

1. Fit gypsum panels around ducts, pipes, and conduits.
2. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

I. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge

trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

J. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

K. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

L. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.4 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: As indicated on Drawings and vertical surfaces unless otherwise indicated.
2. Flexible Type: Apply in double layer at curved assemblies.
3. Moisture- and Mold-Resistant Type: As indicated on Drawings and all perimeter walls.
4. Acoustically Enhanced Type: As indicated on Drawings.

B. Single-Layer Application:

1. Apply single layer gypsum board in fire rated partitions as required by the fire resistance rated assembly.
2. Erect all gypsum board on ceilings perpendicular to framing with staggered end joints over supports.
3. End joints shall be avoided where possible. Apply single layer gypsum board in non-fire rated partitions either vertically with edges over framing or horizontally with ends over framing as required to minimize the number of end joints.

    a. Install vertical boards in lengths required to exceed the ceiling height were possible.

4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On multi-layer partitions/walls, apply gypsum board panels per fire resistive rated assembly and STC rated assembly requirements.
2. On all other multi-layer partition/walls, apply the first layer in the opposite direction as second layer with all ends over framing. Erect the second layer either vertically with edges over framing or horizontally with ends over framing as required to minimize the number of end joints.

    a. Install vertical boards in lengths required to exceed the ceiling height were possible.

3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. For curved partitions, install gypsum panels as follows:

1. Select gypsum panel lengths and cut them as required to produce one unbroken panel covering each curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
2. Wet gypsum panels on surfaces that will become compressed when panels are installed over a curve and where curve radius prevents using dry panels. Comply with gypsum board manufacturer's recommendations relative to curve radii, wetting methods, stacking panels after wetting, and other preparations that precede installing wetted gypsum panels.
3. Apply gypsum panels horizontally with wrapped edges perpendicular to studs. On convex sides of partitions, begin installation at one end of curved surface and fasten gypsum panels to studs as they are wrapped around the curve. On concave side, start fastening panels to stud at center of curve and work outward to panel ends. Fasten panels to framing with screws spaced 12 inches o.c.
4. For double-layer construction, apply gypsum board base layer horizontally and fasten to studs with screws spaced 16 inches o.c. Center gypsum board face layers over joints in base layer and fasten to studs with screws spaced 12 inches o.c.
5. Allow wetted gypsum panels to dry before applying joint treatment.

3.5 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: Install compliant with ANSI A108.11 at showers, tubs and at all locations indicated to receive tile.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

C. Under all ceramic wall tiles, erect 5/8 inch- thick cement board with as few joints as possible. Apply rough side out. Where ceramic tile is not full height of wall, top of cement board shall be 2 inches below top of ceramic. Embed 2 inch interior tape in a skim coat of dry-set cement mortar over the joints and corners.

D. Shower Cubicles: Under ceramic tile, erect 5/8 inch-thick cement board with single sheet covering full wall width, extending from shower receptor to ceiling and from corner to corner. Apply rough side out. Provide 1/4 inch wide open joints between shower receptor and wallboard. Joint to be filled with sealant. Embed 2 inch interior tape in a skim coat of dry-set cement mortar over the joints and corners.

E. Joints/Cement Board: Tape, fill, finish joints, corners, etc., to produce surface ready to receive surface finish. Full finishing must extend behind base to floor. Material shall be tile setting mortar with cement board tape; it shall not be sheetrock joint compound and paper tape.

F. Treat cut edges and holes with sealant.

3.6 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Location of control joints shall be consistent with lines of building spaces, in consistent pattern and as directed by Architect at 30 feet o.c., maximum except provide control joints strike side of door frame on both sides of partition, extending from top of frame to 6 inches above ceiling.

1. Install vertical control joints in UL rated assembles with additional type X drywall behind the control joint, as indicated, to preserve the integrity of the assembly.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. LC-Bead: Use at exposed panel edges.
3. Control Joint: Use at GWB control joints
4. Curved-Edge Cornerbead: Use at curved openings.
5. Bullnose Inside Corner: Use in Clean Rooms.

D. Aluminum Trim: Install in locations indicated on Drawings per manufacturer's instructions.

1. Install horizontal trim in UL rated assemblies with an additional layer of type X drywall behind the trim or by installing the appropriately sized Blaze Frame FSB intumescent backer, per manufacturers written instructions.

3.7 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Joints/Gypsum Wallboard: Tape, fill, finish and sand joints, fasteners, corners, metal trim flanges, to produce surface free of visual defects ready to receive surface finishes. Full finishing shall extend behind base to floor. Tape and fill all joints in concealed locations. Treat all fastener heads in concealed locations with one coat of joint compound.

E. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.

a. All joints and interior angles shall have tape embedded in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges shall be acceptable.

2. Level 2: Where panels form substrate for tile and acoustical tile and where indicated on Drawings.

a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable.

3. Level 3: For gypsum board surfaces receiving medium or heavy textured finishes before painting and for surfaces receiving heavy-duty wall coverings where lighting conditions are not critical.

   a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. One additional coat of joint compound shall be applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges.

4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated and unless scheduled to receive gloss or semi-gloss paint finishes.

   a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compounds shall be smooth and free of tool marks and ridges.
   b. Primer and its application to surfaces are specified in Division 09 Section "Interior Painting."

5. Level 5: Where indicated on Drawings and Finish Schedule (Gloss and semi-gloss paint finishes require a level 5 finish).

   a. All joints and interior angles shall have tape embedded in joint compound and shall be immediately wiped with a joint knife or trowel leaving a thin coating of joint compound over all joints and interior angles as described for Level 2. Two separate coats of joint compound shall be applied over all flat joints. One separate coat of joint compound shall be applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound shall be trowel-applied to the entire surface. Excess compound is immediately sheared off, leaving a film of skim coating compound completely covering the paper. As an alternate to a skim coat, a material manufactured especially for this purpose shall be applied. The surface shall be smooth and free of tool marks and ridges.
   b. Primer and its application to surfaces are specified in Division 09 Section "Interior Painting."
   c. See Finish Schedule and Division 09 Section “Interior Painting” for scheduled paint finishes which require a level 5 finish.

F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.8 FRAMED ASSEMBLY AND SHAFTWALL INSTALLATION, GENERAL

A. Install framed gypsum board and shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, ASTM C754 and ASTM C1007 other than stud-spacing requirements.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing or shaftwall assembly members. Frame both sides of joints independently.

D. Do not attach runners, studs, bracing, or any other component of partition or ceiling system to ducts, pipes, equipment, etc. Attach only to building floors, walls or structural framing.

E. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work which are to be placed in or behind partition framing. Allow such items to be installed after framing is complete.

F. Resilient Clips: Provide and install resilient clips and furring channels in strict accordance with manufacturer's recommendations as required to maintain the design intent for acoustical properties of the assembly. Do not use resilient clips which have been damaged or distorted in any way. Place resilient clips at the minimum spacing recommended by the manufacturer to achieve the required acoustical properties. Drywall attached to the resilient clip may not touch drywall on the adjoining wall. Do not load the resilient clip with drywall heavier than recommended by the manufacturer. Do not allow electrical junction boxes, etc. to be attached to the stud and also the drywall supported by the resilient clip. Use only non-drying non-skinning sealant around electrical boxes, etc. where they penetrate drywall supported by resilient clips. If the ceiling is also resilient, the walls and the ceiling cannot touch each other, i.e., install walls before ceiling.

3.9 INSTALLING STEEL FRAMING ASSEMBLIES

A. Install framing system components according to spacing indicated, but not greater than spacing required by referenced installation standards for assembly types. See details on structural drawings for bracing, blocking, and connection details.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Bracing: For partitions which do not extend to structure above, provide diagonal bracing spaced maximum 48 inches on centers on alternate sides of partitions and at double studs on each side of door frames, extending from top of partition to underside of structure above.

E. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above ceilings except where otherwise indicated. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies. Install with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Fasteners: Use fasteners to connect each flange of each stud to both top and bottom runners except do not fasten studs to top runner at slip-type head joint.

F. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install two studs back to back with closure track at each jamb join studs and track together with #10 screws; space screws at maximum 24 inches on center and maximum 4 inches from end of studs.
2. Base metal thickness of jamb studs shall be the greater of the thickness of adjacent studs or 0.033 inch.
3. Install cripple studs at head adjacent to each strike side jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
4. Extend double jamb studs through ceilings and attach to top runner.

    a. For partitions terminating at structure above, into a slip-type head joint, or
    b. For partitions not terminating at structure above, fastened to top runner; diagonally brace double studs at each side of door frame to structure above.

G. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

H. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

I. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

J. Curved Partitions:

1. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
2. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

K. Direct Furring:
1. Attach to substrate with suitable fasteners spaced 24 inches o.c., for concrete or masonry with screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

L. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

M. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

N. Bridging: Install continuous horizontal cold rolled channel bridging within stud cutout:

1. Spaced 4 feet on center vertically for all partitions which do not have gypsum wallboard installed continuously on both sides of partition
2. Spaced 4 feet on center vertically where stud length exceeds 14 feet.
3. Within 1 foot of the deflection track where partition is full height to structure above
4. Spaced 4 feet on center vertically where there is additional surface loading on the partition, including, but not limited to, ceramic tile, wall cabinets, countertops and lead lining.

O. Blocking/Strapping: Install continuous blocking and strapping only where interferences prevent the installation of bridging channels.

1. Install solid blocking 0.033-inch-thick runners at each end of wall and at every 8 feet on center maximum.
2. Install 0.033 inch continuous metal strapping fastened to each side of metal framing studs. Strapping shall be 2 inches wide minimum.

P. Flush Mounted Countertop Support: Each flush mounted countertop support shall be attached to two studs, each with minimum base metal thickness of 0.033 inch. Wood blocking which is of the full cross-sectional dimension of the stud and 12 inches longer than the countertop support shall be provided in each stud. The countertop support shall be connected to the studs and blocking with minimum three bolts with double nuts or lock washers. Studs shall also be connected with minimum three U-shaped straps.

3.10 INSTALLING GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Provide bracing where shaftwall exceeds 10 feet in height.

2. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.

B. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

C. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.11 INSTALLING CONCEALED BLOCKING

A. Provide blocking concealed in partitions at every location where a fixture or other appurtenance is supported by the partition. Blocking shall be installed horizontally from stud to stud and be positively connected to each stud in a manner so that it supports each fixture or appurtenance. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved. Install blocking for support of all fixtures and other appurtenances including but not limited to toilet partitions, wall cabinets, countertops, casework, millwork, handrails, bumper rails, shelving, toilet accessories, mirrors, wall mounted equipment, hardware including wall door stops, and other wall mounted items. Contractor shall notify the Architect before installing fixtures or other appurtenances weighing in excess of 100 lbs.

1. For fixtures or other appurtenances which weigh 25 lbs. or less attach directly to a minimum 0.033-inch-thick, 3 5/8-inch-wide steel stud section or a 16 gauge cold rolled steel plate, minimum 6-inch-wide installed horizontally from stud to stud. Fasten with minimum two low profile pan head #8-18 screws at each stud.
2. For fixtures or other appurtenances which weigh more than 25 lbs. but less than 100 lbs. or are supporting live loads of more than 25 lbs. (i.e. handrails) attach directly to one of the following:

    a. Provide 2 x 10 nominal fire-treated wood blocking; attach blocking to each stud with minimum three 1¼-inch-long #10 wood screws; space top and bottom wood screws ½ inch from end of wood; do not attach screws into wood end grain; avoid wood end grain by providing a minimum 0.033-inch-thick steel clip angle; install minimum three low profile pan head #8-18 sheet metal screws to connect steel clip angle to stud; kerf blocking to accommodate stud lip.
    b. Provide ¾ inch x 24 inches minimum wide fire-treated plywood blocking; attach blocking to each stud with minimum four 1” long #10 wood screws; space top and bottom wood screws ½” from end of wood; do not attach screws into wood end grain; avoid wood end grain by providing a minimum 0.033-inch-thick steel clip angle; install minimum four #8-18 sheet metal screws to connect steel clip angle to stud; kerf blocking to accommodate stud lip.
    c. Manufactured wood plywood backing plate:

        1) Acceptable Product: Subject to compliance with requirements, provide the following: ClarkDietrich Building Systems; Danback Fire-Treated Wood Backing Plate.

2) Install Danback Backing plate per manufacturer's written instructions and per published load data, but with a minimum of two screws per stud.

d. Provide 0.054-inch-thick nested steel stud and runner; secure stud to runner with 4-# 8 pan head framing screws top and bottom; connect blocking to studs with minimum 0.054 inch-thick cold rolled plates; provide minimum three #8-18 low profile pan head framing screws in each cold rolled plate connection.

3. Shower Seat: Wall mounted shower seats shall be installed as follows:

a. Studs supporting the shower seat blocking (up to three) shall be minimum 0.033 inch thick, 3 5/8-inch-wide steel studs with minimum of three "U" shaped strap anchors to join studs together. Extend the double studs from floor to 1/2 inch short of underside of structure above seated into 2-1/2 to 3 inch deep leg runner track. Maximum stud height shall be limited to 16 ft. 0 in.

b. Provide 2 x 10 nominal fire-treated kerfed wood blocking attached to double studs with a minimum three (3) 1¼-inch- long #10 wood screws at each end of each piece of blocking; space top and bottom wood screws ½ inch from end of wood; do not attach screws into wood end grain; install minimum three #8-18 sheet metal screws at each steel stud/steel stud connection as required to secure a 20 ga. clip on the backside. Add an additional row of wood blocking as required to capture all shower seat attachment points.

c. Secure the shower seat to the wood blocking with the #14 x 2-1/2" stainless steel mounting screws furnished by the manufacturer.

3.12 INSTALLING GYPSUM BOARD CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacing indicated, but not greater than the following spacing:

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interferes with locations of hangers required to support standard suspension system members, the Contractor shall install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within L/360 deflection limit.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications
8. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
9. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
10. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

G. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 inches past each end of openings.

H. Ceiling grillage for ceiling areas with large openings for recessed lighting or to meet HVAC requirements.

1. Main runner channels - 1-1/2 inches deep, not over 48 inches o.c. secured to structure with 3/16 inch x 1 inch asphaltum coated steel flat bar hangers not over 4 feet o.c.
2. Cross furring - 3-5/8 inch stud channels at 24 inches o.c., wire tied or clipped to 1-1/2 inch runner channels
3. Perimeter of recessed light and grille opening shall be formed with 3-5/8 inch stud channels, tied into adjacent furring system. Provide 3/16 inch x 1 inch asphaltum coated steel flat bar hangers at all corners with additional hangers at 4 feet o.c. or as required to support lights, grilles or other items of equipment supported from the ceiling suspension system.

3.13 MARKING AND IDENTIFYING FIRE AND SMOKE RATED WALL ASSEMBLIES

A. Provide stenciled identification on all fire walls, fire partitions, smoke barriers and smoke partitions, or on any other wall required to have protected openings or penetrations.

1. Stencil shall be located in accessible concealed floor, floor-ceiling or attic spaces, generally above the finished ceiling.
2. Stencil shall be repeated at intervals not exceeding 30 feet measured horizontally along the wall or partition.
3. Stencil shall include lettering not less than 3 inches in height, be visible from the floor and shall incorporate the suggested wording: “FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS,” or other lettering height or wording approved by the Authority Having Jurisdiction.

3.14 MOISTURE AND MOLD FIELD QUALITY CONTROL

A. Reference Division 01 Section “Temporary Facilities and Controls” for moisture and mold field testing and remediation procedures applicable to the work of this section.

3.15 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 00 – TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Interior ceramic tile selection and installation.

1. Tile.
2. Waterproofing and crack isolation membrane.
3. Setting materials and accessories.
4. Metal edge strips.

B. Related Sections:

1. Division 09 Section "Gypsum Board Systems" for cementitious backer units.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Reference to the TCNA shall be defined in this section to mean the TCNA (Tile Council of North America) Guidelines, latest edition.

C. Porcelain Tiles are ceramic tiles for wall and floor application and are pressed or extruded and have through-body color. Porcelain tiles are classified impervious per ASTM C373.

D. Pressed Tiles are ceramic tile suitable for use on floors and walls made by pressing and having a facial area equal to or greater than 9 square inches. Pressed tile may be vitreous, semivitreous or nonvitreous per ASTM C373.

E. Ceramic Mosaic Tiles are ceramic tile suitable for use on floors and walls having a facial area of less than 9 square inches and are typically mounted on sheets or strips. Ceramic mosaic tiles may be impervious, vitreous, semivitreous or nonvitreous per ASTM C373.

F. Glazed Wall Tiles are nonvitreous ceramic tiles intended for interior use on walls only.

G. Module Size: Actual tile size plus joint width indicated.

H. Face Size: Actual tile size, excluding spacer lugs.

I. Small Format Tile: Tile less than 15 inches in any one dimension, unless noted otherwise.

J. Large Format Tile: Tile equal to or greater than 15 inches in any one dimension, unless noted otherwise.

K. Lippage: The condition where one edge of a tile is higher that the adjacent tile edge, giving the finished surface an uneven appearance.

1.4 PREINSTALLATION MEETINGS

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. With product data for each floor finish material specified, provide manufacturer's slip resistance data from tests performed by an independent testing agency in accordance with ANSI A137.1 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show tiles and accessories to scale, grout widths, details, transitions, each underlayment type and membrane, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

1. Indicate TCNA system number for each tile assembly.

C. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
2. Full-size units of each type of trim and accessory for each color and finish required.
3. Metal edge strips in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product, signed by product manufacturer.

D. Material Test Reports: For each tile-setting and -grouting product and special purpose tile.

E. Manufacturer shall certify that the type of tile to be installed is compatible with area in which it is to be installed, and that all materials to be used are mutually compatible.

F. Warranties: Sample of special warranties.

1.7 CLOSEOUT DOCUMENTS

A. Maintenance Data For Owner: For each type of tile to include in maintenance manuals, including slip-resistance maintenance requirements.

B. Warranties: Final warranties to include in operation and maintenance manuals.

1.8 MAINTENANCE MATERIAL

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
2. Installer employs Ceramic Tile Education Foundation Certified Installers

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1-12 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.11 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.12 SEQUENCING AND SCHEDULING

A. Sequence installation with other work to minimize possibility of damage and soiling during remainder of construction period.

1.13 WARRANTY

A. Ceramic Tile Manufacturers Standard Warranty: Manufacturer warrants that tile products will be free from defects for a period of one-year from date of substantial completion.

B. Ceramic Tile Installers Warranty: Installer warrants that the tile installation will be free from defects in workmanship for a period of two years for the date of substantial completion.

C. Waterproofing / Mortar / Grout Manufacturers System Warranty: Subject to the conditions and limitations stated below, the manufacturer warrants that the products listed on this document provided as a system will be free from manufacturing defects and will not break down or deteriorate under normal usage for a period of ten (10) years from the date of substantial completion when installed in accordance with the manufacturers written instructions and industry standard guidelines. Excluded from this warranty are exterior installations or installations submerged in liquid.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER PRODUCTS AND LEAD TIMES:

A. Products listed as Basis of Design herein and on the Finish Schedule have been coordinated with other finishes and approved by the Owner for color and pattern in schemes throughout the project area.

B. Proposed substitutions must be approved by the Owner and Architect prior to award or they will not be considered. The Contractor shall be responsible to match all listed characteristics, including color and pattern, to the satisfaction of the Owner and Architect. Submit products for consideration per the requirements of Division 01 Section “Substitution Procedures.”

C. Substitutions for Cause proposed after award shall be submitted for approval per the requirements of Division 01 Section “Substitution Procedures.” Substitutions for Convenience proposed after award will not be considered.

D. Many Division 09 products are long lead. The Contractor is responsible to verify all lead times sufficiently in advance of submittal documents, mockups and need to avoid schedule conflicts. Neither the Owner nor Architect will be held responsible for inaction on the part of the Contractor in ordering material with enough lead time to avoid additional “quick ship” costs or delays to the construction schedule in order to accomplish all requirements herein.

2.2 PERFORMANCE REQUIREMENTS

A. Dynamic Coefficient of Friction: For ceramic tile installed on floor surfaces.

1. For floor products without manufacturers previous testing showing compliance:

    a. Test floors wet and dry in accordance with ANSI A137.1 dynamic coefficient of friction (DCOF) AcuTest.

        1) Flooring products which are required to be field tested and do not satisfactorily pass field testing standards with a DCOF of 0.42 or higher will not be permitted to be installed on the project.

B. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each waterproofing and crack isolation membrane, self-leveling material, mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

D. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

1. Joint sealants.
2. Metal edge strips.

2.3 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installationin wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

E. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1. Match Architect's samples and/or selections.

F. Adhesives shall have a VOC content of 65 g/L or less.

2.4 TILE PRODUCTS

A. Tile Type: Porcelain Floor Tile, PFT.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product(s) indicated on Finish Schedule.
2. Tile Composition, Face Size, Face and Finish are all sub-products of the Basis of Design tile selected and included on the Finish Schedule.
3. Tile Color and Pattern: Per Finish Schedule.
4. Grout Color: Per Finish Schedule .
5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base Cove: Metal cove base per Finish Schedule.
    b. Base Cap for Thin-Set Mortar Installations: Metal top cap for porcelain base tile.
    c. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size same as adjoining flat tile.
    d. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Tile Type: Glazed Ceramic Wall Tile, CT1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product(s) indicated on Finish Schedule.
2. Tile Module Size, Thickness, Face and Finish are all sub-products of the Basis of Design tile selected and included on the Finish Schedule.
3. Tile Color and Pattern: See Finish Schedule .
4. Grout Color: See Finish Schedule .
5. Trim Units: Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Internal Corners: Field-butted square corners.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: See Division 09 Section “Gypsum Board Systems” for information regarding cementitious backer units.

2.6 WATERPROOFING AND CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 Waterproofing Membranes for Thin Set Ceramic Tile and ANSI A118.12 Crack Isolation Membranes for Thin Set Ceramic Tile for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories as recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ardex America: Interior/Exterior: 8 + 9 Waterproofing and Crack Isolation Compound.
b. Custom Building Products; Interior/Exterior: Redgard Waterproofing and Crack Prevention Membrane.
c. Laticrete International, Inc.: Interior/Exterior: Hydro Ban Waterproofing and Crack Prevention Membrane.
d. MAPEI Corporation:

1) Interior: Mapelastic Aquadefense® Waterproofing and Crack Prevention Membrane.
2) Exterior: Mapelastic 315 Waterproofing and Crack Prevention Membrane.

2. Application: Roller (brush or trowel if required by manufacturer).
3. Not for use over cracks greater than 1/8 inch.
4. Maximum allowable concrete moisture content: 75% RH per ASTM F2170.

a. Contractor Note: The waterproofing and crack isolation membrane is not designed to be a substitute for proper moisture mitigation. Where substrate moisture content exceeds manufacturer recommended levels, prepare substrate using moisture mitigation products and methods approved by the Architect.

C. Cracks larger than 1/8 inch in width shall be repaired as recommended by the membrane manufacturer prior to the installation of the membrane. Repairs shall include, but not be limited to, epoxy joint fill, mesh joint bridging or other methods recommended by the manufacturer.

2.7 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set – Small Format Tile): Complies with ANSI A118.4 Specifications for Modified Dry-Set Cement Mortar. A single-component, high-performance, polymer-modified thin-set mortar for installations of ceramic and porcelain tile less than 15 inches in any one dimension.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ardex America:

1) Interior/Exterior: X5 Thin Set Mortar.

b. Custom Building Products:

1) Interior: VersaBond Thin Set Mortar
2) Exterior: Megaflex

c. Laticrete International, Inc.: Interior/Exterior: 254 Platinum Thin Set Mortar.
d. MAPEI Corporation:

1) Interior: Ultraflex 2 Thin Set Mortar
2) Exterior: Granirapid System.

2. Install only at temperatures between 40°F and 95°F and as permitted by manufacturer.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

B. Latex-Portland Cement Mortar (Medium Bed Thin Set – Large Format Tile): Complies with ANSI A118.4 Specifications for Modified Dry-Set Cement Mortar and ANSI A118.15 for Improved Modified Dry-Set Cement Mortar. A single-component, high-performance, polymer-modified thin-set mortar for installations of ceramic and porcelain tile equal to or greater than 15 inches in any one dimension.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ardex America: Interior/Exterior: X77 Microtec
b. Custom Building Products:

1) Interior: Prolite LFT
2) Exterior: Megalite

c. Laticrete International, Inc.:

1) Interior: 4 XLT.
2) Exterior: 255 Multimax

d. MAPEI Corporation:

1) Interior: Ultraflex LFT
2) Exterior: Granirapid System

2. Install only at temperatures between 40°F and 95°F.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Larger format tiles needs to be installed on an FF50 (1/8 inch in 10 feet) base to assist with the prevention of lippage and an uneven installation.

C. Self-Leveling Materials: Self leveling Portland cement based underlayments and manufacturer recommended primers shall be installed where existing floor conditions do not meet tile manufacturer's minimum flatness requirement to avoid uneven installation and lippage beyond specified levels.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ardex America: Interior: TL 1000
b. Custom Building Products: Interior: Levelite.
c. Laticrete International, Inc.: Interior: NXT Level Plus.
d. MAPEI Corporation: Interior: Novoplan 2 Plus

2. Prepare floors and prime per manufacturer's written instructions.

2.8 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: Complies with ANSI A118.3 Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ardex America: Interior/Exterior: WA Epoxy
b. Custom Building Products: Interior/Exterior: CEG Lite
c. Laticrete International, Inc.: Interior/Exterior: Spectralock Pro Premium
d. MAPEI Corporation: Interior/Exterior: Kerapoxy CQ

2.9 ELASTOMERIC SEALANTS

A. Manufacturers provide ASTM C920 Type S, Grade NS, Class 25 mildew resistant silicon sealants to match most of their grout colors. These may be substituted for the Division 07 mildew resistant sealants. Most manufacturers also provide latex sealants which match all of their available grout colors, but these should be avoided for application on floors.

B. Provide and install One-Part, Mildew-Resistant Silicone Sealant per Division 07 Section “Joint Sealants” or 100% silicone sealants by the following:

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Ardex America: Interior/Exterior: SX 100% Silicon
b. Custom Building Products: Interior/Exterior: Commercial 100% Silicon
c. Laticrete International, Inc.: Interior/Exterior: Latisil 100% Silicon
d. MAPEI Corporation: Interior/Exterior: Mapesil 100% Silicon

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips at top of 4” high base tile: L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC designed specifically for flooring applications; stainless-steel, ASTM A666, 300 Series exposed-edge material.

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Schluter Systems L.P. or a comparable product by one of the following:

a. Blanke Corporation.
b. Ceramic Tool Company, Inc.

2. Refer to finish details on the Interior drawings for configurations.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.11 FABRICATION

A. Joint Surfaces: Except for specified beveled or eased edges, if any, dress joint surfaces square for full depth of tile.

B. Backs of Pieces: Gage units by dressing backs of pieces smooth and flat. When tested with a 24-inch straightedge, gap shall not exceed 1/32 inch.

2.12 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

C. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 WATERPROOFING/CRACK-SUPPRESSION MEMBRANE INSTALLATION

A. Install waterproofing and crack-suppression membrane to comply with TCNA Guidelines, ANSI A108.10 and A108.12 and manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.

B. Prepare substrate per manufacturers written recommendations. Acid etching, adhesive removers, solvents and sweeping compounds are not acceptable means for cleaning the substrate.

C. All concrete substrates must be solid, structurally sound, thoroughly clean, thoroughly cured, dry and free of oil, wax, grease, asphalt, latex and gypsum compounds, curing compounds, sealers and any contaminant that might act as a bond breaker. If necessary, mechanically clean the floor down to sound, solid concrete by shot blasting or similar as approved in writing by the manufacturer.

D. Provide mesh in corners, over cracks and elsewhere membrane manufacturer recommends.

E. Do not install tile over waterproofing and crack-suppression membrane until membrane has cured and been tested to determine that it is watertight.

3.4 SUBSTRATE LEVELING

A. Substrate shall be leveled to both manufacturers and TCNA written requirements prior to the installation of ceramic tile.

1. Substrate shall be thoroughly clean and free of all contaminate which might act as a bond breaker.
2. Shot-blast floor surface if recommended by the manufacturer to ensure proper bond.
3. Substrates must be dry and properly primed prior to the application of self-leveling products.
4. Do not walk on or install ceramic tile before manufacturer’s recommended times.

3.5 CERAMIC TILE INSTALLATION

A. Comply with most current edition of TCNA’s "Handbook for Ceramic Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Wipe backs of tiles with a damp cloth to remove dirt and dust before units are installed.

C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

F. Jointing Pattern: Lay tile as indicated in Finish Legend. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than one-half of a tile. Provide uniform joint widths on each side and in all directions.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Install tiles in joint widths recommended by the manufacturer for the types of tile..

1. Where joint widths are not indicated, consult the Architect for joint selection prior to proceeding.

H. Lippage: In addition to the inherent warpage of the tile manufactured in accordance with ANSI 137.1, acceptable lippage for typical installations shall not exceed the following:

1. Glazed wall/Mosaics: sizes to 6 inches square with joint width to 1/8 inch: 1/32 inch.

2. Porcelain tile: All sizes with joint width less than 1/4 inch: 1/32 inch.
3. Porcelain tile: All sizes with joint width equal to or greater than ¼ inch: 1/16 inch

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
2. Follow guidelines for expansion joints as described in TCNA EJ171.
3. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

a. Sealant colors shall be as selected by the architect.

J. Metal Transition Strips: Install at locations where exposed edge of tile flooring meets resilient flooring that finishes flush with or below top of tile and no threshold is indicated.

3.6 CLEANING AND PROTECTING

A. Remove and replace material that is stained or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove epoxy grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

C. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

E. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 TILE INSTALLATION SCHEDULE: The paragraphs below cover a range of warrantable tile installation systems. All warrantable systems shall, by definition, contain products from a single manufacturer. Products shall be as listed in Part 2 PRODUCTS above. The Contractor shall

consult the Finish Schedule and drawings for tile finish locations. Not all scheduled systems will be included on the Finish Schedule and drawings.

A. Interior Floor Installations, Concrete Subfloor:

1. Small Format Tile installation in wet or dry area over flat (non-depressed) slab:

   a. Floor leveling material where required to achieve manufacturer recommended floor flatness and lippage.
   b. Waterproofing and Crack Isolation Membrane: Complies with ANSI 118.10 & 118.12. Fluid-Applied Membrane; Liquid-latex rubber or elastomeric polymer.
   c. Latex-Portland Cement Mortar (Thin Set – Small Format Tile): Complies with ANSI A118.4. Polymer-modified thin-set mortar for installations of ceramic and porcelain tile less than 15 inches in any one dimension.
   d. Water-Cleanable Epoxy Grout: Complies with ANSI A118.3. Tile-Setting and -Grouting Epoxy.

2. Large Format Tile installation in wet or dry area over flat (non-depressed) slab:

   a. Floor leveling material where required to achieve manufacturer recommended floor flatness and lippage.
   b. Waterproofing and Crack Isolation Membrane: Complies with ANSI 118.10 & 118.12. Fluid-Applied Membrane; Liquid-latex rubber or elastomeric polymer.
   c. Latex-Portland Cement Mortar (Medium Set – Large Format Tile): Complies with ANSI A118.4. Polymer-modified thin-set mortar for installations of ceramic and porcelain tile equal to or greater than 15 inches in any one dimension.
   d. Water-Cleanable Epoxy Grout: Complies with ANSI A118.3. Tile-Setting and -Grouting Epoxy.

B. Interior Wall Installations, Cement Board Substrate:

1. Small Format Tile installation in wet area:

   a. Waterproofing and Crack Isolation Membrane: Complies with ANSI 118.10 & 118.12. Fluid-Applied Membrane; Liquid-latex rubber or elastomeric polymer.
   b. Latex-Portland Cement Mortar (Thin Set – Small Format Tile): Complies with ANSI A118.4. Polymer-modified thin-set mortar for installations of ceramic and porcelain tile less than 15 inches in any one dimension.
   c. Water-Cleanable Epoxy Grout: Complies with ANSI A118.3. Tile-Setting and -Grouting Epoxy.

2. Large Format Tile installation in wet area:

   a. Waterproofing and Crack Isolation Membrane: Complies with ANSI 118.10 & 118.12. Fluid-Applied Membrane; Liquid-latex rubber or elastomeric polymer.
   b. Latex-Portland Cement Mortar (Medium Bed Thin Set – Large Format Tile): Complies with ANSI A118.4. Modified Dry-Set Thin-Set Mortar and ANSI 118.15 Improved Modified Dry-Set Cement Mortar for installations of ceramic and porcelain tile equal to or greater than 15 inches in any one dimension.
   c. Water-Cleanable Epoxy Grout: Complies with ANSI A118.3. Tile-Setting and -Grouting Epoxy.

END OF SECTION 09 30 00

SECTION 09 51 13 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for interior ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

A. AC: Articulation Class

B. CAC: Ceiling Attenuation Class

C. LR: Light Reflectance coefficient

D. NRC: Noise Reduction Coefficient

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For components with factory-applied color finishes.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Panel: Set of full-size Samples of each type, color, pattern, and texture.
2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch-long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.
    g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/8 inch = 1 foot .

B. Qualification Data: For installer and testing agency.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

D. Research/Evaluation Reports: For each acoustical panel ceiling and components and anchor and fastener type, from ICC-ES.

1.6 CLOSEOUT DOCUMENTS

A. Maintenance Data: For finishes to include in maintenance manuals.

B. Executed warranty

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
3. Hold-Down Clips: Equal to 2 percent of quantity installed.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

B. Installer Qualifications: Installer with at least 5-years of experience erecting ceilings of the type specified and is acceptable to the ceiling and grid manufacturer(s).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use. Maintain temperature and humidity as recommended by specified manufacturers.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.11 WARRANTY

A. A2 (ACT) and A16 (ACTV): The acoustical ceiling shall be warranted by the manufacturer for a period of fifteen years against sagging, warping, or shrinkage in conditions up to 90% relative humidity subject to normal allowable average manufacturing tolerances. Grid shall be warranted by the manufacturer for a period of fifteen years against the occurrence of 50% red rust and sagging and warping. The subcontractor shall be responsible for any replacement.

1.12 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.13 MANUFACTURER’S RECYCLING PROGRAM

A. Manufacturer of ceiling tile shall have an established material reclamation and recycling program including:

1. Job site reclamation of existing ceiling tile materials.
2. Use of both preconsumer and post-consumer recycled materials in production of the ceiling tile.
3. Provisions for reclamation of material supplied for this project at the end of its useful life.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and additional information indicated on the drawings.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E1264 for Class A materials.
2. Smoke-Developed Index: 450 or less.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E795.

C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type in Finish Legend.

D. ACT - Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial

growth when tested according to ASTM D3273 and evaluated according to ASTM D3274 or ASTM G21.

E. ACTV - Antimicrobial Fungicide Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D3273 and evaluated according to ASTM D3274 or ASTM G21.

2.3 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Basis of Design: Armstrong World Industries, Inc.

B. Other Acceptable Manufacturers/Products subject to compliance with requirements:

1. Decoustics
2. CertainTeed Corporation.
3. USG Interiors, Inc.

C. Acoustical Ceiling Types

Type A2 (ACT).	#1913 square cut lay-in Ultima design, with HumiGuard Plus humidity resistance, DuraBrite finish, Bioblock white acrylic latex paint finish, on an acoustically transparent membrane (Type IV per ASTM E1264), square. Size: 24 inch x 48 inch x 3/4 inch Grid Size: 15/16 Minimum UL certified acoustic values: LR: 0.88 NRC: 0.75 CAC: 35
Type A1 (ACTV).	Clean Room VL #870 washable vinyl faced membrane, with HumiGuard Plus humidity resistance, square edged. Size: 24 inch x 48 inch x 5/8 inch Grid Size: 15/16 Minimum UL certified acoustic values: LR: 0.80 NRC: 0.0 CAC: 40

D. Color: White unless noted otherwise noted on Finish Schedule.

E. Antimicrobial Treatment: based on products noted in Finish Legend.

F. Antimicrobial Treatment (Intercept): Provide acoustical panels treated with manufacturer's standard antimicrobial solution consisting of a synergistic blend of substituted ammonium salts of alkylated phosphoric acids admixed with free alkylated phosphoric acid that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, fully concealed, metal suspension system and accessories of type, structural classification, and finish indicated that complies with applicable requirements in ASTM C635/C635M.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.

B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.

1. Structural Classification: Intermediate-duty system.
2. Access: Upward, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.

a. Initial Access Opening: In each module, 24 by 48 inches .

2.5 SUSPENSION SYSTEM

A. Basis of Design: Armstrong World Industries

B. Other Acceptable Manufacturers subject to compliance with requirements:

1. United States Gypsum Corporation
2. Chicago Metallic Corporation

C. Type conforming to ASTM C635 intermediate duty system.

D. Grid: Nonfire-rated, hot-dipped galvanized exposed tee (except where noted otherwise); all components die cut and interlocking and rotary stitched.

1. Armstrong Prelude XL 15/16 inch exposed tee system - for ceiling Type A2.
2. Armstrong AL Prelude Plus 15/16 inch exposed aluminum tee system, white paint finish - for ceiling Type A16. Aluminum (in accordance with ASTM B211) shall have a minimum of 50% recycled content.

E. Accessories: Stabilizer bars, furring clips, splices and edge moldings as required to complete and complement suspended ceiling grid system. 15/16 inch edge trim shall be hot dipped galvanized angle moulding.

F. Materials/Finish: Commercial quality cold rolled steel hot dipped galvanized; (aluminum grid where noted) paint finish on exposed surfaces to match ceiling.

G. Carrying Channels and Hangers: Galvanized steel; size and type to suit application and to rigidly secure the complete acoustic unit ceiling system, with maximum deflection of 1/360. Hangers shall be minimum 12 gauge.

2.6 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.

    a. Type: Cast-in-placeanchors.
    b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B633, Class SC 1 (mild) service condition.
    c. Locate in Labs only: Corrosion Protection: Stainless-steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.

B. Clean-Room Gasket System (AT15 and AT16): Where indicated, provide manufacturer's standard system, including manufacturer's standard gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

C. Curved Wall Angles: For curved walls, use flexible (or preformed) wall angle. Do not "notch" straight sections.

2.7 METAL EDGE MOLDINGS AND TRIM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong World Industries, Inc.
2. CertainTeed Corporation.
3. Fry Reglet Corporation.
4. Gordon, Inc.
5. Rockfon (Rockwool International).
6. USG Corporation.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

1. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Finish: Painted white >.

C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.8 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Testing Substrates: Before adhesively bonding tiles to wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

C. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C636 per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. General: Perform ceiling system work in accordance with the recommendations of ASTM C636,2018 International Building Code, CISCA Recommendations For Direct-Hung Acoustical Tile and Lay-In Panel Ceilings, Seismic Zones 0-2, current edition, and ASTM E580 (or as herein specified if more stringent). Keep copies of these documents in field office for the duration of project.

C. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 24 inches from ends of each member.
8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

D. In Lab locations only: Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.

E. Supply hangers or inserts for installation to the respective section in ample time and with clear instructions for their correct placement. If steel deck is not supplied with hanger tabs, coordinate the installation of hanger clips during steel deck erection. Provide additional hangers and inserts as required.

F. Use inserts, pigtail wire or other approved methods of attaching hangers and suspension systems. Approved powder driven type method of attaching will be permitted. Hanging from ducts, pipes and other equipment will not be permitted.

G. Hang independently of walls, columns, ducts, pipes, conduit, etc. Where carrying members are spliced, avoid visible displacement of the longitudinal axis or face plane of adjacent members.

H. Except where specifically dimensioned otherwise, center ceiling system(s) on room axis leaving equal border pieces. Border pieces shall be a minimum of 6 inches wide. Install ceiling systems per reflected ceiling plans where included.

I. Recessed lighting fixtures will be supported with clips from or on main runners or cross runners; support these fixture loads by providing supplementary hangers located within 6 inchesof each

corner of fixture. Should additional support be required to prevent deformation of ceiling system, such supports will be provided under Division 26.

J. Air diffusers/grilles/registers will be supported by the grid system with clips from or on main runners or cross runners; support these fixture loads by providing supplementary hangers located within 6 inches of each corner of fixture. Should additional support be required to prevent deformation of ceiling system, such support will be provided under Division 23.

K. Do not permit installation of other fixtures that cause main runners and cross runners to be eccentrically loaded. Where such fixture installation produces rotation of runners, provide stabilizer bars.

L. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches O.C. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
4. Where bullnose concrete block corners occur, provide preformed closers to match edge molding.

M. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

N. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges of tiles so tile-to-tile joints are interlocked.

1. Fit adjoining tiles to form flush, tight joints. Scribe and cut tiles for accurate fit at borders and around penetrations through ceiling.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tiles and moldings, spaced 12 inches o.c.

O. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

5. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
6. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
7. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.
8. Form expansion joints within system. Form to accommodate plus or minus 1/2 inch movement and maintain visual closure.

P. Suspended acoustic ceilings greater than 144 square feet in area shall be installed as unrestrained ceilings in accordance with CISCA recommendations.

Q. Connections to all equipment, devices, fixtures, grilles, registers, diffusers and other appurtenances mounted in the ceilings shall be flexible so that they do not restrict the movement of the unrestrained ceilings. The ceilings must be “free-floating” and the flexible connections must allow for a minimum free movement of the ceiling system of 3/8” in all directions.

R. Terminal ends of main runners and cross members shall be tied together or have some other approved means to prevent their spreading; spreader bars, strut stabilizers or similar devices used to tie ends of main runners and cross members together to prevent their spreading shall occur within 8” of each wall or other structure which may penetrate the ceiling.

S. The terminal ends of suspension members, both main runners and cross runners, shall have a minimum of 3/8” clearance from the wall.

T. Permanent runner end attachment (e.g., pop rivets) for grid alignment purposes shall not be permitted.

U. Allow for ceiling movement at rigid penetrations through ceiling tiles such as sprinkler piping, columns and exhaust duct drops by providing an oversized hole in the ceiling tile. Provide suitable escutcheons or closure details to cover gaps from view.

V. Ceiling suspension system hanger wires shall be provided at all four corners of all light fixtures.

W. Lighting fixtures weighing less than 10 lb. shall have one No. 12 gauge safety wire connected from the fixture housing to the structure above. It is not necessary for these safety wires to be taut.

X. Lighting fixtures weighing greater than 10 lb. but less than 56 lb. shall have, in addition to the requirements outlined above, two no. 12-gauge hanger wires connected from the fixture housing (not the detachable end plates) to the structure above that act as safety wires. It is not necessary for these safety wires to be taut.

Y. Lighting fixtures weighing 56 lb. or more shall be supported directly from the structure above by approved hangers.

Z. Pendant-hung lighting fixtures shall be supported directly from the structure above using no less than no. 9-gauge wire or an approved alternate support. The ceiling suspension system shall not provide any direct support.

AA. Rigid conduit shall not be used for attachment of the fixtures.

BB. Flexible sprinkler hose fittings, ceiling-mounted air terminals or other services weighing less than 20 lbs. shall be positively attached to the ceiling suspension main runners or to cross runners that have the same carrying capacity as the main runners.

CC. Flexible sprinkler hose fittings, air terminals or other services weighing more than 20 lb. but less than 56 lbs. shall have, in addition to the above requirements, two no. 12-gauge hanger wires connected from the terminal or service to the ceiling system hangers or to the structure above that act as safety wires. It is not necessary for these wires to be taut.

DD. Flexible sprinkler hose fittings, air terminals or other services weighing more than 56 lb. shall be supported directly from the structure above by approved hangers.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Compliance of seismic design.

B. Testing Agency: Owner will engagea qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and post installed anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two post installed anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.6 ADJUSTMENTS

A. Adjust any sags or twists which develop in the ceiling system(s) and replace any part which is damaged or faulty.

END OF SECTION 09 51 13

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Thermoset-rubber base.
2. Vinyl base.
3. Rubber stair accessories.
4. Rubber molding accessories.

B. Related Sections:

1. Division 09 Section "Resilient Flooring" for resilient floor coverings.
2. Division 09 Section "Linoleum Flooring" for linoleum floor coverings

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include product data specific to accessory adhesives for each specified product.

- Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

B. Samples for Initial Selection: For each type of product indicated.

C. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Provide Architect with test procedure or ASTM number, required results for acceptability accompanied by actual test results (from independent testing laboratory where required), and

certification from manufacturer that substrate is acceptable for installation of their materials. Tests include:

1. Moisture test - ASTM F1869 (Calcium Chloride Test)
2. ASTM F710
3. ASTM F2170
4. pH level test
5. Adhesive bond test

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.6 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F or more than 90 deg F.

1.8 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 90 deg F, in spaces to receive resilient products during the following periods:

1. 48 hours before installation
2. During installation

B. Ensure concrete floors' pH levels do not exceed the written recommendations of the resilient flooring manufacturer and/or the adhesive manufacturer. Refer to resilient flooring manufacturer's written instructions for guidelines on acceptable pH levels.

C. Ensure concrete floors to receive resilient flooring are free of coatings, finishes, dirt, curing compounds, or other substances which may affect the rate of moisture dissipation from the concrete or the adhesion of resilient flooring to the concrete.

D. Install resilient flooring and accessories after the other finishing operations, including painting, have been completed. Close spaces to traffic during the installation of the flooring.

E. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 90 degrees F.

1.9 GUARANTEE/WARRANTY

A. Special Warranty: Provide written warranty from manufacturer and Subcontractor in accordance with Division 01 “Product Requirements” and “Closeout Procedures”. All materials shall be warranted for 2 years against manufacturing defects. The subcontractor shall be responsible for any replacement and for defective installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 THERMOSET-RUBBER BASE RB

A. Manufacturers

1. Basis of Design Manufacturer: Johnsonite; a Tarkett company.
2. Other Acceptable Manufacturers: Subject to compliance with requirements:

    a. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
    b. Flexco.
    c. Roppe Corporation, USA.

B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:

    a. Style A, Straight: Provide in areas with carpet tile flooring.
    b. Style B, Cove: Provide in areas with resilient floor coverings and concrete .

C. Thickness: 0.125 inch.

D. Height: As indicated on Drawings.

E. Lengths: One length per surface.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors: As indicated on Finish Schedule.

2.3 RUBBER MOLDING ACCESSORY

A. Manufacturers

1. Basis of Design Manufacturer: Johnsonite, a Tarkett Company
2. Other Acceptable Manufacturers: Subject to compliance with requirements:

   a. VPI Corporation
   b. Roppe Corporation, USA

B. Description: Rubber transition strips.

C. Profile and Dimensions: As indicated in the drawings.

D. Locations: Provide rubber molding accessories between resilient flooring of different heights. Provide rubber molding between resilient flooring and carpet of different heights. Provide metal transition strips between concrete or tile and resilient flooring. .

E. Colors and Patterns: As indicated on Finish Schedule.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less and 60 g/L or less for rubber stair treads.

C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Metal Edge Strips: Extruded aluminum with mill specified finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

E. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Treads and Accessories: Ensure substrate surfaces are smooth, flat, and acceptable substrate. Prepare according to ASTM F710. Commencement of installation indicates acceptance of substrate(s).

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Perform an adhesive bond test, as recommended by the resilient flooring manufacturer, on subfloors to determine if surfaces are dry; free of curing and hardening compounds, old adhesive and any other coatings; and ready to receive resilient flooring.
3. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
4. Alkalinity and Adhesion Testing: Perform pH test for alkalinity prior to the installation of resilient flooring. pH levels shall not exceed the written recommendations of the resilient flooring manufacturer and/or the adhesive manufacturer. Refer to resilient flooring manufacturer's written instructions for guidelines on acceptable pH levels.
5. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.

    a. Perform anhydrous calcium chloride test, ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Perform relative humidity test using in situ probes, ASTM F2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 INSTALLATION - STAIR TREADS

A. Install stair treads, one piece for full width of tread.

B. Lightly sand back of each tread to remove any foreign matter and improve bond strength.

C. Apply epoxy nose filler at nosing in accord with manufacturer's recommendations.

D. Adhere over entire surface and fit accurately and securely.

3.6 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

3.7 WASTE MANAGEMENT

A. Separate waste in accordance with the Waste Management Plan and place in designated areas in the following categories for reuse.

B. Close and seal tightly all partly used adhesive containers and store protected in well-ventilated, fire-safe area at moderate temperature.

END OF SECTION 09 65 13

SECTION 09 65 16 – RESILIENT TILE AND SHEET FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Unbacked vinyl sheet flooring.
2. Vinyl composition floor tile.

B. Related Sections:

1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. With product data for each floor finish material specified, provide manufacturer’s slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.

B. Shop Drawings: For each type of resilient sheet flooring.

1. Include sheet flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

C. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size, but not less than 6-by-9-inch sections.

1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

D. Samples for Initial Selection: For each type of resilient sheet flooring indicated.

E. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch sections of each different color and pattern of floor covering required.

1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

F. Product Schedule: For resilient floor coverings. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Provide Architect with test procedure or ASTM number, required results for acceptability, accompanied by actual test results (from independent testing laboratory where required), and certification from manufacturer that substrate is acceptable for installation of their materials. Tests include:

1. Moisture test – ASTM F1869 (Calcium Chloride Test)
2. pH level test
3. Adhesive bond test

B. Qualification Data: For qualified Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data For Owner: For each type of flooring to include in maintenance manuals, including slip-resistance maintenance requirements.

B. Executed warranty

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Sheet Flooring: Furnish quantity not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each color, pattern, and type of floor covering installed.
2. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store resilient floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F . Store rolls upright.

1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F , in spaces to receive floor coverings during the following time periods:

1. 48 hours before installation
2. During installation
3. 48 hours after installation

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 85 deg F.

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install floor coverings after other finishing operations, including painting, have been completed.

1.10 WARRANTY

A. Flooring Manufacturers Standard Warranty: Manufacturer warrants that flooring products will be free from defects for a period of two-years from date of substantial completion.

B. Flooring Installers Warranty: Installer warrants that the flooring installation will be free from defects in workmanship for a period of two years for the date of substantial completion.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER PRODUCTS AND LEAD TIMES:

A. Products listed as Basis of Design herein and on the Finish Schedule have been coordinated with other finishes and approved by the Owner for color and pattern in schemes throughout the project area.

B. Proposed substitutions must be approved by the Owner and Architect prior to award or they will not be considered. The Contractor shall be responsible to match all listed characteristics, including color and pattern, to the satisfaction of the Owner and Architect. Submit products for consideration per the requirements of Division 01 Section “Substitution Procedures.”

C. Substitutions for Cause proposed after award shall be submitted for approval per the requirements of Division 01 Section “Substitution Procedures.” Substitutions for Convenience proposed after award will not be considered.

D. Many Division 09 products are long lead. The Contractor is responsible to verify all lead times sufficiently in advance of submittal documents, mockups and need to avoid schedule conflicts. Neither the Owner nor Architect will be held responsible for inaction on the part of the Contractor in ordering material with enough lead time to avoid additional “quick ship” costs or delays to the construction schedule in order to accomplish all requirements herein.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Dynamic Coefficient of Friction: For resilient flooring installed on floor surfaces.

1. For floor products without manufacturers previous testing showing compliance:

a. Test floors wet and dry in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest.

1) Flooring products which are required to be field tested and do not satisfactorily pass field testing standards with a DCOF of 0.42 or higher will not be permitted to be installed on the project.

2.3 UNBACKED HOMOGENOUS VINYL SHEET FLOORING (RS)

A. Products:

1. Basis of Design: Gerflor, Mipolam Symbioz, 6050 Hurricane .
2. Other Acceptable manufacturers subject to compliance with requirements.

a. Armstrong World Industried, Inc.
b. Mannington Mills, Inc.;
c. Polyflor, Ltd., Distributed by Gerbert Limited;

B. Product Standard: ASTM F1913.

C. Thickness: 0.080 inch.

D. Wearing Surface: Smooth.

E. Sheet Width: As standard with manufacturer.

F. Seamless-Installation Method: Heat weldedRetain "Colors and Patterns" Paragraph below if colors and patterns are not indicated in a separate schedule.

G. Colors and Patterns: As indicated on Finish Schedule.

2.4 VINYL COMPOSITION FLOOR TILE (VCT)

A. Products:

1. Basis of Design: Tarkett, VCT II (VCT)
2. Other Acceptable Manufacturers subject to compliance with requirements:
   a. Armstrong Flooring
   b. American Biltrite

B. Tile Standard: ASTM F1066, Class 2, through-pattern tile .

C. Wearing Surface: Smooth

D. Thickness: 0.125 inch.

E. Size: 12 by 12 inches.

F. Colors and Patterns: As indicated on Finish Schedule.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

1. Adhesives must be those suggested by the manufacturer and have a VOC content of 50 for vinyl composition tile .

C. Seamless-Installation Accessories for sheet flooring:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams

   a. Color: Match floor covering.

2.

D. Integral-Flash-Cove-Base Accessories:

1. Cove Strip: 1-inch radius provided or approved by manufacturer
2. Cap Strip: Square metal cap provided or approved by manufacturer
3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.

B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor coverings until they are same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOOR COVERING INSTALLATION

A. Comply with manufacturer's written instructions for installing floor coverings.

B. Unroll floor coverings and allow them to stabilize before cutting and fitting.

C. Lay out floor coverings as follows:

1. Maintain uniformity of floor covering direction
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates and away from doors and other floor openings
3. Match edges of floor coverings for color shading at seams
4. Avoid cross seams

D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.

E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

J. Integral-Flash-Cove Base: Cove floor coverings 6 inches up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners.

3.4 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient floor coverings.

B. Perform the following operations immediately after completing floor covering installation:

1. Remove adhesive and other blemishes from floor covering surfaces
2. Sweep and vacuum floor coverings thoroughly
3. Damp-mop floor coverings to remove marks and soil

C. Protect resilient floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive and surface blemishes from floor covering before applying floor polish.

1. Per manufacturer’s instructions.

E. Cover resilient floor coverings until Substantial Completion.

END OF SECTION 09 65 16

SECTION 09 67 23 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Resinous flooring systems.

B. Related Sections include the following:

1. Division 07 Section "Joint Sealants" for sealants installed at joints in resinous flooring systems

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

1. With product data for each floor finish material specified, manufacturer shall provide slip resistance data from tests performed by an independent testing agency in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest. Provide field testing where manufacturers test data is not available.

B. Samples for Initial Selection: For each type of exposed finish required.

C. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

1.5 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data For Owner: For each type of flooring to include in maintenance manuals, including slip-resistance maintenance requirements.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 96-inch-square floor area selected by Architect.

    a. Include 96-inch length of integral cove base with inside and outside corner.

2. Simulate finished lighting conditions for Architect's review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Slip Resistance Field Testing

1. Contractors, who fail to submit adequate slip resistance testing from product manufacturers, shall engage the services of a qualified testing agency to perform slip resistance field testing on the installed mockup.
2. Test results shall be provided to the Architect and Owner along with required product data.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

1.10 GUARANTEE/WARRANTY

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of two (2) full years from date of substantial completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing according to ASTM D635.

B. Dynamic Coefficient of Friction: For resilient flooring installed on floor surfaces.

1. For floor products without manufacturers previous testing showing compliance:

a. Test floors wet and dry in accordance with ANSI A326.3 dynamic coefficient of friction (DCOF) AcuTest.

1) Flooring products which are required to be field tested and do not satisfactorily pass field testing standards with a DCOF of 0.42 or higher will not be permitted to be installed on the project.

2.2 MANUFACTURERS

A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.3 RESINOUS FLOORING: EP

A. Products:

1. Basis of Design: Stonhard, Inc. Maple Shade, NJ (800).854.0310

a. Refer to Interior Finish Schedule Drawing DG.1.

1) EP, Stontech TRF, Color TBD

B. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arizona Polymer Flooring, Inc.
b. BASF Corporation.
c. CornerStone Flooring & Linings.
d. Crawford Laboratories Inc.
e. Crossfield Products Corp.
f. Delta Polymers, Inc.
g. DUDICK Inc.
h. Duraflex, Inc.
i. Garland Company, Inc. (The).
j. Key Resin Company
k. Neogard; a division of Jones-Blair, Inc.
l. Polymerica, Incorporated.
m. ROCK-TRED Corporation.
n. Sherwin-Williams Company, General Polymers.
o. Sika Corporation; Flooring.
p. Tufco International Inc

C. System Characteristics:

1. Color and Pattern: As selected by Architect from manufacturer's full range.
2. Wearing Surface: Textured for slip resistance.
3. Integral Cove Base: 4 inches and 6 inches.
4. Overall System Thickness: 3/16 inch.

D. Primer: Type recommended by manufacturer for substrate and body coat(s) indicated.

1. Formulation Description: Stonhard Urethane Primer 100 percent solids.
2. Resin: Urethane.
3. Formulation Description: (2) two component, low viscosity, urethane.
4. Application Method: Squeegee and nap roller.
5. Number of Coats: One

E. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coat(s) indicated.

1. Formulation Description: 100 percent solids.

F. Reinforcing Membrane: Flexible resin formulation that is recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated and that inhibits substrate cracks from reflecting through resinous flooring.

1. Formulation Description: 100 percent solids.

a. Provide fiberglass scrim embedded in reinforcing membrane.

G. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

H. Body Coat:

1. Resin: Stonclad UR Urethane.
2. Formulation Description: 100 percent solids.
3. Formulation Description: 4 components.
4. Type: Clear or Pigmented.
5. Application Method: Screed and Metal trowel.
6. Number of Coats: One.
7. Thickness of Coats: 1/8 inch.

I. Under Coat:

1. Resin: Stontec epoxy undercoat Epoxy.
2. Formulation Description: 100 percent solids.
3. Type: Pigmented.
4. Number of Coats: One

J. Broadcast Coat:

1. Material: Stontec Vinyl Flake
2. Formulation Description: Decorative flake for broadcasting.
3. Type: Tweed (chips to be mixed in Mfg. facility).
4. Finish: Standard
5. Number of Coats: One

K. Topcoats: Sealing or finish coats.

1. Resin: Material Basis: Stonseal CA7 Aliphatic Polyaspartic.
2. Formulation Description: Two-component, UV resistant
3. Type: Clear.
4. Number of Coats: One.
5. Thickness of Coats: 1/16 inch.
6. Finish: Gloss.

L. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 5,000 psi minimum according to ASTM C579
2. Tensile Strength: 1,000 psi minimum according to ASTM C307
3. Flexural Modulus of Elasticity: $1.1x10^6$ psi minimum according to ASTM C580

4. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch permanent indentation per MIL-D-3134
5. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch per MIL-D-3134
6. Abrasion Resistance: <.03 gm max maximum weight loss per ASTM D4060
7. Hardness: 80, Shore D per ASTM D2240
8. Bond Strength: 100 percent concrete failure per ACI 503R

M. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D1308 for 50 percent immersion and ASTM D543, Procedure A, for immersion or ASTM C267 for immersion in the following reagents for not less than 7 days:

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:

    a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    b. Comply with NACE No. 6/SSPC-SP13, with a Concrete Surface Profile (CSP) of 3 or greater in accordance with the International Concrete Repair Institute (ICRI) Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
    b. Relative Humidity Test: Use in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have neutral pH and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

a. Apply joint sealant to comply with manufacturer's written recommendations.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Waterproofing Membrane: Apply waterproofing membrane over entire substrate surface, in manufacturer's recommended thickness.

1. Apply waterproofing membrane to integral cove base substrates.

D. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.

E. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

1. Integral Cove Base: 4 inches and 6 inches high.

2. Aggregates: Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.

F. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended by manufacturer.

G. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.4 CLEANING AND PROTECTING

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 23

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Modular carpet tile.

B. Related Sections include the following:

1. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile

1.3 PREINSTALLATION MEETINGS

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: Show the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles
2. Carpet tile type, color, and dye lot
3. Type of subfloor
4. Type of installation
5. Pattern of installation
6. Pattern type, location, and direction
7. Pile direction
8. Type, color, and location of edge, transition, and other accessory strips
9. Transition details to other flooring materials

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Four full-size samples
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch-long Samples

D. Samples for Initial Selection: For each type of carpet tile.

1. Include Samples of transition(s), and other accessory stripping involving color or finish selection.

E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.

F. Product Schedule: For carpet tile. Use same designations indicated in Finish Legend on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

B. Executed warranty

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.8 QUALITY ASSURANCE

A. Comply with requirements and recommendations of The Carpet and Rug Institute Commercial Carpet Standard for Installation of Commercial Carpet CRI 104, (CRI)

B. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI Carpet Installation Standard, Section 4, "Storage and Handling."

1.10 FIELD CONDITIONS

A. Comply with CRI 104, paragraphs 7.2 & 7.3 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Do not commence with carpet installation until painting, finishing work and all work in or behind carpet surface is complete and ceilings and overhead work, tested, approved and completed.

E. Prior to commencement of installation, the carpet contractor shall inspect all surfaces to receive carpet so as to confirm a suitable substrate for the installation.

F. Field Measurements: Field check area dimensions for establishing carpet starting points and balancing areas of the installation.

1.11 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer's warranty in which manufacturer agrees to repair or replace (full labor and material) components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent edge raveling, snags, and runs.
b. Dimensional instability.
c. Excess static discharge.
d. Loss of tuft-bind strength.

e. Loss of face fiber.
f. Delamination.

3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER PRODUCTS AND LEAD TIMES:

A. Products listed as Basis of Design herein and on the Finish Schedule have been coordinated with other finishes and approved by the Owner for color and pattern in schemes throughout the project area.

B. Proposed substitutions must be approved by the Owner and Architect prior to award or they will not be considered. The Contractor shall be responsible to match all listed characteristics, including color and pattern, to the satisfaction of the Owner and Architect. Submit products for consideration per the requirements of Division 01 Section “Substitution Procedures.”

C. Substitutions for Cause proposed after award shall be submitted for approval per the requirements of Division 01 Section “Substitution Procedures.” Substitutions for Convenience proposed after award will not be considered.

D. Many Division 09 products are long lead. The Contractor is responsible to verify all lead times sufficiently in advance of submittal documents, mockups and need to avoid schedule conflicts. Neither the Owner nor Architect will be held responsible for inaction on the part of the Contractor in ordering material with enough lead time to avoid additional “quick ship” costs or delays to the construction schedule in order to accomplish all requirements herein.

2.2 CARPET TILE, CPT.

A. Manufacturer:

1. Basis of Design Product: Patcraft
2. Other Acceptable Manufacturers: Subject to compliance with requirements:

a. Bentley Prince Street, Inc.
b. Interface, LLC.
c. J&J Invision; J&J Industries, Inc.
d. Mannington Mills, Inc.
e. Mohawk Group (The); Mohawk Carpet, LLC.
f. Tandus; a Tarkett company.

B. Color: As indicated in the Finish Legend.

C. Pattern: As noted in the Finish Legend.

D. Fiber Content: 100 percent nylon 6.

E. Fiber Type: Eco Solution Q Nylon

F. Pile Characteristic: Multi-level pattern loop pile.

G. Density: 9,409 oz./cu. yd.

H. Pile Thickness: 0.088 inches for finished carpet tile per ASTM D6859.

I. Stitches: 9 stitches per inch

J. Gauge: 1/10 gauge in ends per inch

K. Total Weight: 23 oz./sq. yd. for finished carpet tile.

L. Primary Backing/Backcoating: Non-Woven Synthetic.

M. Secondary Backing: Manufacturer's standard material EcoWorx Tile

N. Size: 12 inches by 48 inches plank tile.

O. Applied Treatments:

1. Applied Soil-Resistance Treatment: SSP Shaw Soil Protection Retain "Antimicrobial Treatment" Subparagraph below unless antimicrobial treatment is integral to carpet or if antimicrobial treatment is not needed for Project; consult manufacturer.
2. Antimicrobial Treatment: Manufacturer's standard material .

    a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

P. Performance Characteristics:

1. Carpet systems shall meet or exceed the requirements of the Carpet and Rug Institute's Green Label Plus Indoor Air Quality Test Program.
2. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
3. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm, Class I
4. Dry Breaking Strength: Not less than 100 lbf per ASTM D2646.
5. Tuft Bind: Not less than 5 lbf per ASTM D1335.
6. Delamination: Not less than 3.5 lbf/in. per ASTM D3936.
7. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
8. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
9. Resistance to Insects: Comply with AATCC 24.
10. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
11. Colorfastness to Light: Not less than 4 after 40AFU (AATCC fading units) per AATCC 16, Option E.
12. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
13. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

1. Adhesives must be the manufacturer’s recommended product(s) and have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. , and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 65 percent relative humidity level measurement.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 7 "Site Conditions" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks,

holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 18 “Patterned Carpet Installations" and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer. Minimum size of carpet tile shall be 1/3 of full size.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Terminate carpet at center of door openings where adjacent floor finish is dissimilar unless noted otherwise on drawings.

H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

I. Install pattern parallel to walls and perpendicular to doors.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the CRI 104, paragraph 13.7.2.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 91 13 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following exterior substrates:

1. Concrete (Non-traffic).
2. Galvanized Metal.
3. Galvanized Structural Steel.

B. Related Requirements:

1. Division 05 Sections "Structural Steel Framing" for shop priming of metal substrates.
2. Division 05 Section "Metal Fabrications" for shop priming metal fabrications.
3. Division 05 Section "Metal Stairs and Railings" for shop priming metal floor plate stairs.
4. Division 08 Section “Hollow Metal Doors and Frames” for shop priming of metal substrates specified in that Section.
5. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.3 DEFINITIONS

A. MPI Gloss Levels:

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
5. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
6. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
7. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.5 INFORMATIONAL SUBMITTALS

A. Certifications

1. Before starting work, new and existing surfaces scheduled to be painted shall be inspected by paint manufacturer's representative and certified that surfaces are compatible and in satisfactory condition to receive finish specified.
2. Provide certification letter attesting that shop applied primers have been reviewed for compatibility and are acceptable to the topcoat manufacturers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Coating Maintenance Manual: Upon conclusion of the project, furnish a maintenance manual which shall include an area summary with finish schedule, paint color and gloss samples, where used, product data, MSDS sheets, care & cleaning instructions and touch up procedures.

B. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation, VOC content and instructions for mixing and/or reducing.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

C. Include precautionary measures to prevent fire hazards and spontaneous combustion in the approved Site-Specific Safety Manual and post in the paint storage area.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.9 WARRANTY

A. Provide a one year written warranty from painting subcontractor covering defects in material and workmanship. Areas deemed to be defective shall be repaired as required to make the repair indiscernible.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Sherwin Williams Company (SW)
2. Benjamin Moore (BM)
3. PPG Industries (PPG)

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: Color selections from manufacturers full colors or as have been made from color charts published by the manufacturer(s) listed in the Finish Schedule..

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (CMU): 12 percent.
3. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

1. SSPC-SP1 Solvent Cleaning: Remove all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces with solvent, vapor, cleaning compound, alkali, emulsifying agent, or steam prior to SSPC-SP3.
2. SSPC-SP 3, Power Tool Cleaning: Remove all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by power wire brushing, power sanding, power grinding, power tool chipping, and power tool descaling.

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces. Verify specified topcoat is compatible with shop primer prior to field painting. Prepare shop primed surfaces for painting per primer manufacturer’s written instructions.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. Prepare galvanized surfaces for painting per primer manufacturer’s written instructions.

1. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.

H. Existing Surfaces: Where existing painted surfaces are scheduled to be painted, prepare as follows:

1. Remove dirt, mold, mildew and other contaminates per manufacturer’s instructions.
2. Lightly sand entire surface to be painted.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.

4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Galvanized exterior items and miscellaneous fabrications to be field painted include, but are not limited to, the following:

1. Exposed steel stair work
2. Steel hand railings and supports
3. Exterior metal doors and frames.
4. Bumper guards and angles at loading docks
5. Exterior steel channel jambs
6. Steel bollards
7. Chain link and wire mesh partitions.
8. Exposed primed metal without a finish coat.

E. Paint exposed galvanized structural steel and dunnage scheduled for painting.

F. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

   a. Other items as indicated.

2. Color banding and identification (flow arrows, naming, numbering, etc.) are provided by the Division 21, 22, 23, 25, 26, 27 and 28 Contractors.
3. Do not paint or in any way obscure certification or identification labels on any material or equipment.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE: The paragraphs below cover a range of painting systems. The Contractor shall consult drawings for paint location, type, gloss and color to be applied to each individual substrate. Not all scheduled systems will be included on the drawings. Provide products from a sole source single manufacturer.

A. Concrete (Non-traffic), Concrete.

1. Latex System; Flat (Gloss Level 1)

a. 1 Coat Primer: water borne emulsion type primer for exterior surfaces.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Loxon Concrete and Masonry Primer and Sealer
b) BM Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer 608
c) PPG Architectural Coatings Seal Grip Universal Primer/Sealer

b. 2 Coats Topcoat: Latex, exterior, institutional low odor/VOC, Flat.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW A-100 Exterior Latex Flat
b) BM Ultra Spec EXT Flat Finish N447
c) PPG Architectural Coatings Sun-Proof Exterior Latex Flat

2. Existing Painted Surfaces:

a. Apply one coat low VOC primer product as recommended by the manufacturer compatible with painted substrate and specified topcoat.
b. Apply two coats specified topcoat.

B. Galvanized Metal Fabrications: Including but not limited to, steel control panels, ornamental iron, steel fences and chain link, steel pipes and downspouts, steel gutters, steel posts and bollards, hollow metal doors and frames and steel window sash.

1. Latex System; Semi-Gloss

a. 1 Coat Primer: Water based, anti-corrosive pigments and acrylic resins, for cleaned/etched galvanized metal.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Pro-Cryl Universal Primer
b) BM Ultra Spec HP Acrylic Metal Primer HP04
c) PPG Architectural Coatings Pitt-Tech Plus Exterior DTM Industrial Primer.

b. 2 Coats Topcoat: Latex, exterior, institutional low odor/VOC, Semi-gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial DTM Acrylic
b) BM Ultra Spec HP DTM Acrylic Enamel Semi-gloss HP 29, Gloss HP28
c) PPG Architectural Coatings Pitt-Tech Plus Exterior DTM Industrial Enamel.

C. Galvanized, Non-Ferrous and Ferrous Structural Steel: Exposed structural steel, steel dunnage, steel equipment supports, steel lintels, steel fire escapes and stairs, steel ladders and cross-overs, and steel catwalks.

1. High Performance System: High Build; Semi-Gloss

a. 1 Coat Epoxy: Water Borne Emulsion Type Primer for Exterior Surfaces.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Protective and Marine Macropoxy 646-100 Fast Cure Epoxy (7 mil dft minimum)
b) BM Corotech Surface Tolerant Epoxy Mastic (V160) (7 mil dft minimum).

b. 2 Coats Aliphatic Urethane, Semi-gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Acrolon Ultra, Semi-Gloss (4 mils dft minimum).
b) BM Corotech Aliphatic Urethane Semi-gloss V510 (4 mil dft minimum)

D. Fluoropolymer Coated Aluminum:

1. 1 Coat Primer

a. Acceptable Product: Subject to compliance with requirements, provide the following:

1) SW DTM Bonding Primer.
2) BM
3) PPG

2. 2 Coats Topcoat: Latex, intended for use on new exterior surfaces.

a. Acceptable Product: Subject to compliance with requirements, provide the following:

1) SW A-100 Exterior Latex Semi-Gloss
2) BM Ultra Spec EXT Low Lustre N455 Satin N448, Gloss N449
3) PPG Architectural Coatings Sun-Proof Exterior Latex Semi-Gloss

END OF SECTION 09 91 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Ferrous metal.
4. Galvanized metal.
5. Gypsum board.

B. Related Requirements:

1. Division 05 Sections "Structural Steel Framing," “Architecturally Exposed Structural Steel Framing” and “Steel Decking” for shop priming of metal substrates with primers specified in that Section.
2. Division 05 Section "Metal Fabrications" for shop priming metal fabrications.
3. Division 05 Section "Metal Stairs and Railings" for shop priming metal stairs and railings and other interior pipe railings.
4. Division 08 Section “Hollow Metal Doors and Frames” for shop priming of metal substrates with primers specified in that Section.
5. Division 08 Section “Flush Wood Doors” for transparent finishes for wood doors.
6. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 DEFINITIONS

A. MPI Gloss Levels:

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

5. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
6. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
7. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

B. Finished Spaces: are all spaces or rooms throughout the area of construction, except spaces above suspended ceilings, unless otherwise specified or noted.

C. Finish Schedule: The Finish Schedule lists interior finishes for project, including paint, and can be found on the drawings. The Finish Schedule will indicate paint type, color and gloss for the project. Additional finish information may be found elsewhere on the drawings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 INFORMATIONAL SUBMITTALS

A. Certifications

1. Provide certification of compliance with Low VOC requirements for all filler, primer, paint and coating products.
2. Provide certification letter attesting that shop applied primers have been reviewed for compatibility and are acceptable to the topcoat manufacturers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Coating Maintenance Manual: Upon conclusion of the project, furnish a maintenance manual which shall include an area summary with finish schedule, paint color and gloss samples, where used, product data, MSDS sheets, care & cleaning instructions and touch up procedures.

B. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation, VOC content and instructions for mixing and/or reducing.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

C. Include precautionary measures to prevent fire hazards and spontaneous combustion in the approved Site-Specific Safety Manual and post in the paint storage area.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F and as recommended by the paint manufacturer .

1. Provide adequate continuous ventilation and sufficient heating and cooling facilities to maintain temperatures between 50 and 95 degrees and as recommended by the paint manufacturer for 24 hours before, during and 48 hours after application of finishes.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces and as recommended by the paint manufacturer.

C. Provide a minimum 25-foot candles (270 lux) of lighting on surfaces to be finished.

1.9 WARRANTY

A. Provide a one-year written warranty from painting subcontractor covering defects in material and workmanship. Areas deemed to be defective shall be repaired as required to make the repair indiscernible.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Sherwin Williams Company (SW)
2. Benjamin Moore (BM)
3. PPG Industries (PPG)
4. Dunn Edwards

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.

C. Colors: Color selections have been made from color charts published by the manufacturer(s) listed in the Finish Legend; contractor shall match these colors without exception.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner will direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (CMU): 12 percent.
3.
4. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust and loose mill scale, if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:

1. SSPC-SP 3, "Power Tool Cleaning."

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces. Verify shop applied primer is compatible with specified top coats.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. Prepare galvanized metal surfaces for field painting per primer manufacturer’s written instructions.

1. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.

I. Existing Surfaces: Where existing painted surfaces are scheduled to be painted, prepare as follows:

1. Remove dirt, mold, mildew and other contaminates per manufacturer’s instructions.
2. Lightly sand entire surface to be painted.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, orange peel or other surface imperfections. Cut in sharp lines and color breaks.

E. Paint Primed and Exposed Steel including, but not limited to, the following:

1. Exposed steel stair work
2. Steel hand railings and supports
3. Interior metal doors and frames.
4. Steel channel jambs
5. Exposed metal without a finish coat.

F. Paint exposed structural steel and deck scheduled for painting (except shop priming).

1. Do not prime steel surfaces scheduled for the application of applied fireproofing materials.

2. Paint the following work where exposed in occupied spaces:

   a. Pipe hangers and supports.
   b. Metal conduit.

3. Paint portions of internal surfaces (black) of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.
4. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment.
5. Color code equipment, piping, conduit and exposed ductwork in accordance with requirements indicated in Division 21, 22, 23, 25, 26, 27 and 28.
6. Color banding and identification (flow arrows, naming, numbering, etc.) are provided by the Division 21, 22, 23, 25, 26, 27 and 28 Contractors.
7. Do not paint or in any way obscure certification or identification labels on any material or equipment.

G. When painting operating units, paint shall not be applied to sliding or rolling contacts where bare material is necessary for proper operation. Paint applied to such surfaces shall be removed.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE (INTERIOR- LOW VOC LATEX PAINTS): The paragraphs below cover a range of painting systems. The Contractor shall consult the Finish Schedule and drawings for paint location, type, gloss and color to be applied to each individual substrate. Not all scheduled systems will be included on the Finish Schedule. Where the product line permits, provide products from a sole source single manufacturer.

A. CMU Substrates: Consult Finish Schedule for gloss and color.

1. Institutional Low-Odor/VOC Latex System Semi-gloss (Gloss Level 5):

a. 1 Coat Block Filler: Block filler, latex, interior/exterior.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) ProIndustrial Heavy Duty Interior/Exterior Block Filler
b) BM Ultra Spec High Build Masonry Block Filler 571
c) PPG Pitt-Glaze Interior Exterior Block Filler 16-90

b. 2 Coats Topcoat: Latex, interior, institutional low odor/VOC, Semi-Gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProMar 200 Zero VOC Acrylic Semi-Gloss.
b) BM Ultra Spec 500 Zero VOC Interior Semi-Gloss N539.
c) PPG Architectural Coatings Speedhide Interior Zero VOC Latex Semi-Gloss.

B. Ferrous Metal: (Including, but not limited to, steel cabinets, exposed equipment support fabrications & unistrut, control panels, hollow metal doors and frames, handrails, ornamental iron and trim).

1. Institutional Low-Odor/VOC Latex System; Semi-Gloss (Gloss Level 5):

a. 1 Coat Primer: Primer, rust-inhibitive, water based.

1) If metal fabrications are shop primed the Contractor may elect to skip the prime coat. However, the Contractor shall verify the approved topcoat is compatible with the factory installed primer.
2) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Pro-Cryl Universal Primer

b. 2 Coats Topcoat: Water Based Alkyd Urethane (minimum pencil hardness 5H) Latex, interior, institutional low odor/VOC, Semi-gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProIndustrial Water-Based Alkyd Urethane, semi-gloss
b) Shop applied structural steel primers are included in Division 05 Sections "Structural Steel Framing" and "Steel Decking." Coordinate the work of this section with the Structural Engineer before editing. Field or shop applied fireproofing coatings are included in Division 07 Section "Intumescent Mastic Fireproofing." Coordinate the work of this section with manufacturer recommendations for topcoating fireproofing products to verify the topcoat products listed above are compatible.

2. Structural Steel: Verify with paint manufacturer that primers and field applied protective coats are compatible with ferrous metal topcoats specified above before proceeding. Notify the Architect where incompatibilities are noted.

3. Existing Painted Surfaces:

a. Apply one coat low VOC primer product as recommended by the manufacturer compatible with painted substrate and specified topcoat.
b. Apply two coats specified topcoat.

C. Galvanized-Metal Substrates: Galvanized-metal substrates should not be chromate passivated if primers are field applied. If galvanized metal is chromate passivated, consult manufacturer for appropriate primers.

1. Institutional Low-Odor/VOC Latex System, Semi-gloss (Gloss Level 5):

a. 1 Coat Primer: Primer, galvanized, water based.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Pro-Cryl Universal Primer

b. 2 Coats Topcoat: Water Based Alkyd Urethane (minimum pencil hardness 5H) Latex, interior, institutional low odor/VOC, Semi-gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProIndustrial Water-Based Alkyd Urethane, semi-gloss

D. Gypsum Board and Plaster Substrates: Consult Finish Schedule for gloss.

1. Institutional Low-Odor/VOC Latex System; Gloss Level 1; Flat:

    a. 1 Coat Primer: Primer sealer, latex, interior, Flat (Gloss Level 1).

        1) Acceptable Product: Subject to compliance with requirements, provide the following:

            a) SW ProMar 200 Zero Interior Latex Primer
            b) BM Ultra Spec 500 Interior Latex Primer N534
            c) AN Glidden Professional Lifemaster No VOC Interior Primer

    b. 2 Coats Topcoat: Latex, interior, institutional low odor/VOC, Flat.

        1) Acceptable Product: Subject to compliance with requirements, provide the following:

            a) SW ProMar 200 Zero VOC Interior Latex Flat.
            b) BM Ultra Spec 500 WB Interior Latex Flat N536
            c) PPG Architectural Coatings Speedhide Interior Zero VOC Latex Sealer.

2. Institutional Low-Odor/VOC Latex System; Gloss Level 3; Eggshell:

    a. 1 Coat Primer: Primer sealer, latex, interior Gloss Level 1; Eggshell (Gloss Level 3).

        1) Acceptable Product: Subject to compliance with requirements, provide the following:

            a) SW ProMar 200 Zero Interior Latex Primer
            b) BM Ultra Spec 500 WB Interior Latex Primer N534
            c) PPG Architectural Coatings Coatings Speedhide Interior Zero VOC Latex Sealer.

    b. 2 Coats Topcoat: Latex, interior, institutional low odor/VOC, Egg Shell.

        1) Acceptable Product: Subject to compliance with requirements, provide the following:

            a) SW ProMar 200 Zero VOC Interior Latex Egg Shell
            b) BM Eco Spec WB Interior Latex Egg Shell N538
            c) PPG Architectural Coatings Speedhide Interior Zero VOC Latex Egg Shell.

3. Institutional Low-Odor/VOC Latex System; Gloss Level 5; Semi-Gloss:

    a. 1 Coat Primer: Primer sealer, latex, interior, Semi-Gloss (Gloss Level 5).

        1) Acceptable Product: Subject to compliance with requirements, provide the following:

            a) SW ProMar 200 Zero Interior Latex Primer

b) BM Ultra Spec 500 Interior Latex Primer N534
c) PPG Architectural Coatings Speedhide Interior Zero VOC Latex Sealer

b. 2 Coats Topcoat: Latex, interior, institutional low odor/VOC, Semi-Gloss.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProMar 200 Zero VOC Acrylic Semi-Gloss
b) BM Ultra Spec 500 Zero VOC Interior Semi-Gloss N539
c) PPG Architectural Coatings Speedhide Interior Zero VOC Latex Semi-Gloss

2) Semi-Gloss and Gloss products applied over Gypsum Drywall require a level 5 finish. Coordinate with Division 09 Section Gypsum Board Systems Contractor before proceeding.

4. Institutional Low-Odor/VOC Microbicidal Latex System; Gloss Level 3; Eggshell:

a. 1 Coat Primer: Primer sealer, latex, interior, Semi-Gloss (Gloss Level 5).

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProMar 200 Zero Interior Latex Primer

b. 2 Coats Topcoat: Latex, interior, institutional low odor/VOC, Egg Shell.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Paint Shield Microbicidal Latex. Egg Shell.

5. Existing Painted Surfaces:

a. Apply one coat low VOC primer product as recommended by the manufacturer compatible with painted substrate and specified topcoat.
b. Apply two coats specified topcoat.

3.7 INTERIOR PAINTING SCHEDULE (INTERIOR- HIGH PERFORMANCE LOW VOC EPOXY COATINGS): The paragraphs below cover a range of painting systems. The Contractor shall consult the Finish Schedule and drawings for epoxy-modified paint location, type, gloss and color to be applied to each individual substrate. Not all scheduled systems will be included on the Finish Schedule. Where the product line permits, provide products from a sole source single manufacturer.

A. CMU Substrates: Consult Finish Schedule for gloss and color.

1. Institutional Low-Odor/VOC Epoxy System: Manufacturer shall formulate to specified gloss level (See Finish Schedule).

a. 1 Coat Block Filler: Block filler, latex, interior/exterior. Contractor shall apply two (2) coats block filler in high humidity areas (greater than 60%), kitchen/food prep areas, labs and clean rooms.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) ProIndustrial Heavy Duty Interior/Exterior Block Filler

b. 2 Coats Topcoat: Epoxy-modified interior latex low odor/VOC.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Waterborne Catalyzed Epoxy

B. Ferrous Metal: (Including, but not limited to, steel cabinets, exposed equipment support fabrications & unistrut, control panels, hollow metal doors and frames, handrails, ornamental iron and trim).

1. Institutional Low-Odor/VOC Epoxy System: Manufacturer formulate to specified gloss level (See Finish Schedule).

a. 1 Coat Primer: Primer, rust-inhibitive, water based.

1) If metal fabrications are shop primed the Contractor may elect to skip the prime coat. However, the Contractor shall verify the approved topcoat is compatible with the factory installed primer.

2) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Pro-Cryl Universal Primer (E-2: 51-150 g/l)
b) BM Ultra Spec HP Acrylic Metal Primer HP04 (VOC 48 g/l, LEED)
c) PPG Architectural Coatings Pitt-Tech Plus Interior DTM Industrial Primer

b. 2 Coats Topcoat: Epoxy-modified interior latex low odor/VOC.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Waterborne Catalyzed Epoxy

2. Structural Steel: Verify with paint manufacturer that primers and field applied protective coatings are compatible with ferrous metal topcoats specified above before proceeding. Notify the Architect where incompatibilities are noted.

3. Existing Painted Surfaces:

a. Apply one coat low VOC primer product as recommended by the manufacturer compatible with painted substrate and specified topcoat.

b. Apply two coats specified topcoat.

C. Gypsum Board and Plaster Substrates: Consult Finish Schedule for gloss and color.

1. Institutional Low-Odor/VOC Epoxy System; Manufacturer formulate to specified gloss level (See Finish Schedule).

a. 1 Coat Primer: Primer sealer, latex, interior.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW ProMar 200 Zero Interior Latex Primer
b) BM Ultra Spec 500 WB Interior Latex Primer N534

b. 2 Coats Topcoat: Epoxy-modified interior latex low odor/VOC.

1) Acceptable Product: Subject to compliance with requirements, provide the following:

a) SW Pro Industrial Waterborne Catalyzed Epoxy.
b) BM Corotech Acrylic Epoxy V450

2) Semi-Gloss and Gloss products applied over Gypsum Drywall require a level 5 finish. Coordinate with the drawings and the Division 09 Section Gypsum Board Systems Contractor before proceeding.

END OF SECTION 09 91 23

SECTION 10 14 23.13 - ROOM-IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.4 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: Full-size Sample

2. Variable Component Materials: Full-size Sampleof each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
3. Exposed Accessories: Full-size Sample of each accessory type.
4. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer and manufacturer.

B. Sample Warranty: For special warranty.

1.7 CLOSEOUT DOCUMENTS

A. Maintenance Data: For signs to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: 12 replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: One set(s) of specialty tools for assembling signs and replacing variable sign components.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Installer Qualifications: Manufacturer of products or an entity that employs installers and supervisors who are trained and approved by manufacturer.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal.
b. Deterioration of embedded graphic image.
c. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Signs as noted in the drawings, sheet DGS-1 : Sign system with smooth, uniform surfaces; with message and characters having uniform faces, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ACE Sign Systems, Inc.
b. Advance Corporation.
c. Allen Industries Architectural Signage.
d. APCO Graphics, Inc.
e. ASE, Inc.
f. ASI Sign Systems, Inc.
g. Best Sign Systems, Inc.
h. Clarke Systems.
i. Cosco.
j. Diskey Architectural Signage Inc.
k. Inpro Corporation.
l. Mohawk Sign Systems.
m. Nelson-Harkins Industries.
n. Poblocki Sign Company, LLC.
o. Signature Signs, Inc.
p. Signs & Decal Corp.
q. Stamprite Supersine; a division of Stamp Rite Inc.
r. Vista System.
s. Vomar Products, Inc.

2. Installation Method:

a. Vinyl tape: Manufacturer's standard high-bond, foam-core tape, 0.045-inch thick, with adhesive on both sides

3. Adhesive: As recommended by manufacturer.

a. Adhesives shall have a VOC content of 70 g/L or less.

B. General: Provide manufacturer's standard plaques, characters and signs according to requirements indicated.

1. Preassemble in the shop to greatest extent possible. Disassemble only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match finish.
6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

C. Surface-Engraved Graphics: Machine-engrave characters and other graphic devices into indicated surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.

D. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted items to suit construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match background color unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install product at heights to conform to Americans with Disabilities Act Accessibility Guidelines (ADAAG), ANSI 117.1 and applicable local amendments and regulations.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:

1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position and push to engage tape adhesive.

C. Mounting to Glass: Provide opaque sheet matching sign material and background finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 23.13

SECTION 10 26 00 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Corner guards.
2. End-wall guards.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for metal angle corner guards.
2. Division 08 Section "Door Hardware" for metal and plastic protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact-resistant wall-protection unit.
2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.

B. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.

1. Include Samples of accent strips and accessories to verify color selection.

D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Corner and End-Wall Guards: 12 inches long.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of corner and end guard.

B. Qualification Data: For installer.

C. Warranty: Sample of warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each impact-resistant wall-protection unit to include in maintenance manuals.

1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

B. Executed warranty

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E329 for testing indicated, as documented according to ASTM E548.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.

a. Store corner and end wall-guards in a horizontal position.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. Field Measurements: Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards CG1: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Babcock-Davis.

b. Balco; a CSW Industrials Company.
c. Boston Retail Products.
d. CS-Construction Specialties
e. Hiawatha, Inc; a division of the Activar Construction Products Group.
f. Inpro Corporation.
g. JL Industries, Inc.; a division of the Activar Construction Products Group.
h. Korogard Wall Protection Systems; a division of RJF International Corporation.
i. Nystrom.
j. Pawling Corporation.
k. Tepromark International, Inc.
l. WallGuard.com.

2. Material: Stainless-steel sheet, Type 304.

a. Thickness: Minimum 0.0625 inch
b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
4. Corner Radius: 1/8 inch.
5. Mounting: Adhesive.

2.4 END-WALL GUARDS

A. Surface-Mounted, Metal, End-Wall Guards EG1: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CS-Construction Specialties
b. Inpro Corporation.
c. Korogard Wall Protection Systems; a division of RJF International Corporation.
d. Pawling Corporation.

2. Material: Stainless-steel sheet, Type 304.

a. Thickness: Minimum 0.0625 inch.
b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
4. Corner Radius: 1/8 inch.
5. Mounting: Adhesive.

2.5 MATERIALS

A. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

B. Adhesive: As recommended by protection product manufacturer.

1. Adhesives shall have a VOC content of 70 g/L or less.

2.6 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.7 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall protection in locations and at mounting heights indicated on Drawings.

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

1. Provide anchoring devices and suitable locations to withstand imposed loads.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 00

SECTION 10 28 00 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Washroom accessories.
2. Shower room accessories.
3. Custodial accessories.
4. Under-Lavatory guards.

B. Related Sections include the following:

1. Division 06 Section “Miscellaneous Rough Carpentry” and Division 09 Section “Gypsum Board Systems” for wood and metal blocking installed to support toilet accessories.

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

C. Contractor shall be responsible to coordinate blocking requirements for all accessory items, including changing stations, grab bars and shower seat with specific requirements noted in Division 06 Section “Miscellaneous Rough Carpentry” and Division 09 Section “Gypsum Board Systems”

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

3. Include electrical characteristics.

B. Samples: Full size, for each exposed product and for each finish specified.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

B. Certification: Certification letter from the manufacturer stating that all accessories provided meet the minimum requirements of ICC A117.1, current edition.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

B. Copy of Executed Warranty

1.7 WARRANTY

A. Standard Accessory Warranty: Warrant products to be free from defects in workmanship and material under normal usage from the date of purchase for the periods set forth below,

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.2 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.

C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

I. Keyed (tumbler lock) accessories shall be keyed alike with the exception of coin receiving boxes on dispensing machines.

J. Lettering for identification of accessories and operation instructions shall be silk screened using international symbols unless otherwise specified.

2.3 ACCESSIBILITY REQUIREMENTS

A. All products shall be manufactured in compliance with ICC A117.1 requirements for accessibility by elderly, child and disabled persons, without exception and as may be required by other jurisdictional authorities.

2.4 EXPOSED FINISHES

A. Stainless Steel: No. 4 satin luster finish.

2.5 TOILET AND BATH ACCESSORIES

A. Manufacturers:

1. Basis-of-Design: Bobrick Washroom Equipment, Inc.
2. Other Acceptable Manufacturers subject to compliance with requirements:

    a. American Specialties, Inc.
    b. Bradley Corporation.
    c. Brey-Krause Manufacturing Co.

d. GAMCO Specialty Accessories; a division of Bobrick.
e. Tubular Specialties Manufacturing, Inc.

B. Accessories

TA-1. Recessed Twin Roll Tissue, Seat Cover & Waste Dispenser, - Bobrick B-3091L & B-3092R

TA-5. Recessed/Paper Towel Dispenser- Bobrick B-3803

TA-13. Recessed Soap Dispenser - Bobrick B-306

TA-18. Robe Hook - Bobrick B-6727

TA-19. Mop Strip - Bobrick B-223 x 24

TA-20. Framed Mirror: B290 2436
24 x 36 (long dimension vertical) -

Bobrick B-290 1836 minimum 20 gauge stainless steel, with mitered corners, welded and ground smooth to match frame. Where butt joints, edges shall be ground smooth with tight joints. Glass- No. 1 quality, 1⁄4" glass mirror; warranted against silver spoilage for 15 years. Galvanized steel back. Secured to concealed wall hanger with theft-resistant mounting.

TA-25. L-Shaped Shower Seat – Bobrick B-5181, reversable, as indicated.

TA-27. Shower Curtain Rod - Bobrick B-6107

TA-28. Straight Grab Bar - Horizontal, length as indicated, with peened grip- Bobrick B-6806.

TA-30. Stall Shower, Small Grab Rail (15-7/8 x 30-7/8), with peened grip- Bobrick B-6861

TA-31. Swing Type Grab Bar; With Peened Grip - Bobrick B-4998

C. Under-Lavatory Guard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Buckaroos, Inc.
b. Plumberx Specialty Products, Inc.
c. Trubro by IPS Corporation

2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

D. Minimum Requirement: As indicated on Drawings and as follows:

1. Tissue Holder - One each water closet.
2. Towel Dispenser: Min. unless otherwise noted on drawings - One up to four lavatories. One for each additional 3 lavatories.

3. Waste Receptacle - One up to four lavatories. One for each additional 3 lavatories.
4. Napkin Vendor - One for each female toilet room.
5. Napkin Disposal - One for each female cubicle.
6. Soap Dispenser - One for each lavatory.
7. Robe Hook - One for each shower cubicle. One each individual Toilet Room; and additional as indicated.
8. Mop Strip - One each Janitor's closet.
9. Mirror - One for each lavatory, and additional as indicated.
10. Grab Bars - All baths, showers, water closets as indicated and where required per ICC A-117.1.

2.6 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

C. Provide non-corrosive steel anchor plates and anchor components for installation of accessories herein specified.

D. Back paint components where contact is made with building finishes to prevent electrolysis.

E. Stainless steel anchors and fastening devices.

F. Shop assemble components and package complete with anchors and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions and fasten to blocking as indicated in Division 06 Section “Miscellaneous Rough Carpentry” and Division 09 Section “Gypsum Board Systems”, using fasteners appropriate to substrate indicated and. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Protrusion Limit: Installed units protrude maximum 1 inch from wall surface, unless noted otherwise.

B. Contractor shall be responsible to coordinate blocking requirements for all accessory items, including changing stations, grab bars and shower seat, with specific requirements indicated in Division 06 Section “Miscellaneous Rough Carpentry” and Division 09 Section “Gypsum Board Systems”

1. Grab Bars: Install to comply with specified structural-performance requirements.
2. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 28 00

SECTION 10 44 13 - FIRE EXTINGUISHERS AND FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire protection cabinets for:

a. Portable fire extinguishers

2. Hand carried fire extinguishers with mounting brackets.

B. Related Requirements:

1. Division 21 Section "Fire-Suppression Standpipes" for fire-hose connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Fire Protection Cabinets: Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction. Include rating and classification.
2. Fire Extinguishers: Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of exposed cabinet finish required.

D. Samples for Verification: For each type of exposed cabinet finish required, prepared on Samples of size indicated below:

1. Size: 6 by 6 inches square.

E. Product Schedule:

1. For fire protection cabinets. Indicate whether recessed, semi-recessed, or surface mounted. Coordinate final fire protection cabinet with fire extinguisher to ensure proper fit and function.
2. For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.4 CLOSEOUT DOCUMENTS

A. Maintenance Data: For fire extinguishers and fire protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire protection cabinets with wall depths.

C. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10
b. Faulty operation of valves or release levers

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 CABINET PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 FIRE EXTINGUISHER PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.4 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis of Design: Larsen's Manufacturing Company; Architectural steel series

B. Other Acceptable Manufacturers subject to compliance with requirements

1. J. L. Industries, Inc., a Division of Activar Construction Products Group; Ambassador steel series.
2. Potter-Roemer, LCC; Alta steel series

C. Cabinet Construction: Nonrated, 1-hour fire rated or 2-hour fire rated. Rating shall be the same as the partition in which it is located.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch thick, cold-rolled steel sheet lined with minimum 5/8-inch thick, fire-barrier material. Provide factory-drilled mounting holes.

D. Cabinet Material: Stainless-steel sheet

E. Semi Recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

1. Square-Edge Trim: 1-1/2-inch backbend depth.

F. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

G. Cabinet Trim Material: Same material and finish as cabinet

H. Door Material: Same material and finish as cabinet

I. Door Glazing: Full Clear Acrylic Panel

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

1) Location: Applied to cabinet door.
2) Application Process: Silk-screened**.**
3) Lettering Color: Red **.**
4) Orientation: Vertical.

L. Materials:

1. Stainless Steel: ASTM A666, Type 304.

a. Finish: No. 4 directional satin finish.

2. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), 6 mm thick, with Finish 1 (smooth or polished).

2.5 CABINET FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

2.6 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each indicated.

B. Basis of Design: Buckeye Fire Equipment, Inc.

1. Other Acceptable Manufacturers subject to compliance with requirements

a. Ansul by Johnson Controls Company.
b. Babcock-Davis.
c. Badger Fire Protection.
d. Guardian Fire Equipment, Inc.
e. JL Industries, Inc.; a division of the Activar Construction Products Group.
f. Larsens Manufacturing Company.
g. Potter Roemer LLC; a Division of Morris Group International.

C. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

D. Fire Extinguishers by Type:

1. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.7 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Basis of Design: Buckeye Fire Equipment, Inc.

1. Other Acceptable Manufacturers subject to compliance with requirements

a. Ansul by Johnson Controls Company.
b. Babcock-Davis.
c. Badger Fire Protection.
d. Guardian Fire Equipment, Inc.
e. JL Industries, Inc.; a division of the Activar Construction Products Group.
f. Larsens Manufacturing Company.
g. Potter Roemer LLC; a Division of Morris Group International.

C. General Extinguishers:

1. Buckeye Fire Equipment, Model 10CD (45600)

2.8 FIRE EXTINGUISHER SIGN

A. Identification: Lettering complying with the local authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify fire protection cabinet location and bracket-mounted fire extinguisher locations with a 5” x 6”, 3D Rigid Aluminum Fire Extinguisher Arrow Sign, with white lettering on a red background. The words "FIRE EXTINGUISHER" in white letters above a white downward pointing arrow.

a. Orientation: Vertical
b. Visibility: Must be mounted directly over the fire extinguisher unit and within 6-12 inches of the finished ceiling and be visible from 3 directions.

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

B. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recess for fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet or as noted otherwise.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, notify Architect.
2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

C. Identification:

1. Apply vinyl lettering at locations indicated.

D. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 42 inches above finished floor to top of fire extinguisher unless noted otherwise or required by ADA.

E. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

SECTION 10 51 29 – PHENOLIC-CORE LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes Phenolic-Core Lockers and locker accessories.

B. Related Sections include the following:

1. Division 06 Section "Rough Carpentry" for concealed wood support base, furring, blocking, and shims required for installing lockers and concealed within other construction before locker installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of phenolic locker.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of phenolic locker.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
3. Include graffiti resistance data when tested in accordance with ASTM D 6578.

B. Shop Drawings: For phenolic lockers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Show base, sloping tops,filler panels, recess trim and other accessories.
3. Show details full size.
4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
5. Show locations and sizes of cutouts and holes for items installed in lockers.
6. Include locker identification system and numbering sequence.

C. Samples: For each color specified, in manufacturer's standard size.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

E. Samples for Verification: For the following products, in manufacturer's standard size:

1. Phenolic panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
2. Melamine interior finish, not less than 8 x 8 inches.
3. Exposed cabinet hardware and accessories, one unit for each type and finish.

F. Product Schedule: For lockers. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Research/Evaluation Reports: Showing that material complies with building code in effect for Project for Class B fire rating when tested in accordance with ASTM E 84.

C. Sample Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT DOCUMENTS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of phenolic locker manufacturer for installation and maintenance of units required for this Project.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of phenolic lockers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver phenolic lockers until spaces to receive them are clean, dry, and ready for phenolic locker installation.

B. Deliver master and control keys or combination control charts to Owner by registered mail or overnight package service.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install lockers until wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify the following by field measurements before fabrication and indicate measurements on Shop Drawings:

1. Concealed framing, blocking, and reinforcements that support phenolic lockers before they are enclosed.
2. Verify actual dimensions of recessed openings by field measurements before fabrication.
3. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish recessed opening dimensions and proceed with fabricating phenolic lockers without field measurements. Coordinate wall and floor construction to ensure that actual recessed opening dimensions correspond to established dimensions.

1.10 COORDINATION

A. Coordinate size and location of bases for phenolic lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that phenolic lockers can be supported and installed as indicated.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of phenolic lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures
b. Faulty operation of latches and other door hardware
c. Delamination and defects of phenolic finish.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for Phenolic Lockers: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain phenolic lockers and accessories from single source from single locker manufacturer.

1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

B. Flame Spread: When tested in accordance with ASTM E84, Lockers, Athletic Lockers, Wardrobe Cabinets, School Cubbies and Locker Bench materials shall meet or exceed all requirements for Class B Flame Spread Rating and Smoke Developed and shall carry a Class B Fire Rating Certification in accordance with the requirements of NFPA and ICC. Class B Fire Rating Certification shall be in the name of the Locker Manufacturer and shall be less than six (6) months old.

1. Flame Spread shall not exceed 75.
2. Smoke Developed shall not exceed 450.

C. Graffiti Resistance Requirements: When tested in accordance with ASTM D6578, Locker materials shall prove resistant to all chemicals tested for a period of 1 to 10 minutes and shall leave no mar or blemish on the surface when cleaned. Locker materials shall have guaranteed surface clean ability from permanent markers and shall have Non-Ghosting properties.

D. Scratch Resistance Requirements: When tested in accordance with ASTM D2197, Locker materials shall prove to be scratch resistant when the maximum Load Value exceeds 10 kilograms.

E. Impact Resistance Requirements: When tested in accordance with ASTM D2794, Locker materials shall withstand an Impact Force Value in excess of 45-inch lbs.

F. Screw Holding Strength: When tested in accordance with ASTM D1037, Direct Screw Withdrawal Test, Locker materials shall withstand a direct pull force that exceeds 2,500 lbs per fastener.

G. Tensile Strength: Locker materials shall have a Modulus of Elasticity of 1.55 Million PSI.

H. Shear Strength: Locker materials shall have a Shear Strength of 2,000 PSI minimum.

I. Compression Strength: Locker materials shall have a Compression Strength of 24,000 PSI minimum.

J. Water Absorption Requirements: When tested in accordance with ASTM D570 Locker materials shall have a Water Absorption Rate of less than 0.37%.

2.3 PHENOLIC LOCKERS: LK1

anufacturers: subject to compliance with requirements, provide products by one of the following:

1. Holman, Inc.

2. Forman Phenolic Lockers.
3. Summit Lockers, Inc.

B. Materials: Solid Phenolic with a High-Pressure Melamine matte finish surface made as an integral part of the core material. Laminated surfaces are not acceptable. Surface and edges shall be non-porous and shall not support fungus or bacteria.

1. Provide material which has been selected for uniform color, surface flatness and smoothness.
2. Exposed surfaces which exhibit discolorations, pitting, seam marks, roller marks, stains, telegraphing of core material, or other imperfections on finished units are not acceptable.
3. Defects such as chipping along edges and corners are unacceptable.

C. Locker Doors: Locker Door shall be the full width of the Locker and shall be frameless, allowing access to the entire width of the Locker. Framed Doors are unacceptable. Perimeter ventilation.

D. Doors shall be attached to the Hinge with Stainless Steel Theft Proof Torx Head with Pin fasteners. The Hinge shall be attached to the locker box with Stainless Steel Theft Proof Torx Head with Pin Bolts.

E. The locker shall incorporate mortise and tenon construction and shall be mechanically fastened together with Stainless Steel fasteners. Locker Shelves shall be mortised into side walls of the locker box at location determined by Architect.

1. Relocation of Shelves in the field shall be possible without the need for special tools or welders.

F. Lockers shall arrive at construction site fully assembled.

G. Slope Tops, End Panels, and Toe Kick Plates: Shall be manufactured of the same color, thickness and material as the Locker Doors.

H. Phenolic-Panel Finish: Per Finishes Schedule

1. Edge Color: Through-color matching facing sheet color.

2.4 HARDWARE

A. Locker Hinges: Hinges shall be concealed and shall be made of 14 Gauge Type 304 Stainless Steel and have a Satin finish. Hinge shall have five (5) knuckles and shall allow door to open 90°.

B. Locker Hasp Bar: Hasp shall be fabricated of 11 Gauge Type 304 Stainless Steel with a Satin Finish. All edges shall be polished and smooth. Hasp shall be attached to the Locker Body with two (2) Stainless Steel Theft Proof Torx Head with Pin, Through Bolts. Hasp shall extend through a slot in the face of the Locker Door and the Locker Number Plate. Locker Hasp Bar is to be used with padlocks (padlocks are not included).

C. Coat Hooks: Coat Hooks shall be fabricated of 11 Gauge Type 304 Stainless Steel with a Satin Finish. All edges shall be polished and smooth. Coat Hooks shall be attached to the Locker Body

with Stainless Steel Theft Proof Torx Head with Pin fasteners or Through Bolts. Provide three (3) Coat Hooks for “Z” Lockers. Plastic and aluminum Coat Hooks are unacceptable.

D. Number Plates: Provide a Number Plate for each Door or opening, in the sequence as indicated on the drawings. Number Plate shall be engraved from the back side to prevent the accumulation of dirt and grime.

E. Locker Legs: Provide Locker Legs for all Lockers. Locker Leg assembly shall be structural and shall be fully adjustable to provide for leveling and plumbing of Locker Body. Provide Toe Kick Plates with all necessary hardware for attaching to the Locker Leg.

F. Slope Top Mounting Channels and Supports: Slope Top Mounting Channels and Supports shall be made of Heavy Duty Extruded 6063-T5 Aluminum and shall have a (Black Anodized) finish. Mounting Channels shall be field installed and shall attach to the front top edge of the Locker Body and shall be continuous across the front of the Lockers. Supports shall be universal and shall attach to any standard depth or width Locker via factory pre-drilled holes.

G. Locks: Combination padlocks provided by Owner. ADA compliant locks shall be furnished that is equivalent to Manufacturer: ‘MasterLock’, Model: 2650 PushKey, Portable lock with easy-to-grip wide rubberized body and “no turn” key operation. Keys shall be given to Owner for distribution as required.

H. 5% of lockers shall be furnished in compliance with ADA requirements with factory applied symbol, wire pulls and specialty locks. Coordinate locations with Architect.

2.5 FABRICATION

A. General: Provide factory pre-assembled Locker units. Lockers shall be complete with all hardware and accessories listed above. Knock down units are unacceptable.

B. Slope Tops and End Panels: Provide Slope Tops and End Panels per drawings and as required to complete the installation of the Lockers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Condition lockers to average prevailing humidity conditions in installation areas before installation.

B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

C. Verify that blocking and support framing meet conditions required by manufacturer.

3.3 INSTALLATION

A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
2. Anchor single rows of phenolic lockers to walls near top and bottom of lockers of lockers and to floor.
3. Anchor back-to-back lockers to floor.

B. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach hooks with at least two fasteners.

C. Attach door locks on doors using security-type fasteners specified.

D. Conceal screw heads with plastic caps to match locker interior.

E. Identification Plates: Identify lockers with identification indicated on Drawings.

1. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.

F. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate fillers panels where indicated on Drawings.
3. Attach sloping top units to lockers, with closures at exposed ends.
4. Attach boxed end panels with concealed fasteners to conceal exposed ends of nonrecessed lockers.
5. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed lockers.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

B. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

C. Touch up marred finishes or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13

SECTION 10 56 13 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Four-post metal storage shelving.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. Shop Drawings: For metal storage shelving.

1. Include plans, elevations, sections, and attachment details.
2. Include installation details of connectors, lateral bracing, and special bracing.

C. Product Schedule: For metal storage shelving. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint of metal storage shelving.

B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shelf-to-Post Connectors: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 connectors.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver metal storage shelving palleted, wrapped, or crated to provide protection during transit and Project-site storage.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weatherproof, wet work in spaces is completed and dry, and ambient temperature is being maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and the information provided on the drawings.

1. Seismic Component Importance Factor: 1.5.

2.2 FOUR-POST METAL STORAGE SHELVING

A. Wire-Type, Four-Post Metal Storage Shelving: Complying with MH 28.1; field assembled from factory-formed components. Shelves span between supporting corner posts that allow shelf-height adjustment over full height of shelving unit. Provide adjustable shelves and accessories indicated.

1. Basis-of-Design Product: InterMetro Industries Corporation; Super Erecta Shelving System or a comparable product by one of the following:

a. AMCO Corporation.
b. Gillis Associated Industries.

c. Lyon Workspace Products, LLC.

2. Posts: Fabricated from 1-inch-OD, round tubing of indicated material; with grooves or notches at 1 inch o.c. to receive shelf-to-post connectors. Label posts with numbers at not less than 2 inches o.c. for determining shelf height.

   a. Post Material:

      1) Chrome plated steel for shelving units in all spaces other than BSL3 areas and cold rooms.
      2) Stainless steel for shelving units in BSL3 areas and cold rooms.

   b. Post Base: Adjustable steel floor plate, drilled for floor anchors or 5” lockable caster with Polyurethane tread.

   c. Post Cap: Nylon or plastic.
   d. Unit Configuration: Configure shelving units as starter and add-on unit assemblies.

3. Truss-Edge Type Wire Shelves: Wire-over-wire construction, with downturned wire truss edges; with manufacturer's standard post collar, designed to engage collet (wedge), welded at each corner.
4. Solid-Type Shelves:

   a. Stainless steel 18-gauge Type 304.

5. Shelf Quantity: As indicated on the Equipment Schedule drawings.
6. Shelf-to-Post Connectors: Manufacturer's standard one-piece collet (wedge), designed to engage post collar attached to shelves.
7. Bracing: Manufacturer's standard diagonal cross bracing, as required for stability, load-carrying capacity of shelves, and number of shelves.
8. Overall Unit Width: As indicated on the Equipment Schedule drawings, inclusive of two end posts.
9. Overall Unit Depth: As indicated on the Equipment Schedule drawings.
10. Overall Unit Height: As indicated on the Equipment Schedule drawings.
11. Accessories:

    a. Shelf-Label Holders: Stainless steel, designed to clip onto front edge of shelf.

12. Stainless-Steel Finish: Manufacturer's standard nondirectional-polish finish.

2.3 ANCHORS

A. Floor Anchors: Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.

2.4 FABRICATION

A. Fabricate metal storage shelving components to provide field-assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.

1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum and clean finished floor over which metal storage shelving is to be installed.

3.3 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.

1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
3. Adjust post-base bolt leveler to achieve level and plumb installation.
4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
5. Install seismic restraints.
6. Connect side-to-side and back-to-back shelving units together.
7. Install shelves in each shelving unit at equal spacing.

    a. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.

B. Accessories:

1. Shelf-Label Holders: Install one on each shelf.

a. Install centered within each shelving unit.

2. Back Ledges: Install one per shelf.
3. Side Ledges: Install on sides of end shelves.

3.4 ERECTION TOLERANCES

A. Erect four-post metal storage shelving to a maximum tolerance from vertical of 1/2 inch in up to 10 feet of height, not exceeding 1 inch for heights taller than 10 feet.

B. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of 1/4 inch in 84 inches of height.

3.5 ADJUSTING

A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.

B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.

C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.

D. Replace metal storage shelving components that have been damaged beyond successful repair

END OF SECTION 10 56 13

SECTION 12 24 13 – ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manually operated roller shades with single and double rollers.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for custom metal pockets for window treatments fabricated from metal extrusions.
2. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for mounting roller shades and accessories.
3. Division 09 Section "Gypsum Board Systems" for wood blocking for mounting roller shades and accessories.
4. Division 09 Section "Acoustical Ceilings" for coordination with acoustical ceilings.
5. Division 26 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized shade operation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Samples for Initial Selection: For each type and color of shadeband material.

1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than 3 inches square. Mark interior face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 10 inches long.

F. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than twounits.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.10 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth: Non-depreciating five year warranty.

B. Roller Shade Motors and Motor Control Systems: Labor and material; no maximum limit; also non-depreciating five year warranty.

C. Roller Shade Installation: One year from date of Substantial Completion, Labor and material; no maximum limit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 APPLICATION/SCOPE

A. Roller Shade Schedule:

1. Shade Type 1: Manual operating, chain drive, sunscreen roller shades in all exterior windows of rooms and spaces on the Drawings.
2. Shade Type 2: Manual operating interior, chain drive room darkening roller shades with blackout fabric in all exterior windows of the Conference Room and related mounting systems and accessories.

2.3 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Basis of Design Manufacturer: MechoShade Systems, Inc.

B. Other acceptable manufacturers subject to compliance with requirements:

1. BTX Window Automation Inc.
2. DFB Sales Inc.
3. Draper Inc.
4. Hunter Douglas Contract.
5. Lutron Electronics Co., Inc.
6. OEM Shades Inc.
7. Rollease Acmeda.

8. Silent Gliss Inc.
9. SM Automatic, Inc.
10. Springs Window Fashions; SWFcontract.

C. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Nickel-plated metal

a. Loop Length: Full length of roller shade.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: Clip, jamb mount.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.

D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Right side of interior face of shade.
2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
3. Shadeband-to-Roller Attachment: Manufacturer's standard method.

E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

F. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

G. Shadebands:

1. Shadeband Material: Light-filtering fabric, 3% openness factor.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shadeband materialRetain "Color and Finish" Subparagraph below for exposed bottom bars.
b. Color and Finish: As noted in Finish Legend.

H. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

a. Shape: L-shaped

b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.

2.4 MANUALLY OPERATED SHADES WITH DOUBLE ROLLERS

A. Basis of Design Manufacturer: MechoShade Systems, Inc.

B. Other acceptable manufacturers subject to compliance with requirements:

1. BTX Window Automation Inc.
2. DFB Sales Inc.
3. Draper Inc.
4. Hunter Douglas Contract.
5. Lutron Electronics Co., Inc.
6. OEM Shades Inc.
7. Rollease Acmeda.
8. Silent Gliss Inc.
9. SM Automatic, Inc.
10. Springs Window Fashions; SWFcontract.

C. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Manufacturer's standard.

a. Loop Length: Full length of roller shade.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: Clip, jamb mount.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.

D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Double-Roller Mounting Configuration: Side by side.
2. Inside Roller:

a. Drive-End Location: Right side of interior face of shade.
b. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

3. Outside Roller:

a. Drive-End Location: Left side of interior face of shade.
b. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

4. Shadeband-to-Roller Attachment: Manufacturer's standard method.

E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

F. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

G. Inside Shadebands:

1. Shadeband Material: Light-filtering fabric, 3% openness factor.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

    a. Type: Enclosed in sealed pocket of shadeband material.
    b. Color and Finish: As noted in the Finish Legend.

H. Outside Shadebands:

1. Shadeband Material: Light-blocking fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

    a. Type: Enclosed in sealed pocket of shadeband material.
    b. Color and Finish: As noted in the Finish Legend.

I. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

    a. Shape: L-shaped .
    b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

    a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.

3. Endcap Covers: To cover exposed endcaps.

4. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

    a. Closure-Panel Width:2 inches.

5. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

6. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
7. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.5 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Roller shade manufacturer .
2. Type: 75% PVC and 25% polyester.
3. Weave: Basketweave.
4. Thickness: 0.022 in.
5. Weight: 12.33 oz./sq. yd.
6. Roll Width: 98” wide.
7. Orientation on Shadeband: Up the bolt.
8. Openness Factor: 3 percent.
9. Color: As indicated on Drawings.

C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.

1. Source: Roller shade manufacturer .
2. Type: 73% vinyl coating and 27% fiberglass.
3. Thickness: 0.013 inches.
4. Weight: 12.50 oz./sq. yd..
5. Roll Width:72 inches.
6. Orientation on Shadeband: Up the bolt.
7. Features: Washable and bacterial and fungal resistant.
8. Color: As indicated on Drawings .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Roller Shade Locations: At exterior windows .

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 12 24 13

SECTION 12 35 53 - LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal laboratory casework
2. Utility-space framing at backs of base cabinets and between backs of base cabinets
3. Filler and closure panels
4. Laboratory casework system that includes support and utility-space framing, filler and closure panels and modular countertops
5. Laboratory countertops
6. Tables
7. Shelves
8. Laboratory accessories

B. Related Sections:

1. Division 06 Section "Miscellaneous Rough Carpentry" or wood blocking for anchoring laboratory casework
2. Division 09 Section "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework
3. Division 09 Section "Resilient Base and Accessories" for resilient base applied to metal laboratory casework
4. Division 09 Section "Resilient Tile & Sheet Flooring" for coved base flooring applied to metal laboratory casework
5. Divisions 22 and 26 Sections for installing service fittings specified in this Section, including and connecting service utilities

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of laboratory equipment.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For laboratory casework.

1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations and types of service fittings.
6. Include details of utility spaces showing supports for conduits and piping.
7. Include details of support framing system.
8. Include details of exposed conduits, if required, for service fittings.
9. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and laboratory equipment.
10. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples: For casework finishes and materials requiring color selection.

D. Samples for Initial Selection: For casework finishes and materials requiring color selection.

E. Samples for Verification: For each type of casework, exposed-hardware, and countertop-material finish, in manufacturer's standard sizes.

1. One full-size, finished base cabinet complete with hardware, doors, and drawers.
2. One full-size, finished wall cabinet complete with hardware, doors, and adjustable shelves.
3. One Sample each of hinged and sliding doors.
4. 6-inch-square Samples for each type of countertop material.
5. One of each service fitting specified, complete with accessories and specified finish.
6. One of each type of sink and accessory item specified.
7. One of each type of hardware item specified.

1.6 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For laboratory casework indicated to comply with seismic performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For qualified manufacturer.

C. Product Test Reports:

1. Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified

product standard and system structural performance specified in "Performance Requirements" Article.

2. Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface material with requirements specified for chemical and physical resistance.

D. Provide a certification from the manufacturer that the metal casework complies with this specification.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each type and color of casework finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Mounting Clips and Related Hardware: Quantity equal to 5 percent of amount installed, but no fewer than 20 of each type.
2. Modular Countertop Units: Two extra units of each length and material installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 M.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet-work are complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Established Dimensions: Where laboratory casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where laboratory casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Casework

1. Basis of Design: Mott Manufacturing Optima Series Table system.
   Mott Manufacturing Ltd.; 452 Hardy Rd. Brantford, ON, Canada N3T 5L8.
   Tel: (519) 752-7825 Email: inquire@mott.ca, www.mott.ca.

2. Other Acceptable Manufacturers subject to compliance with requirements

   a. ICI; Jamestown Metal Products.
   b. Kewaunee Scientific Corp.

3. Other manufacturers that comply with the minimum thicknesses of material and similar construction appearance and quality as specified and shown in drawings.

   a. Modular system shall be made of tubular style framing combined with square formed steel uprights.
   b. To be used in island, wall, or peninsula situations.

4. 2. Tubular Frames: Table supports.

   a. Table supports to be adjustable height in 1” increments.
   b. Table support frames to have levelers equipped.

5. 3. Rear frame to be used for carrying plumbing, data, and electrical services.

   a. Rear upright supports to be equipped with slots for adjustable shelving and levelers.
   b. All services must terminate at the top of the rear tubular support frame with a plug or receptacle for all types of services.

6. Assembled frame to be self-supporting without needing to be anchored to the building.
7. The modular system must ship complete from the factory with minimal on-site assembly

B. Service Fixtures

1. Basis of Design: Broen A/S
2. Other Acceptable Manufacturers subject to compliance with requirements

   a. Chicago Faucets; Geberit Company.
   b. Water Saver Faucet Co., Chicago, Illinois
   c. T&S Brass and Bronze Works

C. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.

D. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with Specifications may be considered. See Section 016000 "Product Requirements."

2.2 PERFORMANCE REQUIREMENTS

A. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:

1. Support Framing System: 600 lb/ft..
2. Suspended Base Cabinets (Internal Load): 160 lb/ft..
3. Work Surfaces (Including Tops of Suspended Base Cabinets): 160 lb/ft..
4. Wall Cabinets (Upper Cabinets): 160 lb/ft..
5. Shelves: 40 lb/sq. ft. .

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design laboratory casework installation.

C. Seismic Performance: Laboratory casework installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Design earthquake spectral response acceleration, short period (Sds) for Project is indicated on Drawings.
2. Component Importance Factor: 1.5.
3. Base Cabinet Load (Including Countertop and Load on Countertop): 320 lb/ft..
4. Wall Cabinet (Upper Cabinet) Load: 160 lb/ft..

2.3 DESIGN CRITERIA

A. Single Source Responsibility: All equipment covered by this Specification section and accompanying Drawings (except where specific manufacturers are indicated) shall be the product of one manufacturer and installed under his direction to eliminate any divided responsibility.

B. Performance Criteria

1. Casework components shall withstand the following minimum loads without damage to the component or to the casework operation:

a. Steel Base Unit Load Capacity: 500 lbs. per lineal foot
b. Suspended Units: 300 lbs.
c. Drawers in a Cabinet: 150 lbs.
d. Utility Tables (4 legged): 300 lbs.
e. Hanging Wall Cases: 300 lbs.
f. Load Capacity for Shelves of Base Units, Wall Cases and Tall Cases: 100 lbs.

2. Metal Finish Performance Requirements

   a. Abrasion Resistance: Maximum weight loss of 5.5 mg. per 100 cycle when tested on a Taber Abrasion Tester #E40101 with 1000 gm wheel pressure and Calibrase #CS10 wheel.
   b. Hardness: Surface hardness equivalent to 4H or 5H pencil.
   c. Humidity Resistance: Withstand 1000 hour exposure in saturated humidity at 100° F.
   d. Moisture Resistance

      1) No visible effect to surface finish after boiling water trickled over test panel inclined at 45° for five minutes.
      2) No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.

   e. Adhesion: Score finish surface of test panel with razor blade into 100 squares, 1/16 inch x 1/16 inch, cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.
   f. Salt Spray: Withstand minimum 200 hour salt spray test.

3. Chemical Resistance Finish Performance Requirements

   a. Apply 10 drops of each reagent identified to the surface of the finished test panes laid flat and level on a horizontal surface. Ambient temperature: 68-72° F. (20-22° C.). After one hour flush away chemicals with cold water and wash surface with detergent and warm water at 150° F. (65.5° C.) and with alcohol to remove surface stains. Examine surface under 100 foot candles of illumination.
   b. Evaluation Ratings: Change in surface finish and function shall be described by the following ratings:

      1) Excellent: No change to slight detectable change in color or gloss.
      2) Good: Clearly discernible change in color or gloss. Finish remains intact and protective with no significant impairment to function or life.
      3) Failure: Obvious and significant deterioration, visible blistering, bare spots, or roughness of surface.

   c. Test Results

Reagent	Rating
Acetic Acid, 93%	Excellent
Formic Acid, 33%	Good/Excellent
Hydrochloric Acid, 37%	Good/Excellent
Nitric Acid, 25%	Good/Excellent
Nitric Acid, 60%	Good/Excellent
Phosphoric Acid, 75%	Excellent
Sulfuric Acid, 28%	Excellent
Sulfuric Acid, 85%	Good/Excellent
Ammonium Hydroxide, 28%	Excellent
Sodium Hydroxide, 10%	Excellent

Sodium Hydroxide, 25%	Excellent
Acetone	Excellent
Carbon Tetrachloride	Excellent
Ethyl Acetate	Excellent
Ethyl Alcohol	Excellent
Ethyl Ether	Excellent
Formaldehyde, 37%	Excellent
Hydrogen Peroxide, 5%	Excellent
Methylethyl Ketone	Excellent
Phenol, 85%	Good/Excellent
Xylene	Excellent

C. Performance Criteria for Work Surfaces

1. Test Procedure: Apply five drops of each reagent to surface and cover with 25MM watch glass, convex side down; test volatiles using one ounce bottle stuffed with saturated cotton. After 24 hour exposure flush surface, clean, rinse and wipe dry.
2. Evaluation Ratings: Change in surface finish and function shall be described by the following ratings:

    a. No Effect: No detectable change in surface material.
    b. Excellent: Slight detectable change in color or gloss, but no change to the function or life of the work surface material.
    c. Good: Clearly discernible change in color or gloss, but no significant impairment of work surface function or life.
    d. Fair: Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period.
    e. Failure: Pitting, cratering or erosion of work surface material; obvious and significant deterioration.

3. Minimum Performance Criteria

    a. Epoxy Resin Surface

Reagent	Rating
Hydrochloric Acid, 37%	Excellent
Sulfuric Acid, 33%	No Effect
Sulfuric Acid, 77%	No Effect
Sulfuric Acid, 96%	Failure
Formic Acid, 90%	Excellent
Nitric Acid, 20%	Excellent
Nitric Acid, 30%	Excellent
Nitric Acid, 70%	Good
Hydrofluoric Acid, 48%	Fair
Phosphoric Acid, 85%	No Effect
Chromic Acid, 60%	Failure
Acetic Acid, 98%	Excellent
3 & 8 Equal Parts	Excellent
Ammonium Hydroxide, 28%	No Effect
Sodium Hydroxide, 10%	No Effect

Sodium Hydroxide, 20%	No Effect
Sodium Hydroxide, 40%	No Effect
Sodium Hydroxide Flake	No Effect
Sodium Sulfide	Excellent
Zinc Chloride	No Effect
Tincture of Iodine	Excellent
Silver Nitrate	No Effect
Methyl Alcohol	No Effect
Ethyl Alcohol	No Effect
Butyl Alcohol	No Effect
Benzene	Excellent
Xylene	No Effect
Toluene	Excellent
Gasoline	No Effect
Dichlor Acetic Acid	Good
Di Methyl Formamide	Excellent
Ethyl Acetate	No Effect
Amyl Acetate	Excellent
Acetone	Excellent
Chloroform	Excellent
Carbon Tetrachloride	No Effect
Phenol	Excellent
Cresol	Excellent
Formaldehyde	No Effect
Trichlorethylene	Excellent
Ethyl Ether	Excellent
Furfural	Good
Methylene Chloride	Excellent
Mono Chlor Benzene	Good
Dioxane	Excellent
Methyl Ethyl Ketone	Excellent
Acid Dichromate	Fair
Hydrogen Peroxide	No Effect
Naphthalene	Excellent

b. Phenolic Resin Surface

Reagent	Rating
Hydrochloric Acid, 37%	No Effect
Sulfuric Acid, 33%	No Effect
Sulfuric Acid, 77%	Excellent
Sulfuric Acid, 96%	Failure
Formic Acid, 90%	No Effect
Nitric Acid, 20%	Good
Nitric Acid, 30%	Fair
Nitric Acid, 70%	Failure
Hydrofluoric Acid, 48%	No Effect
Phosphoric Acid, 85%	No Effect
Chromic Acid, 60%	No Effect
Acetic Acid, 98%	No Effect

3 & 8 Equal Parts	Fair
Ammonium Hydroxide, 28%	No Effect
Sodium Hydroxide, 10%	No Effect
Sodium Hydroxide, 20%	No Effect
Sodium Hydroxide, 40%	No Effect
Sodium Hydroxide Flake	No Effect
Sodium Sulfide	No Effect
Zinc Chloride	No Effect
Tincture of Iodine	No Effect
Silver Nitrate	No Effect
Methyl Alcohol	No Effect
Ethyl Alcohol	No Effect
Butyl Alcohol	No Effect
Benzene	No Effect
Xylene	No Effect
Toluene	No Effect
Gasoline	No Effect
Dichlor Acetic Acid	Excellent
Di Methyl Formamide	Excellent
Ethyl Acetate	No Effect
Amyl Acetate	No Effect
Acetone	No Effect
Chloroform	No Effect
Carbon Tetrachloride	No Effect
Phenol	No Effect
Cresol	No Effect
Formaldehyde	No Effect
Trichlorethylene	No Effect
Ethyl Ether	No Effect
Furfural	Fair
Methylene Chloride	No Effect
Mono Chlor Benzene	No Effect
Dioxane	No Effect
Methyl Ethyl Ketone	No Effect
Acid Dichromate	No Effect
Hydrogen Peroxide	No Effect
Naphthalene	No Effect
Perchloric Acid	No Effect

No effect other than slight discoloration when subjected for five minutes to a bunsen burner flame. Length of flame - four inches and a two inch inner core.

D. Design Criteria for Casework

1. Flush Construction: Surfaces of doors, drawers and panel faces shall align with cabinet fronts without overlap of case ends, top or bottom rails. Horizontal and vertical case shell members (panels, top rails and bottoms) shall meet in the same plane without overlap, cracks or crevices.
2. Slimline Styling: Maximum front width of end panels 3/4 inch and maximum front height of top and bottom members 1 inch.

3. Self-supporting Units: Completely welded shell assembly without applied panels at ends, backs or bottoms, so that cases can be used interchangeably or as a single, stand-alone unit.
4. Interior of Case Units: Easily cleanable, flush interior. Base cabinets, 30 inches and wider, with double swinging doors shall provide full access to complete interior without center vertical post.
5. Drawers: Sized on a modular basis for interchange to meet varying storage needs, and designed to be easily removable in field without the use of special tools.
6. Case Openings: Rabbeted-like joints all four sides of case opening for hinged doors and two sides for sliding doors in order to provide dust resistant case.
7. Framed Glazed Doors: Identical in construction, hardware and installation to solid panel doors. Design frame glazed doors to be removable for glass replacement.

E. Provide certified laboratory test results from a recognized testing laboratory verifying compliance with the previous listed criteria.

2.4 CASEWORK, GENERAL

A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."

B. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 METAL CASEWORK MATERIALS

A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

B. Nominal Metal Thickness:

1. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.048 inch. Except for flammable liquid storage cabinets, bottoms may be 0.036 inch if reinforced.
2. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.036 inch except 0.048 inch for back panels and doors of flammable liquid storage cabinets and for unreinforced shelves more than 36 inches long.
3. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.060 inch.
4. Drawer Runners, Sink Supports, and Hinge Reinforcements: 0.075 inch.
5. Leveling and Corner Gussets: 0.105 inch.

2.6 AUXILIARY CABINET MATERIALS

A. Acid Storage-Cabinet Lining: 1/4-inch-thick, polyethylene, polypropylene, epoxy, or phenolic-composite lining material.

B. Glass for Glazed Doors: Clear tempered glass complying with ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.7 CABINET HARDWARE

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches high or less and three for doors more than 48 inches high.

C. Hinged-Door and Drawer Pulls: stainless-steelback-mounted pulls. Provide two pulls for drawers more than 24 inches wide.

1. Design: Wire pulls
2. Overall Size: 1-1/4 by 4-1/2 inches .

D. Door Catches: Dual, self-aligning, permanent magnet catches. Provide two catches on doors more than 48 inches high.

E. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.

1. Provide Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
2. Provide Grade 1HD-200; for drawers more than 6 inches high or 24 inches wide.
3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-extension, ball-bearing type.

F. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and size of sliding-door units.

2.8 COUNTERTOP, TABLETOP AND SHELF MATERIALS

A. Epoxy: Factory-molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Durcon; a Wilsonart Company.
b. Prime Industries, Inc.

2. Physical Properties:

a. Flexural Strength: Not less than 10,000 psi.
b. Modulus of Elasticity: Not less than 2,000,000 psi.
c. Hardness (Rockwell M): Not less than 100.
d. Water Absorption (24 Hours): Not more than 0.02 percent.
e. Heat Distortion Point: Not less than 260 deg F.

3. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

    a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
    b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

4. Color: As selected by Architect from epoxy manufacturer's full range.

B. Phenolic Resin Composite: Phenolic Resin is constructed of saturated melamine resins and layers of phenolic impregnated kraft paper. The melamine resin produces a very durable thermoset plastic when combined with formaldehyde.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arborite.
    b. Formica Corporation.
    c. Nevamar; a Panolam Industries International, Inc. brand.
    d. Trespa North America.

2. Chemical Resistance: Composite countertop material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

    a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), ethyl acetate, ethyl alcohol, formaldehyde (37 percent), furfural, phosphoric acid (85 percent), sulfuric acid (33 percent) and toluene.

3. Color: As selected by Architect from phenolic-composite manufacturer's full range.

C. Stainless-Steel Sheet: ASTM A240/A240M, Type 316L.

2.9 METAL CABINETS AND TABLES

A. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt- and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.

B. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.

C. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.

D. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

E. Drawers: Fronts made from outer and inner pans that nest into box formation, without raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal.

F. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

G. Toe Space: Fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.

H. Tables: Welded tubing legs, not less than 2 inches square with channel stretchers as needed to comply with product standard. Weld or bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device welded to bottom of each leg.

1. Leg Shoes: Satin-finished, stainless-steel, open-bottom, slip-on type.

I. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

1. Provide base cabinets with removable backs for access to utility space.

J. Utility-Space Framing: Steel framing units consisting of two steel slotted channels complying with MFMA-4, not less than 1-5/8 inches square by 0.105-inch nominal thickness, that are connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch steel flat bars. Framing units may be made by welding channel material into rectangular frames instead of using U-shaped brackets.

K. Filler and Closure Panels: Provide where indicated and as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework and with hemmed or flanged edges unless otherwise indicated.

1. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed. Fabricate from back-to-back panels or of hollow construction to eliminate exposed hemmed or flanged edges.
2. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
3. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.10 LABORATORY CASEWORK SYSTEM

A. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular cabinets, filler and closure panels, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.

1. Cabinets can be removed and reinstalled without use of special tools for relocation within system.
2. Base cabinets can be removed without providing temporary support for, or removing, countertops.
3. Sinks are supported independent of base cabinets.
4. Support framing has provision for fastening pipe supports at utility space in not more than 1-inch increments.
5. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate panels from same material and with same finish as metal cabinets and with hemmed or flanged edges.

B. Support Framing: Casework manufacturer's standard system consisting of vertical supports and connecting braces and rails as follows:

1. Cabinets, shelves, and countertops are supported from vertical supports except where floor-supported. Vertical positioning of supported cabinets, shelves, and countertops can be varied in 1-inch increments through full height of supports.
2. Vertical supports rest on adjustable leveling bases and are secured to floor with metal clips fastened to floor.
3. Vertical supports are installed with braces and rails, connecting them to each other and to permanent building walls to create a stable, rigid structure with framed utility spaces where indicated.

C. Countertops: Provide in modular lengths indicated, without seams for epoxy and seamed to match the table sections for phenolic resin.

2.11 METAL CABINET FINISH

A. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.

B. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to organic coating to be applied over it.

C. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 M. Acceptance level for chemical spot test shall be no more than for Level 3 conditions.
2. Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.

2.12 COUNTERTOPS, TABLETOPSAND SHELVES

A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch.

B. Sinks, General: See Division 22 for Stainless Steel drop-in sinks.

C. Epoxy Countertops and Tabletops:

1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside 1/2 inch from overhang edge.

1) Edges and Corners: Beveled.
2) Backsplash: Applied.

b. Construction: Uniform throughout full thickness.
c. Product Alternate Option: Provide a separate cost for Phenolic-composite countertops as substituted for epoxy countertops.

2. Tabletop Fabrication:

a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside at perimeter.

1) Edges and Corners: Beveled.

b. Tabletop Construction: Uniform throughout full thickness.
c. Product Alternate Option: Provide a separate cost for Phenolic-composite tabletops as substituted for epoxy countertops.

D. Phenolic-Composite Countertops and Tabletops:

1. Countertop Fabrication: Fabricate with cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.

a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside 1/2 inch from overhang edge and integral coved backsplash.

1) Edges and Corners: Beveled.

2. Tabletop Fabrication:

a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside at perimeter.

1) Edges and Corners: Beveled.

E. Stainless-Steel Countertops: Made from stainless-steel sheet, not less than 0.062-inch nominal thickness, with No. 4 satin finish.

1. Extend top down 1 inch at edges with a 1/2-inch return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
2. Form backsplash coved to and integral with top surface.
3. Provide raised (marine) edge where indicated.
4. Pitch countertops that contain sinks two ways to sink without channeling or grooving.
5. Factory punch holes for service fittings.
6. Reinforce underside of countertop with channels, or use thicker metal sheet where necessary to ensure rigidity without deflection.
7. Weld shop-made joints.
8. Where field-made joints are required, provide hairline butt joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
9. Where stainless-steel sinks and cup sinks occur in stainless-steel countertops, factory weld into one integral unit.
10. After fabricating and welding, grind surfaces smooth and polish to produce uniform, directionally textured finish with no cross scratches or evidence of welds. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.

2.13 LABORATORY ACCESSORIES

A. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop, unless otherwise indicated.

B. Burette Rods: Stainless-steel rods, 1/2 inch in diameter and 18 inches long, threaded on 1 end to fit tapered plug adapter for flush socket receptacle. Provide with tapered plug adapter and receptacle.

C. Upright Rod Assembly and Metal Crossbar: Stainless steel. Two vertical rods and 1 horizontal crossbar, 3/4 inchin diameter and 36 inches long, unless otherwise indicated; 2 flush socket receptacles and 2 crossbar clamps. Ends of vertical rods are tapered to fit receptacles; all other rod ends are rounded.

D. Pegboards: Stainless-steel pegboards with removable polypropylene pegs and stainless-steel drip troughs with drain outlet.

2.14 WATER AND LABORATORY GAS SERVICE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Broen A/S.
2. Chicago Faucets; Geberit Company.
3. WaterSaver Faucet Co.

B. Service Fittings: Provide units that comply with SEFA 7, "Recommended Practices for Fixtures." Provide fittings complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items.

1. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.

C. Materials: Fabricated from cast or forged red brass unless otherwise indicated.

1. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.

D. Finish: Acid- and solvent-resistant powder coating complying with requirements in SEFA 7 for corrosion-resistant finishes.

1. Provide chemical-resistant powder coating in laboratory casework manufacturer's standard white, or other color as approved by Architect.

E. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 100 psig.

1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
3. Self-Closing Valves: Provide self-closing valves where indicated.

F. Ball Valves: Chrome-plated ball and PTFE seals. Handle requires no more than 5 lbf to operate. Provide units designed for working pressure up to 75 psig, with serrated outlets.

G. Ground-Key Cocks: Tapered core and handle of one-piece forged brass, ground and lapped, and held in place under constant spring pressure. Provide units designed for working pressure up to 40 psig, with serrated outlets.

H. Needle Valves: Provide units with renewable, self-centering, floating cones and renewable seats of stainless steel or Monel metal, with removable serrated outlets.

1. Provide units designed for working pressure up to 100 psig.

I. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."

J. Handles: Provide three- or four-wing, powder-coated-metal handles for valves unless otherwise indicated.

1. Provide lever-type handles for ground-key cocks. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
2. Provide lever-type handles for ball valves unless otherwise indicated. Lever handle aligns with outlet when valve is closed and is perpendicular to outlet when valve is fully open.
3. Provide heat-resistant plastic handles for steam valves.
4. Provide knurled, molded-plastic handles for needle valves.

K. Service-Outlet Identification: Provide color-coded plastic discs with embossed identification, secured to each service-fitting handle to be tamper resistant. Comply with SEFA 7 for colors and embossed identification.

2.15 ELECTRICAL AND COMMUNICATION SERVICE FITTINGS (See Division 26 and Division 27.)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of laboratory casework.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet
2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet
3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet
4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch
5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch

B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than 2 fasteners per side.

D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c.

E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.

B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Prepare edges in shop for field-made joints.

C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.

D. Provide required holes and cutouts for service fittings.

E. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

F. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.3.

B. Semiflush Installation of Stainless-Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.

B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.

C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 INSTALLATION OF SERVICE FITTINGS

A. Comply with requirements in Divisions 22 and 26 Sections for installing water and laboratory gas service fittings and electrical devices.

B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.7 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

3.8 SERVICE-FITTING SCHEDULE

A. Laboratory Sink, Type L-1: See Plumbing drawing P4.1.1

B. Water Faucet Service Fixture, Type WF-1:

1. Manufacturer Make & Model Number: Broan Hands Free Bench Mounted Standard Spout TMV #2601 004 2035-52 & 2603 011 2035Y
2. Type of Fitting: Remote-control, rigid, gooseneck, single-service faucet.
3. Outlet: Vacuum breaker and removable serrated outlet.
4. Mounting: Deck mounted.
5. Additional Requirements: N/A

C. Laboratory Gas Service Fitting, Type GF-1:

1. Manufacturer Make & Model Number: Broan 2598 or 2532 Series (depending upon installation type)
2. Service: Compressed Air, Vacuum, CO_2, Nitrogen and Helium.
3. Type of Fitting: Turret.
4. Outlets: Two, at 90 degrees.
5. Outlet Type: Straight.
6. Valve Type: Ground-key cock or Needle valve.

END OF SECTION 12 35 53

SECTION 13 21 26 - LABORATORY ENVIRONMENTAL ROOMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Furnish and install controlled environmental rooms complete with all equipment, controls and accessories required for specified operation and performance, coordinating with other trades as required to complete the specified work.

B. This Section includes the following:

1. Cold Rooms

C. Related Sections:

1. Division 08 Section "Access Doors and Frames" for access panels required to access condensing units.
2. Division 08 Section "Resinous Flooring" for cold room flooring.
3. Division 22 Sections “Plumbing.”
4. Division 23 Sections “HVAC.”
5. Division 26 Sections “Electrical.”

1.3 REFERENCE STANDARDS

A. Comply with all applicable codes, specifications and standards below, except where more stringent local codes may apply:

1. ASHRAE/ANSI: American Society of Heating, Refrigeration and Air Conditioning Engineers, Standard 15-1994 – Refrigeration Components, Safety and Use of Refrigerants.
2. NEC: National Electric Code.
3. NSF: National Sanitary Foundation Seal of Approval – Room Panels.
4. UL: Underwriters Laboratories, 508A – Industrial Control Panels.
5. UL: Underwriters Laboratories, 723 – Room Panel Flame Spread Ratings.
6. ARI: Unitary Air-Conditioning Equipment.
7. ARI: Air Source Unitary Heat Pump Equipment.
8. ARI: Sound Rating & Outdoor Unitary Equipment

1.4 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Environmental rooms constructed of pre-molded, modular panels. Each panel shall have dimensions to allow passage through normal doorways. Construction of panels shall allow for future expansion and easy disassembly for relocation. Rooms shall be complete with necessary controls, circulation systems, and mechanical and electrical equipment to meet these Specifications.
2. Where environmental rooms are designed with common connecting walls, provide each room with independent control, airflow, and mechanical systems.
3. Maintain noise levels in special purpose room enclosures during steady state control conditions below NC-65 curve over audible frequency range as measured by standard ASA methods when external ambient is 85 decibels or less.

B. Control and Performance:

1. Temperature Range:

a. Cold Room: 5 degrees C. Range: +/- 3 deg. C.

2. Temperature Control Stability: Plus or minus 0.3 degrees C.
3. Temperature Uniformity: Plus or minus 1.0 degrees C.
4. Temperature Gradient as measured between any two points in the room:

a. Cold Rooms: +/- 0.5 degrees C.

5. Relative Humidity Range:

a. Humidity: 35%; Range +/- 5%; as scheduled.

1.5 ACTION SUBMITTALS

A. Product Data: Manufacturer's Product Data indicating compliance with Contract Documents. Include manufacturer's installation instructions.

B. Shop Drawings:

1. Include rough-in, clearance and maintenance requirements.
2. Include plans, elevations, and details.
3. Indicate utility requirements and connections.
4. Include locations and layout of all condensing units.
5. Include control panels and monitoring.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual: Submit complete instruction and maintenance manual for each environmental room that includes sequential operating instructions, routine preventative maintenance instructions, and complete schematic drawings of rooms.

B. Warranty: Submit warranty certificate with operation and maintenance manuals for each environmental room.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firm that has produced environmental rooms for not less than 10 years, with not less than 50 similar projects that have been in successful use for not less than 5 years.

1. Performance and Payment Bond: Provide products from a manufacturer which has the capability to provide a Performance and Payment Bond for this Project.

B. Installer Qualifications: Minimum 10 years of experience in successful installation of systems of type specified.

C. Single Source Responsibility: Controlled environment rooms shall be designed, manufactured and installed by one supplier for single source responsibility.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1. Store in a weather tight location and protect from corrosive environments, distortion and other damage during delivery storage and handling.

1.9 WARRANTY

A. Provide manufacturer's written one-year warranty against defects. Manufacturer shall agree to repair or replace items proven to be defective.

1. The insulated panel portion of the structure is warranted free from defects under normal use and service for a period of 10 years from date of installation

B. Installing contractor shall monitor environmental/cold rooms for one year following start up and Owner acceptance.

1.10 COMMISSIONING

A. Commissioning of components, equipment and/or system specified in this division is part of the construction process. Documentation and testing of these components, equipment and/or system, as well as training of the Owner’s operation and maintenance personnel on these components, equipment and/or system, is required in cooperation with the Owner’s Representative and Commissioning Agent. Project Closeout is dependent on successful completion of all

commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13 – General Commissioning Requirements, for detailed commissioning requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Frost Environmental Rooms, Inc. TX. 832-593-9400.

B. Acceptable manufacturers pending compliance with specified requirements:

1. Thermmax Scientific Products. PA. 800-899-3774.
2. BioCold Environmental Inc., MD. 636-349-0300.
3. Bahnson Environmental Specialties, LLC, Raleigh, NC 919-829-9300.
4. Darwin Chambers Company, LLC, St. Louis, MO 877-783-6774.
5. Bally Refrigerated Boxes, Morehead City, NC; 1-800-24BALLY
6. R.W. Smith & Co. / Controlled Environment Rooms (800-942-1101).

2.2 MANUFACTURED UNITS

A. General: Pre-fabricated walk-in rooms, metal clad, sectionals constructed and designed for accurate field assembly with provisions to facilitate disassembly for relocation and to add extra panels to increase size.

B. Panel Construction:

1. Interchangeable panels, UL approved, designed for quick assembly, consisting of interior and exterior metal pans accurately formed with metal dies and checked with gauges for uniformity.
2. Panels shall be insulated with 100% urethane without internal wood, wood fiber, fillers, steel or substructure.
3. Panel Edges: Tongue and groove interfaces to assure a tight joint. Provide flexible vinyl gasket on interior and exterior of each panel along each tongue edge to provide sealing at each joint.

    a. Do not use batten strips, pressure clips, or other fastening hardware for covering joints or joining panel sections.

C. Panel Locking Devices: Self-contained, interior cam-lock fasteners locked and released with single hex wrench tool.

D. Insulation: 4 inch (102 mm) foamed-in-place urethane insulation, using EPA Montreal Protocol accepted non-toxic, non-flammable fluorocarbon blowing agents, adhered to interior and exterior faces of panels. The resulting cured foam shall be an odorless closed-cell product and shall not emit or outgas the fluorocarbon blowing agent.

1. Thermal Conductivity Factor K: No more than 0.14 BTU per hour per square foot between wall faces.

2. R-Value: Panels and doors must meet or exceed minimum R-Values for cooler (R-25) and Freezer (R-32) when tested per ASTM C518 per Federal Regulation 431.304.
3. Flame Spread Rating: 25 or lower and smoke generation of 450 or lower when tested in accordance with ASTME-84.25.

E. Partition Walls: Insulated, 4" thick metal clad panels shall be provided to form separate compartments within the Walk-In. A non-conductor strip must be built into all exterior panels at the joints where partitions butt to prevent transfer of heat from one compartment to another. Partition panels shall be locked to these panels.

F. Closure Panels: Provide closure panels, matching materials, colors, and finishes of adjacent panel material, to fill in between building and environmental room.

G. Doors: Number of doors, location and direction of swing shall be specified in the Walk-In layout.

1. Doors are in-fitting and flush-mounted, and conform to the same standards as vertical panels.
2. Magnetic core, thermoplastic gaskets installed on the top edge and both sides of the door shall keep the door in a closed position, forming a tight seal; a flexible, dual blade wiper gasket shall be installed at the bottom of the door.
3. NSF Certified gaskets shall be replaceable and resistant to damage from oil, fats, water and detergent.
4. A heavy U-channel structural steel frame around the perimeter of the door opening shall prevent racking or twisting; steel frame is to be reinforced for hardware attachment.

H. Door Hardware: Heavy-duty door hardware with high luster finish. Incorporate keyed lock cylinders and latches into door latch and handle assemblies.

1. Hinges: Self-closing type with durable stainless-steel pins and self-closing nylon cams.
2. Door Handle and Latch Assembly: Automatic closing type. Provide safety release mechanism on inside of room preventing personnel from being locked from outside.

    a. For swing doors with 42" wide opening: two spring-loaded, cam-lift, self-closing hinges; cylinder latch with provision for padlocking and safety release mechanism; door closer.

3. Kick Plates: Provide diamond-plate kick panels covering the bottom 30" on interior and exterior.
4. Sliding Door Hardware: Self closing to accommodate weight of door.

I. Heated Gasket: Low voltage heater built into perimeter of jamb and door threshold to prevent door from accumulating ice and freezing temperatures.

1. Anti-condensate heater wire shall be concealed behind the metal edge of the doorjambs

J. Observation Window in Entrance Door: a heated observation window shall be provided in the entrance door.

1. Window to consist of three panes of glass with either heat reflective treated glass or Argon gas filled.
2. 14" x 14" windows to be used on standard doors (30" to 42" wide).

3. Window heat system shall be controlled by a thermostat to minimize energy consumption.

K. Floor: Exposed concrete with seamless epoxy flooring.

2.3 ROOM SURFACE FINISH

A. Standard Finishes: Where scheduled, provide panel sections with the following surface finishes:

1. Interior and Exterior Wall Panel Finish: 0.040 inch (1 mm) thick, Stucco embossed white aluminum finish.

2.4 LIGHTING

A. Lighting Systems: Vapor-proof LED lighting.

1. Provide UL-approved fixtures.
2. Mount light fixtures mounted and provide in sufficient quantity for minimum intensities of 50 foot-candles measured 36 inches (1016 mm) above floor.
3. Install lights to provide uniform distribution of light.
4. Install occupancy sensors to turn off lights when not in use.

B. Low Temperature Electronic Ballasts: Provide low temperature for cold rooms operating between 8 degrees C and -35 degrees C.

2.5 INSTRUMENTS AND CONTROL SYSTEMS

A. CONTROL PANEL SYSTEM: Touch Screen Control System: A surface Mounted Control Console will be provided using an Allen Bradley MicroLogix 1400 PLC and Fuji MoniTouch, touch screen (HMI) or approved equal.

1. The full color, six-inch Touch Screen will provide all On/Off equipment controls, Temperature set point and display, High/Low temperature Alarms, data logging and interface for remote computer recording and monitoring via Ethernet connection. Temperature is measured with a 100 Ohm Platinum RTD sensor.
2. A minimum of 90 days of data will be stored in the data logger.
3. The Operator Interface will be recessed in a Control Console with a clear acrylic lockable door to protect tampering. All touch screen access including set points, alarm settings, and system operation is password protected.
4. In the event of an Alarm condition, a local audible buzzer will activate until reset. All alarms are logged and the last ten (10) Alarm conditions can be displayed on the Touch Screen. Isolated dry relay contacts are provided for connection to the BAS.
5. The Environmental Cold Room is furnished with a High Temperature Failsafe. This Over-temperature safety cutout device is designed to protect the environmental room from thermal damage. This is an adjustable device but always set for maximum value of 55 degrees C (131 degrees F). When actuated, all heat producing components including circulation fans, lights, receptacles and heaters become electrically deactivated.

6. Sensors will be precision, platinum, resistance temperature devices (RTD). The controller output is a true proportional 4-20 mA signal from the PLC which drives a proportional valve in the suction line of each refrigeration system.
7. High and Low Temperature Alarms will be provided with dual set points, one for HIGH and one for Low.
8. Analog signals are also provided for remote monitoring of Temperature and Humidity at the Building System.
9. Separate independent C-contact sets are provided for connections to the building alarm system (BAS) to activating a remote alarm in the event of over/under temperature condition.

B. The following items will be readily operated:

1. Control function to adjust temperature set point (°C).
2. Control function to adjust Relative Humidity set point (% RH) (when specified).
3. Alarm Set points for high and low temperature and/or Relative Humidity.
4. Data recording mode to indicate in chart recorder format temperature and humidity history over the 8 hours or 24-hour period.
5. Data download connector to interface with operator's standard windows based PC. Data can be archived and printed using manufacturer's provided software package. Alarm events shall also be logged.
6. Touch Screen buttons to perform the functions:

    a. Refrigeration on/off
    b. Heat on/off
    c. Ventilation on/off
    d. Dehumidification on/off
    e. Defrost on/off

7. The panel shall clearly indicate when the above operating functions are on.

C. Room control parameter adjustments such as PID values, defrost times and frequencies shall be adjustable only by using password security access. Set Points and other basic operator functions are also only available by password access. Three levels of access security are provided. These adjustments once accessed shall not require special computer equipment or factory personnel to change.

D. All settings will be stored in non-volatile memory so that all information, adjustable parameters, and control programs are not lost on power failure.

E. Recorder: Synchronous motor driven circular chart recorder provided to continuously indicate control conditions within room.

1. Microprocessor-type, analog, programmable to achieve proper parameter ranges and time bases.
2. Chart Recorder, Model DR4300 10 inch Circular Chart Recorder by Honeywell, Inc. or equal.

F. Computer Interface: Digital computer communication interfaces designed to enable user to monitor and record process variables. Format: RS485 formats.

2.6 CONDITIONING PLENUMS

A. Ceiling Conditioning Plenum:

1. Design environmental room air to be completely conditioned in ceiling plenum, with motor-driven blowers designed to recirculate air continuously to ensure temperature uniformity.
2. Plenum Housing shall be fabricated with metal finishes to match the Room Interior Color.
3. Provide open ceiling plenums containing heaters, copper tube with aluminum finned evaporator coil, humidification apparatus, and condensate drain pan.
4. Ceiling plenums shall be low profile and have dual horizontal air flow to evenly distribute recirculation air through the working space of the room. Air flow velocities from the plenum shall not exceed 450 feet per minute.
5. Components shall be easily accessible from inside the room to service fan motors, heaters, control valves and sensor components.
6. Motors: Fractional horsepower, high-efficiency PSC type, serviceable from inside environmental room.

B. Dehumidification:

1. Moisture removal accomplished by means of specially designed, direct expansion refrigeration coil located in conditioning plenum.
2. Design coil for effective latent heat removal with minimum removal of sensible heat.
3. Provide non-freezing dehumidification system that produces low humidity condition limited by dew point of 6 degrees C.

C. Sealants: Silicone silastic sealing compound, flexible when cured to allow for thermal contraction and expansion over its entire environmental range.

2.7 REFRIGERATION SYSTEMS

A. Design Requirements:

1. The environmental room design and installation shall conform to applicable codes, ordinances and regulations governing the use and safety of refrigerants including, but not be limited to, ASHRAE/ANSI standard 15, ARI 420-77, ARI 520-78.
2. Condensing Unit: Semi-hermetic serviceable compressor, spring mounted and located on top of chamber roof; or in mechanical room, as shown on drawings; in an accessible location. System shall be designed to operate continuously using a hot gas bypass system control. Cycling compressor systems and electric reheat systems are not acceptable.
3. Equip each condensing unit as follows:

    a. High/low pressure control with automatic reset.
    b. Vibration eliminating devices on suction and discharge lines.
    c. Fusible plug.
    d. Liquid line dryer.
    e. Moisture indicating sight glass.
    f. Suction line filter.
    g. Magnetic contactor on all three phase units.

h. Accessories including isolation mountings and racks, expansion valve, interconnecting piping, piping insulation, solenoid valves, fused disconnect switch or circuit breaker, motor starter and all necessary equipment to achieve the specified performance for each room.
i. All other safety mechanical devices required.
j. Select refrigerant to give optimum operation considering evaporating and condensing temperatures. Refrigerant shall conform to latest protocol concerning its use based on ozone depletion potential.
k. Water cooled condensers shall be manufactured and be properly matched to compressors determined by condensing unit manufacturer.
l. Condensing units shall be designed, engineered, manufactured and of adequate capacity to fulfill operating temperature requirements and performance, and shall be balanced with the air handling system in operation.
m. Electrical Requirements: 208V/3 phase/3 wire power for each condensing unit.

4. Refrigeration Piping: ASTM B 280, ACR type, hard drawn, cleaned and capped Type L copper tubing soldered with silver brazed joints (AWS A5.8). All lines shall be installed to allow for linear expansion of copper after start-up.

a. Suction Lines: Size for velocity of 500-700 FPM on horizontal runs and show a slight pitch toward condensing unit. When condensing unit is located below evaporator and there is no possibility of trapping oil, size vertical runs same as horizontal runs. When condensing unit is located above evaporator, size vertical runs for velocity of 1,000-1,500 FPM and install proper (shallow) "P" traps spaced not over 10 feet apart on all tubing risers.
b. Hot Gas Lines: When hot gas lines are field installed remote from compressor, size tubing at same velocities as specified above for suction lines.
c. Liquid Lines: Size all liquid lines for maximum 2 PSIG pressure drop.
d. Hangers: F & M ring type or Unistrut assemblies with appropriate tubing Hydrosorb clamps to support liquid, suction, and discharge lines individually. Space hangers or clamps 8 feet o.c. maximum.
e. Condensate Drain Piping: 7/8 inch O.D., or greater, Type L copper tubing piped from evaporators to open floor drain or nearest sink, rigidly supported at walls 3 feet o.c. maximum, installed in such a manner that leaves 1 inch clearance space between wall and drain, and equipped with cleanout tee near evaporator. Adequately pitch piping toward floor drain or sink, carry through wall of refrigerated areas properly trapped and discharged within 2 feet of floor drain.
f. Heat Tracing: Heat Trace drain lines within freezer rooms. Refer to Specification Section 23 05 33.
g. Refrigerant Testing: Pressurize and leak test entire system at not less than 100 PSIG, clean and dehydrate by maintaining a vacuum of 500 microns or lower for a five hour period.
h. Add required charge of refrigerant, and oil if necessary, and test entire system for performance using an electronic lead detector for presence of refrigeration leaks. Mark each system clearly as to refrigerant type used.

5. Refrigerant: R-404a. Do not use refrigerants containing CFC or HCFC. Alternate refrigerants will be acceptable provided they are not CFC or HCFC based.
6. Insulation: Refer to Specification 23 07 00.

B. System Capacity: Provide refrigeration system specifically designed, engineered, and manufactured of adequate capacities to achieve and maintain individual room temperature and performance requirements noted in Part 1. Provide system balanced in operation with conditioning system.

1. Interior building ambient conditions ranging from 72 – 75 degrees F. and 30 – 50 % relative humidity.
2. Door Openings: Personnel entering and leaving environmental chamber at a rate of six (6) per hour.
3. Include heat gain from lighting in load calculations.
4. Provide factory-assembled and tested system by manufacturer. Include high/ low-pressure controls, receiver, sight glass, moisture indicator, replaceable dryer, thermal expansion valve, and necessary equipment to achieve specified performance.

C. Compressors: Semi-hermetic or Scroll, heavy-duty, industrial unit with solid-state motor protection and oil pressure safety control. Provide compressor with oil sight glass, lubrication protection cutout, and integral suction and discharge service valves.

D. Water-Cooled Condenser: Provide system with water-cooled condenser units for placement inside of the building. Provide 2-position automatic isolation valve wired to open when condenser is operating.

E. Control: Design refrigeration system to contain full capacity control to operate continuously regardless of control system demand.

1. Incorporate bypass to maintain specified temperature ranges. Proportionally control cooling by means of electronic temperature controller modulating liquid refrigerant feed to conditioning coil.

F. Redundant Refrigeration System: 100 percent backup redundant refrigeration system designed to work in conjunction with passive system. These two (2) systems will periodically rotate operation on an adjustable cycle timer to assure that both systems are given equal running time and are periodically tested to be functional. On failure, passive system will automatically come on line to maintain room temperature. Failure mode alarm will be activated and backup system will then run continuously until fault is cleared.

G. Defrost System: When room temperatures operate continuously below 4 degrees C (39 degrees F), automatic hot gas defrost system will be employed.

1. Defrost Cycles: Controlled by 24-hour timer adjustable to determine number of defrosts per day, and duration of each defrost.
2. Electric Defrost System: On freezer rooms operating at minus 20 degrees C (minus 4 degrees F) or below and on rooms with remote condensers an electric defrost system will be used in lieu of hot gas system.

2.8 ELECTRICAL

A. All electrical components utilized within each room shall be UL approved with interior wiring practices in accordance with UL and the National Electric Code. All electrical runs shall be out of sight from the interior of the chamber, whenever possible, either on top of the box or foamed

within the walls. Conductors to conform to Article 310 of the National Electric Code and all motors, motor circuits and controllers shall conform to Article 430 of the National Electrical Code.

B. The Contractor shall provide power to all condensing units and to the control panel. The Environmental Room electrical contractor will provide all control and high voltage wiring from the control panel to all other components as required to make the environmental room function as specified.

C. Circuit Breakers: Complete breaker protection for lights, receptacles, controls, condensing units, etc., shall be provided. All circuits at rooms shall be protected by circuit breakers of proper amperage rating (common fuses will not be accepted). An individual circuit breaker type disconnect shall be provided at each condensing unit in addition to other breakers. Each room and controls shall operate from a separate 120/208 volt, 3-phase, 4-wire feeder and each condensing unit shall operate from a separate 208 volt, 3-phase, 3-wire feeder.

D. Vapor-proof, duplex, 115-volt, 20 amp GFI receptacles flush mounted on inside wall 45 inches above floor. Wire each receptacle to terminal box on top of room for connection by others.

E. Pre-wire: Rooms shall be pre-wired and shall require a maximum of two power connections:

1. 460V - 3 Phase - 20 Amp for the condensing unit.
2. 120/208V - 3 Phase - 40 Amp for the control console (Room power to evap-fans, lighting, door heat, fan powered HEPA filters and controls).
3. Control wiring and conduit between the control console and the room equipment and lighting shall be by the room supplier.

2.9 FIRE PROTECTION

A. UL listed and FM approved dry pendent sprinkler heads to be provided in all environmental rooms by Division 21.

B. Penetrations of environmental room ceiling for sprinkler head locations to be provided by environmental room manufacturer and to be coordinated with Division 21 Contractor.

2.10 SOURCE QUALITY CONTROL

A. Manufacturer shall perform factory test and inspection on major components to assure basic quality, conformance of design, and functional operation.

B. Each control console shall be bench tested using simulator panel to test logic functions, control systems function, and alarm operations.

C. Each condensing unit and air unit shall be pressure tested for leaks and checked for design conformance.

D. Notify Owner of testing time a minimum of 72 hours in advance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are acceptable to tolerances.

B. Verify construction of substrates, building walls, and floors are in place and ready to receive Work of this Section.

C. Start of installation indicates installer's acceptance of substrate and conditions.

3.2 PREPARATION

A. Verify the following is in place prior to installation:

1. Area is completely ready for proper and efficient installation of environmental rooms, floor is flat and level, area is clear of partitions, piping, obstructions, and loose articles preventing erection and assembly of environmental rooms and support equipment.
2. Electrical service to area of Work of this Section, including fused disconnect is in place.
3. Floor drains, condensate removal pump system, or both are installed to remove room drainage.
4. Water supply and return line, if required, are installed and final connections made.
5. Other special utilities and service connections are in place.
6. Building wall, roof, or floor penetrations are completed.

3.3 INSTALLATION

A. Install environment rooms per manufacturer's recommendations and final approved Shop Drawings.

1. Install components straight, plumb, level and true. Install service lines at right angles to walls and floors, except where required to pitch to drains. Ensure that proper access is maintained to all accessible components and devices.
2. Seal or otherwise insure that fastenings to rooms do not compromise vapor barriers or insulation. Seal between piping and sleeves.
3. Do not install damaged units. Replace components damaged during shipping, handling, or installation with new identical factory-supplied components.

B. Pressurize and leak test entire system at not less than 100 psig. Clean and dehydrate by maintaining a vacuum of 500 microns, or lower, for a 5-hour period. Add required charge or refrigerant, and oil if necessary, and test entire system for performance. Mark each system clearly as to refrigerant type used and amount of charge.

C. Install condensate piping and extend to floor drain located on the outside and adjacent to the chamber. Condensate piping shall be insulated to the drain.

D. Install filler panels to enclose spaces between top of walk-in room and finished ceiling and sides of unit and construction of surrounding area.

E. Install shelving per manufacturer's instructions, with adjustable shelf heights as indicated on Drawings.

F. Mechanical and Electrical:

G. Mount equipment securely with vibration isolation for as required.

H. Prior to installation the architect shall review placement of any exposed pipe and conduit.

I. Install condensate drain line to evaporator coil drain pan and route through wall panel for routing/ connection to building waste receptacle.

J. a. Paint exposed condensate piping with white enamel.

K. Install electrical wiring from control console to all control and electrical components.

L. Charge refrigeration system per manufacturer's written recommendations.

M. Penetrations into room shall be properly sealed with silicone caulk. Provide escutcheon plates at visible locations.

N. Provide and seal penetrations in insulated roof of controlled environment rooms for fire sprinkler piping installation. Sprinkler piping shall be by others.

3.4 FIELD QUALITY CONTROL

A. Measure temperature accuracy and uniformity inside completed room using 15 Temperature Escort (or equal) Data Loggers. Place pods throughout internal workspace at strategic locations no closer than 12 inches (305 mm) from surfaces.

1. The data loggers will remain in the test space for 24 hours. When test is complete the temperature data loggers are downloaded into a PC computer. Data is formatted in an Excel Format to provide tabular and graphical results of uniformity and stability. Test Reports will be turned over to owner.

B. Refrigerant Piping Pressure Test:

1. Pressure test refrigeration piping with dry nitrogen to a gauge pressure of minimum 150 psi. When inaccessible remote piping is required, provide testing prior to gyp-bd. Installation.
2. When pressure test is completed and system found to be tight and free of leaks, release pressure to the atmosphere and evacuate.
3. Evacuate system(s) by vacuum to less than 350 microns for a minimum of two hours.
4. Break the vacuum with system refrigerant and proceed with charge and testing.

C. Certification and Testing:

1. Acceptance testing shall consist of sustained operation at design temperature condition for a minimum period of 48 hours. Furnish recorder charts to the Architect. Indicate time(s)

Lead/Lag systems switched assignments. Acceptance shall be conditioned upon successful completion of the acceptance test, as witnessed by the Owner's Representative.

2. Controlled environment room supplier to conduct a demonstration for designated Owner's Representatives. Demonstration is to include proper room operation and maintenance.
3. Provide written certification that room performance complies with specified criteria and applicable standards.

D. Owner's representatives shall be given option of witnessing and confirming test results. Notify Owner's representative in writing, 72 hours prior to test.

3.5 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to completion of performance tests, provide manufacturer's representative to conduct demonstration for designated Owner’s personnel with respect to room's controls and related systems. Manufacturer's representative will inform Owner’s personnel of proper room operation and maintenance. Notify Owner at least 72 hours in advance to permit Owner’s authorized representative to schedule such an instruction period.

3.6 CLEANING AND PROTECTION

A. Repair or remove and replace defective Work, equipment, and accessories as directed upon completion of installation. Remove and refinish damaged or soiled areas.

B. Clean exposed and semi-exposed surfaces, touch-up finish as required. Remove cartons and debris from the Work site and legally dispose of the same. Leave Work area in a clean condition.

C. Protection: Adequately protect the Work from damage until final acceptance by the Owner.

END OF SECTION 13 21 26

SECTION 14 21 23.16 - MACHINE-ROOM-LESS ELECTRIC TRACTION PASSENGER ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Machine-room-less electric traction passenger elevators.

B. Related Requirements:

1. Division 01 Section "Summary" for purchase contract for elevators negotiated by Owner and assigned to Contractor.
2. Division 01 Section "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Division 03 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Division 05 Section "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.

5. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Divider beams.
    c. Hoist beams.
    d. Structural-steel shapes for subsills.
    e. Pit ladders.
    f. Cants made from steel sheet in hoistways.
    g. Railings between adjacent elevator pits.

6. Division 09 painting Sections for field painting of hoistway entrance doors and frames.
7. Division 26 Sections for electrical service for elevators to and including disconnect switches at machine room door and standby power source, transfer switch, and connection from auxiliary contacts in transfer switch to controller and connection from auxiliary

contacts in disconnect switch in machine room to controller for shut down of variable speed drive.

8. Division 27 Section "Communications Horizontal Cabling" for telephone service for elevators.
9. Division 28 Section "Fire Detection and Alarm" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.3 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

B. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
2. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.

B. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station and standby power operation control panel.
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples for Initial Selection: For each type of exposed finish involving color selection.

D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch-square Samples of sheet materials; and 4-inch lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway and pit layout and dimensions, as indicated on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44 including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard two-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, a "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways and pits.

C. Short Circuit Current Ratings (SCCR) for Equipment

1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the HVAC equipment shall be equal to or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

Equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.

All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned ‘Resubmit’ or ‘Rejected’.

No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual

deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

2. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Fujitec America, Inc.
2. KONE Inc.
3. Mitsubishi Electric Corporation.
4. Otis Elevator Co.
5. Schindler Elevator Corp.
6. ThyssenKrupp Elevator.

B. Source Limitations: Obtain elevator components from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and the information provided on the drawings and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Project Seismic Design Category: D.
3. Elevator Component Importance Factor: 1.0.
4. Design earthquake spectral response acceleration short period (Sds) for Project is 0.0509.
5. Provide earthquake equipment required by ASME A17.1/CSA B44.
6. Provide seismic switch required by ASCE/SEI 7.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Elevator Number(s): 1.
2. Rated Load: 3500 lb.
3. Rated Speed: 150 fpm.
4. Operation System: Selective-collective automatic operation.
5. Auxiliary Operations:

    a. Standby power operation.
    b. Standby-powered lowering.
    c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
    d. Nuisance-call cancel.
    e. Distributed parking.
    f. Off-peak operation.
    g. Automatic operation of lights and ventilation fans.
    h. Independent service for one car in group.

6. Car Enclosures:

    a. Inside Width: Not less than 80 inches from side wall to side wall.
    b. Inside Depth: Not less than 64-1/2 inches from back wall to front wall (return panels).
    c. Inside Height: Not less than 93 inches to underside of ceiling.
    d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/480M, No. 4 finish.
    e. Car Fixtures: Satin stainless steel, ASTM A480/480M, No. 4 finish.
    f. Side and Rear Wall Panels: Satin stainless steel, ASTM A480/480M, No. 4 finish.
    g. Reveals: Satin stainless steel, ASTM A480/480M, No. 4 finish.
    h. Door Faces (Interior): Satin stainless steel, ASTM A480/480M, No. 4 finish.
    i. Door Sills: Nickel silver.
    j. Ceiling: Manufacturer’s Standard.
    k. Handrails: 1/2 by 2 inches rectangular, at sides and rear of car.
    l. Floor: Resilient Sheet Flooring.
    m. Floor prepared to receive resilient flooring (specified in Division 09 Section "Resilient Sheet Flooring").

7. Hoistway Entrances:

    a. Width: 42 inches.
    b. Height: 84 inches.
    c. Type: Single-speed side sliding.
    d. Frames: Satin stainless steel, ASTM A480/480M, No. 4 finish.
    e. Doors: Satin stainless steel, ASTM A480/480M, No. 4 finish.
    f. Sills: Nickel silver.

8. Hall Fixtures: Manufacturer’s Standard.
9. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, ASTM A480/480M, No. 4 finish.
    b. Provide hooks for protective pads complete set of full-height protective pads.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Permanent magnet, variable-voltage, variable-frequency, ac-type hoisting machines and solid-state power converters.

1. Provide nonregenerative system.

B. Fluid for Hydraulic Buffers: Fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Division 05 Section "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: Roller guides or polymer-coated, nonlubricated sliding guides. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Auxiliary Operations:

1. Single-Car Standby Power Operation: On activation of standby power, car is returned to first floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at Resilient Sheet Flooring Manual operation causes automatic operation to cease.
2. Single-Car Standby-Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
3. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.
4. Independent Service: Keyswitch in car-control station removes car from operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is

in independent service. When in independent service, doors close only in response to door close button.

5. Emergency Hospital Service: Service is initiated by a keyswitch at designated floors. If retaining "Security features" Paragraph below, indicate in "Elevators" Article which elevators require security features.

6. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound, and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. Provide enameled or powder-coated steel car enclosures to receive removable wall panels, with removable car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor:

a. Exterior, underlayment grade plywood, not less than 7/8-inch nominal thickness.

2. Floor Finish:

a. Specified in Division 09 "Resilient Sheet Flooring"

3. Stainless Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.
4. Fabricate car with recesses and cutouts for signal equipment.
5. Fabricate car door frame integrally with front wall of car.
6. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet.
7. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
8. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
9. Light Fixture Efficiency: Not less than 35 lumens/W.

10. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.

1. Fire-Protection Rating: 1 hour with 30-minute temperature rise of 450 deg F.

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Provide with factory-applied, rust-resistant primer or powder-coating for field painting.
2. Steel Subframes: Formed from cold- or hot-rolled steel sheet, with factory-applied enamel or powder-coat finish or rust-resistant primer. Fabricate to receive applied finish as indicated.
3. Stainless Steel Frames: Formed from stainless steel sheet.
4. Stainless Steel Doors: Flush, hollow-metal construction; fabricated from stainless steel sheet.
5. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
6. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

2.9 SIGNAL EQUIPMENT

A. Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide buttons and lighted elements illuminated with LEDs.

B. Car-Control Stations: Provide manufacturer's standard semirecessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Addressable Fire-Alarm Systems."

F. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

G. Hall Push-Button Stations: Provide one hall push-button station at each landing.

1. Provide manufacturer's standard wall-mounted units.
2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
3. Possibly insert a provision for either an "In Use" signal or a digital display of car position for single elevators.
4. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section "Addressable Fire-Alarm Systems."

H. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
2. Integrate ground-floor hall lanterns with hall position indicators.

I. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

J. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.

K. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, commercial steel, Type B, exposed, matte finish.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, commercial steel, Type B, pickled.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304.

D. Stainless Steel Bars: ASTM A276, Type 304.

E. Stainless Steel Tubing: ASTM A554, Grade MT 304.

F. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500 or UNS No. C77600.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, and pits as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and

doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.

G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

B. Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

B. Check operation of elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance during normal working hours.
2. Perform emergency callback service during normal working hours with response time of two hours or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

END OF SECTION 14 21 23.16

SECTION 22 05 00 – COMMON MATERIALS AND METHODS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section is intended to describe the common materials and installation methods of the mechanical work and it applies in general to all other Sections under Division 22.

B. Due to the small scale of the drawings, all work required is not shown on the floor plans and certain work is shown on flow diagrams, riser diagrams and details. Work of Division 22 shall include all required work shown on plans, riser diagrams, flow diagrams and details.

C. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems
2. Transition fittings
3. Dielectric fittings
4. Mechanical sleeve seals
5. Sleeves
6. Escutcheons
7. Grout
8. Equipment installation requirements common to equipment sections
9. Painting and finishing
10. Concrete bases
11. Hangers and supports for plumbing system piping and equipment
12. Identification for plumbing piping and equipment

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 REFERENCES

A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:

1. ASME/ANSI B31: Code for Pressure Piping
2. ASME Boiler and Pressure Vessel Codes
3. AWS D1.1: Structural Welding Code-Steel
4. MSS SP58: Pipe Hangers and Supports – Materials, Design, and Manufacturers
5. MSS SP69: Pipe Hangers and Supports – Selection and Application except spacing for hangers
6. ANSI A13.1: Scheme for Identification of Piping Systems
7. Applicable NFPA Codes and Standards
8. NSF/ANSI 61: Drinking Water System Components

1.5 SUBMITTALS

A. Provide Product List of factory fabricated items, in accordance with Section 01 60 00 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 22.

B. Provide submittals in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.

C. Product Data: Provide for each type of factory-fabricated product indicated.

D. Welding certificates.

E. Brazing certificates.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Comply with warranty and contract closeout requirements specified in Division 01.

B. Provide Special Warranties and/or warranty service in accordance with Section 01 60 00 “Product Requirements” where specified in the various sections of Division 22.

C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 22.

D. Provide testing and cleaning reports. Indicate dates of testing and cleaning operations, procedures used and results obtained for each system. Reports shall be certified as complete.

E. Provide instructions and demonstration to the Owner’s representatives for all equipment and systems installed under Division 22. Instruction and demonstration shall be appropriate for the size and complexity of the installed system.

F. Include information for all products specified in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Use welders fully qualified and licensed by the state authorities.

C. Laboratory compressed gas brazers and installers shall be certified in accordance with Section IX, “Welding and Brazing Requirements” of ASME Boiler and Pressure Vessel Code or AWS B2.2 for, “Standard for Bracing Procedure and Performance Qualification” and/or ASSE 6010 Medical Gas System Installers Professional Qualification Standards 2018.

D. The specifications for certain products and alternative materials may appear in more than one section of Division 22. Work of Division 22 shall be coordinated for all sections of Division 22 to assure that where two or more items of any given product are furnished under Division 22 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 22.

E. Except for spacing of hangers, provide hangers and supports in accordance with the latest issue of Manufacturer’s Standardization Society (MSS) Specifications SP 58 and 69.

F. All pipe, valves, fittings, stops, faucets, and domestic water pumps shall comply with the Federal "Reduction of Lead in Drinking Water Act" NSF/ANSI 61 and NSF/ANSI 372 for lead content of 0.25%.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle all material and equipment in accordance with manufacturer’s instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and

moisture. If end caps are missing, contractor shall provide temporary pipe caps during storage, prior to installation.

C. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. The Mechanical systems are indicated on the Plumbing Drawings. Certain pertinent information and details involving the installation of plumbing work appear on Architectural, Structural, Mechanical and Electrical Drawings. Become familiar with all Drawings and incorporate all pertinent requirements.

B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the plumbing work. Do not scale the Drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.

C. Arrange for pipe spaces, chases, slots, duct shafts and openings in building structure during progress of construction, to allow for plumbing installations.

D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

E. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Coordinate installation of identification labels with locations of access panels and doors.

F. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.

G. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.

H. Install identification devices prior to installation of ceilings and similar concealment.

1.10 SEISMIC REQUIREMENTS

A. Seismic Design

1. All new plumbing systems (equipment and piping) shall be provided with seismic restraints in accordance with the requirements of the 2009 International Building Code, and Division 22 Section “Vibration Isolation and Seismic Restraints for Plumbing Systems”.
2. Refer to Structural Drawings or Division 01 for seismic criteria to be used for this project.
3. Use a component Importance Factor, I_p, of 1.5 for all life safety systems required to function during and after an earthquake; including, but not limited to:

a. Laboratory compressed gas systems
b. Laboratory utility systems

4. Use a component Importance Factor, I_p, of 1.5 for all components that contain hazardous material including, but not limited to:

    a. Laboratory compressed gas systems
    b. Natural gas or propane piping systems
    c. Biohazard waste piping systems (decontamination drainage piping from BSL-3 laboratory to decontamination holding stank).

5. Use a component Importance Factor, I_p, of 1.5 for all systems and components required for continuous operation of the facility or whose failure could impair the continued operation of the building, including:

    a. Piping
    b. Suspended equipment

6. Except as noted otherwise herein, use an Importance Factor, I_p, of 1.0 for all other components.
7. Employ a Professional Engineer registered in the jurisdiction for which the project is located to design all restraints necessary to meet the seismic requirements. Said Engineer shall sign and seal all drawings and calculations prepared for this purpose.
8. Prior to first Application for Payment, provide a complete listing of all components and elements that are to be seismically restrained and/or braced.
9. It is the entire responsibility of the equipment manufacturer to design their equipment so that the strength and anchorage of the components of the equipment exceeds the force level used to restrain and anchor equipment itself to the supporting structure. Factory manufactured and/or field or shop fabricated equipment shall be designed to safely accept and resist, at its points of anchorage or suspension without failure or permanent displacement of the equipment, earthquake generated external forces required by the code.
10. The preparation and submittal of product data and shop drawings to the Architect for review shall constitute a representation by the manufacturer, contractor and vendor that all components comply with the above requirements.
11. The functional and physical interrelationship of components and their effect on each other shall be installed so that failure of an essential or nonessential architectural, mechanical, electrical component shall not cause the failure of nearby essential architectural, mechanical, or electrical components.

B. Seismic Design

1. Installation of all new plumbing systems (equipment and piping) to be in accordance with seismic requirements of the 2009 International Building Code, considering exemptions where applicable.
2. Refer to structural drawings or Division 01 “Summary of Work” for seismic criteria to be used on project.

1.11 ENERGY PERFORMANCE CRITERIA

A. All equipment provided under Division 22 shall meet the requirements of the International, or State, Energy Code, ASHRAE Standard 90 or the latest issue of the Standards for Equipment in the National Energy Policy Act (NEPA), whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. In other Part 2 articles of various sections of Division 22 where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Unless otherwise noted, substitutions of specified manufacturers shall comply with the requirements of Division 01.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F493
2. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
3. ABS Piping: ASTM D2235
4. PVC to ABS Piping Transition ASTM D3138

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve type coupling.
3. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end. Fernco, Mission or equal.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Steel, zinc, dichromate for fire protection reinforced nylon polymer elsewhere. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
4. Thunderline link seal or equal.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings; Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. General: Manufactured wall and ceiling escutcheons and floor plates, with an inside diameter to closely fit around pipe, tube, and insulation of insulated piping and an outside diameter that completely covers opening.

B. One piece construction on exposed piping in finished areas. Elsewhere, split pattern with setscrew. Provide deep pattern type where required to conceal protruding fittings and sleeve.

C. Provide polished chromium plated escutcheons on pipes passing through walls, floors or ceilings wherever such pipes are exposed to view.

2.9 HANGERS AND SUPPORTS

A. Acceptable Manufacturers

1. Other Than Roof Supports

    a. B-Line Systems, Inc.
    b. Grinnell Company
    c. National Pipe Hangers
    d. Penn Construction Industries
    e. Other approved United States manufacturer whose products comply with the referenced standards.

2. Roof Pipe, Supports

    a. ThyCurb
    b. Pate
    c. Roof Products and Systems Co.

B. Reference Standards

1. ASTM A36 - Specification for Structural Steel
2. ASTM A123 - Zinc (Hot-Dip Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip)
3. ASTM A653 G90 - Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process
4. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
5. AWS D1.1 - Structural Welding Code - Steel
6. MSS SP58 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Materials, Design and Manufacture
7. MSS SP69 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Selection and Application
8. NFPA 13 - Standard for the Installation of sprinkler Systems

C. Quality Assurance

1. Steel pipe hangers and supports shall have the manufacturer's name, part number and applicable size stamped in the part itself for identification.

2. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

D. General

1. Except for spacing of the hangers, design and fabrication of pipe hangers, supports and welding attachments shall conform to ANSI B31.9 or B31.1 as applicable.
2. Except for spacing of the hangers, hanger types and supports for bare and covered pipe shall conform to MSS SP69 for the temperature range except that only flat wide band hangers shall be used for hangers installed outside of insulation and plastic pipe.
3. Except for spacing of pipe hangers and elsewhere as otherwise indicated, horizontal and vertical piping attachment shall conform to the more stringent of this specification or MSS SP58 or MSS SP69. Continuous inserts and expansion bolts may be used.
4. All ferrous hangers, supports and hardware located outdoors shall be hot dip galvanized after fabrication per ASTM A123.
5. Hangers and clamps for support of bare copper piping shall be coated with copper colored (for identification) baked on epoxy paint. Use additional PVC coating of the epoxy painted hangers where necessary.
6. Provide suitable chromium plated brass supports for chromium plated pipe with exposed heads of bolts and screws chromium plated.
7. Hangers other than described above shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
8. Strut channels shall be pregalvanized in accordance with ASTM A653 G90 or shall have an electrodeposited finish.
9. All hangers and supports shall have some form of adjustment available after installation.

E. Inserts

1. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
2. Size inserts to suit threaded hanger rods.

F. Pipe Hangers and Supports: For plumbing plastic piping systems provide hangers, supports and support channels as recommended by piping manufacturer, use V-bottom clevis hanger with galvanized 18 gauge continuous support channel where required. For other systems, provide as follows:

1. Hangers for Pipe Sizes to 1-1/2 Inch: Adjustable carbon steel ring or clevis.
2. Hangers for Hot or Cold Pipe Sizes 2 Inches to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Adjustable carbon steel clevis.
3. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke and cast iron roll.
4. Multiple or Trapeze Hangers: Factory-enameled steel channels with welded spacers and hanger rods or 12 gauge rolled formed ASTM A570 Grade 33 structural quality steel channels (strut), cast iron roll and stand for hot pipe sizes 6 inches and over. Cross section suitable for span and loading. Suspension by outside hanger rods sized for total load on trapeze.
5. Wall Support for Pipe Sizes to 3 Inches: Carbon steel hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.

7. Vertical Support: Steel riser clamp.
8. Floor Support for Hot Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Adjustable pipe saddle and pipe nipple attached to steel base stand, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
10. Design hangers to impede disengagement by the movement of supported pipe. Provide spring and neoprene hangers as required.

G. Beam Clamps: Forged steel C-clamps shall include retaining strap, locking nut or other device for nonslip attachment, except LOCKING NUT NOT ALLOWED for project requiring seismic restraints.

H. Hanger Rod: Steel hanger rod zinc plated per ASTM B633.

I. Roof Pipe and Equipment Support

1. 18 gauge galvanized steel, unitized construction, straight base section without cant strip and with integral base plate, all welded construction, pressure treated wood nailer, counterflashing with lag screws, internal reinforcement.
2. Unless otherwise indicated, overall height recommended by SMACNA Fig. 5-4 to provide clearance for roof maintenance. If used as pier or curb base for attachment of pipe or steel support, minimum overall height as required for top of pier or curb base not less than 12 inches above finished surface of roofing or ballast as applicable.
3. Furnish sloped curbs when installed on sloped roofs to provide a level support surface.
4. Furnish supports to Division 07 for installation.
5. Refer to other Section of Division 22 "Vibration Isolation and Seismic Restraints for Plumbing Systems" where pipe and/or other equipment requires vibration isolation, or combination support/isolation/restraint unit.

2.10 THERMOMETERS

A. Acceptable Manufacturers

1. Trerice
2. Taylor Instrument Company
3. U.S. Gauge
4. Weksler
5. Weiss

B. ASTM E1, liquid in place thermometer. Cast aluminum case, black baked epoxy enamel finish, 9 inch minimum liquid filled tube, brass stem, adjustable angle type with locking device and with brass union type separable socket. Socket length to suit installation. Mercury filled thermometer not allowed.

C. Select range of thermometer to indicate normal operating temperatures at midpoint of scale. Scale division of 1 degree F for cold service and 2 degree F for hot service.

D. Install wells with stem extending to center of pipe. Fill wells with oil or graphite and secure caps.

2.11 PRESSURE GAUGES

A. Acceptable Manufacturers

1. Trerice
2. Taylor Instrument Company
3. U.S. Gauge
4. Weksler
5. Weiss
6. Ashcroft

B. ASTM B40.1, Grade A phosphor bronze seamless Bourdon spring type with white face, black numerals, 4-1/2-inch cast aluminum case, black baked epoxy enamel finish, brass bronze brushed movement and brass socket. Select range of gauge to indicate normal operating pressure of system at midpoint of scale.

C. Provide brass snubber of material suitable for system fluid. Provide with needle valve.

2.12 IDENTIFICATION DEVICES AND LABELS

A. General

1. Products specified are manufacturer's standard products of categories and types required for each application as referenced in Part 3 of this section and elsewhere on the drawings or in Division 22 specifications. Where more than single type is specified for listed application, selection is Contractor's option, but provide single selection for each product category.
2. Products shall comply with requirements of ANSI A13.1 and OSHA where applicable.

B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ANSI A13.1. Minimum letter height is 1-1/4 inches for piping and 3/4 inch for access door signs and similar operational instructions.

1. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ANSI A13.1, except as otherwise indicated.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color-coded pipe markers conforming to ANSI A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ANSI A13.1.

E. Pipes/Insulation Smaller Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe/insulation at each location.

F. Pipes/Insulation 6 Inches And Larger: Either full-band or strip type pipe markers, at least 3 times the letter height and of length required for label.

G. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

H. Plastic Tape: Manufacturer's standard color-coded, pressure- sensitive, self-adhesive, vinyl tape, at least 3 mils thick. Width 1-1/2 inches wide on pipes with outside diameters (including insulation) less than 6 inches; 2-1/2 inches wide for larger pipes. Color shall comply with ANSI A13.1 unless otherwise indicated.

I. Valve Tags: Stamped or engraved brass with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide a hole for fastener. Brass wire-link chain, beaded chain, or S-hook fasteners.

J. Access Panel Markers: 1/16 inch thick engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed device. Provide center hole for attachment.

K. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on masonry walls for each page of valve schedule. Polished hardwood or extruded aluminum frame.

L. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening. 1/16 inch thick for units up to 20 square inches or 8 inch length, 1/8 inch thick for larger units. Self-tapping stainless steel screws or contact-type permanent adhesive.

M. Plasticized Tags: Preprinted accident-prevention tags, of plasticized card stock. Size approximately 3-1/4 by 5-5/8 inches. Brass grommets and wire fasteners.

N. Nomenclature: Large-size wording such as "DANGER," "CAUTION," or "DO NOT OPERATE", or as noted on the drawings in the specification.

O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

P. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

2.13 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.

2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 22 to assure that all general service valves throughout the work of Division 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for Classes 200 and 300, copper-silicon bronze stem.
5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.
6. Domestic water system valve construction shall comply with NSF 61, 372 and Federal law 111-380 and shall be certified as lead free compliant.

B. Types V1, V2, V4, V5 General Service Valves: Industrial valve construction. Handwheel operator, except where specified to be provided with chain-wheel operator. Figure numbers listed are those of Stockham Valve Co. Valves shall be products of a single manufacturer.

Ball	Swing Check	Globe
See Type V9	B-309	B-16
*Use B104 where space prevents full extension of rising steam.		

2. Type V2: Class 125 bronze, for screwed piping 2 inch and smaller in size; 125 psig steam working pressure; 200 psig cold water, oil or gas working pressure:

Ball	Swing Check	Lift Check	Globe	Angle
See Type V9	B319	B316	B22T	B222T
*Use B103 where space prevents full extension of rising steam.				

3. Type V4: Class 125 flanged, iron body, bronze mounted (IBBM) - for copper and steel piping 2-1/2 inch and over in size; 125 psig saturated steam working pressure; 200 psig cold water, oil or gas working pressure:

Gate/OS&Y	Swing Check	Globe	Angle
G623	G931	G512	G515

4. Approved Manufacturers:

   a. Crane
   b. Nibco
   c. Stockham
   d. Hammond
   e. Jomar

C. Type V8 Shutoff Valves

1. Type V8a, 10 Inches and Larger (10 Inches and Larger for Shutoff Service): 150 psig WOG, bubbletight shutoff, 250^{o} F continuous: Butterfly type with 1 piece semisteel body (split body design not acceptable), threaded lugs (same number of lugs as connecting flange), extended neck to suit insulation thickness, 316 stainless steel disc, three shaft bearings, 316 stainless steel shaft and continuous retained EPDM resilient seat

to provide dead end or isolation service without use of downstream flanges. Certified lead-free for potable/drinking water; DeZurik Industrial Type BOS-US.

D. Types V9 and V10, Ball Valves

a. Valves in copper piping constructed with thermal barrier suitable for installation with nonlead solder joint (95-5 or equivalent as specified in the "Solder" article of). Include verification of suitability for high temperature solder with submittal.
b. Where stainless steel piping systems are used, provide Apollo 76F series.
c. Natural gas and propane system valves shall be Apollo 77G-UL series with NPT ends.
d. Approved Manufacturers:

1) Apollo
2) Nibco
3) Crane
4) Stockhom
5) Watts
6) Hammond
7) Victaulic
8) Jomar
9) Milwaukee

2. Type V10, General Service: 4 inches and larger ductile iron epoxy coated full port Class 125 ball valve, flanged or grooved ends. FDA epoxy grade coating, PTFE seats and seals, stainless steel ball and stem. CWP rating 200 psig. Apollo IBV-125-6Q series.

a. Approved Manufacturers:

1) Apollo
2) American Valve Co.
3) Watts
4) Victaulic
5) Jomar

E. Type V11, Nonslam (Silent) Check Valve: Combination Pump Valve Co. figure numbers are indicated.

1. 1/2 Inch Through 2 Inch in Size: Model 36, 300 psi, with union end. Bronze body and trim and stainless steel spring.
2. 2-1/2 Inch Through 8 Inch, Styles 10D and 11D Wafer Type; 10 Inch and Larger in Size, Styles 20D and 21D Globe Body: Cast iron body, bronze trim and stainless steel spring. Pressure classification to suit application.

F. Type CPBV, Chrome Plated Brass Valves: Similar to Type V2 and V3, except chrome plated brass finish and black composition wheel handle.

G. Balancing Valves

1. BVA : Balancing valve assembly shall have integral flow meter, DZR low-lead brass body (<0.25% Lead content), stainless steel ball with PTFE ball seal seat and union sweat connections. Flow meter body and headwork shall be DZR low-lead brass and have stainless steel flow meter bypass valve stem. Unit shall have inlet flow check valve, have a maximum working pressure 150 psi; working temperature range 14° to 230°F, flow rate range unit of measurement in gallons per minute (gpm), accuracy ± 10%, control stem angle of rotation 90°. Provide with optional outlet temperature gauge, 30° to 210°F scale, 2-inch diameter. Assembly shall be similar Caleffi QuickSetter 132.

    a) Install balancing valve with a minimum of 3-pipe diameters of straight run upstream and 1-pipe diameter downstream of valve.

2. Approved Manufacturers:

    a. Bell and Gossett Circuit Setter
    b. Taco
    c. Armstrong
    d. Victaulic
    e. Caleffi

H. Drain Valves

1. Valves 3/4 Inch and Smaller in Size: Interior hose bibb, brass, compression type, with renewable seat and male threads for attachment of hose and fitted with wheel handle and cap when not piped to drain. Valves exposed in finished spaces chromium plated.
2. Water/riser drain valve: Ball valve, lead-free, two-piece, bronze body, full-port, chrome plated brass ball, solder x ¾"threaded hose end, with dust cap and chain, similar to Milwaukee Valve #UPBA150H or similar.
3. Valves 1 Inch and Larger in Size: Hose end gate valves fitted with cap except that valves indicated as piped to drain shall be standard shutoff type for system.

I. Refer to other sections of Division 22 for additional valve requirements.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Furnish, deliver, erect, connect, and finish in every detail all materials, equipment and accessories required for the Work.
2. Include in the work and in the bid minor details not usually shown or specified, but manifestly necessary for the proper installation and operation of the various systems, the same as if specified or shown.
3. If any departures from the Contract Documents are deemed necessary, submit details of such departure and the reasons therefore to the Architect for approval.
4. Be responsible to request clarification from the Architect on any conflicts represented between the drawings and specifications.

5. Adequately guard all exposed moving parts of equipment, such that contact by operating personnel will not cause personal damage or injury.

B. Layout and Coordination With Other Trades

1. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of all measurements in connection with the Work. Any change made in major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to use of equipment of a manufacturer other than that used as basis of design shall cause no interference with other Work.
2. Examine the Drawings of other trades, cooperate and coordinate with other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from the arrangements shown are required, consult with other trade involved. Come to agreement as to changed locations and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop drawings to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown on the drawings; provide such offsets or bends as required to meet structural or finish conditions.
4. Coordinate layout with architectural ceilings and lighting layouts and similar work.
5. Coordinate and be responsible for the required clearances in shafts, chases, furred partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review large scale composite Drawings showing space requirements that exceed those shown.
6. Install systems so that they do not interfere with any openings, doors or windows, or with other work, and so as to permit proper access.
7. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
8. Except where greater clearance is specified or required by applicable codes, rules or regulations, install piping, fittings, valves, etc., to provide not less than 1 inch between their finished covering and the structure or adjacent work of any kind. The minimum space between finished hot piping of any kind and adjacent electrical conduit shall be 6 inches.
9. Make reasonable modifications in the layout to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the systems are to be installed in relation to the work of other trades. Issue such Drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades such that reasonable modifications cannot be made, detail and submit such deviation or conflict to the Architect for review.
11. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or as not to provide proper access for maintenance or repair, make necessary changes to correct the condition at no increase in the Contract sum.

12. For alterations to existing facilities, be fully responsible for coordinating work with all existing conditions. Verify location of existing piping, and equipment in the field. Relocate or offset new piping, and make reasonable modifications to existing piping, as required to fit in available space whether or not such relocation of offset is shown on the Drawings.
13. Manufacturer's Instructions and Recommendations

14. Perform the installation, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of the specifications.
15. Should a conflict exist between specifications and manufacturer's instructions, consult with the Architect.

C. Electrical Rooms

1. Do not install any piping, or equipment in or through an electrical room or similar room containing electrical equipment, other than piping, or equipment exclusively serving the room or equipment in the room.
2. If there is a conflict between the above requirement and the Drawings, the above shall govern. If reasonable modifications cannot be made to accommodate this requirement, obtain instructions from the Architect before proceeding with the work.

D. Painting

1. Except where specified otherwise in Division 22, Work of Division 09 will provide painting of plumbing systems, equipment and components.
2. Protect all equipment from rust, corrosion, and similar damage by either factory applied or field applied protective coatings.
3. Repair marred and damaged factory painted finishes with manufacturer's touch up paint and application procedures to match original factory finish.

E. Wall and Ceiling Access Doors

1. Access Doors shown on Architectural Drawings will be provided under Division 05.
2. Furnish access doors required for access to concealed valves, air vents, traps, cleanouts, unions, expansion joints, and other equipment where no other means of access is available. Access doors shall be of adequate size for the service requirements, minimum clear opening of 14 inches by 16 inches.
3. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors shall be specified in Division 08 Section "Access Doors and Frames."

F. Roof Pipe and Equipment Support

1. Work by Division 07 will install all roof pipe or equipment support curbs, furnished by Division 22.
2. Roof pipe and equipment supports specified in various sections of Division 22 shall be coordinated for exact location and type suitable for roof construction.

3.2 PENETRATIONS

A. General

1. Coordinate with other trades as to the size and location of openings to be provided in new floors, walls, roofs and ceilings as construction progresses.
2. Do not cut openings in new or existing floors and walls without proper structural reinforcement.
3. Install both piping and seals so as to maintain integrity of seals with expansion and contraction of piping.
4. Clean Room, Biohazard Laboratory, mechanical equipment rooms Sealing Requirements:

    a. Seal completely all penetrations of piping through any surface.
    b. Seal completely all penetrations of piping through above ceiling full height partitions.
    c. Seal completely the perimeter of all access doors or panels in any surface.

B. Sleeves

1. Provide each pipe, passing through a masonry or concrete wall, floor or partition, and elsewhere as indicated, with a sleeve made from standard weight galvanized steel pipe for pipe or conduit.
2. Select sleeves two pipe sizes larger than any pipe to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide minimum of 3/8 clearance.
3. Be responsible for the proper location and alignment of all sleeves.
4. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
5. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral water stop flanges, where they are to receive either water tight or hydrostatic seals.

C. Fire Rated Penetrations

1. Provide through-penetration firestop sealing system for pipe penetrations through fire or smoke rated construction. Refer to Division 07 for through-penetration fire stop sealing system.
2. Coordinate with Division 07 to determine requirements for sleeves and clearances.

D. Interior Non-Rated Wall Pipe Penetrations

1. For acoustically treated partitions, and walls between mechanical equipment rooms and occupied spaces, fill annular void at penetration with acoustical sealant.

E. Resilient Penetration Sleeve/Seal

1. Provide resilient penetration sleeve seal for piping subject to vibration to prevent transmission to the building structure.
2. Maintain an airtight seal around the penetrating element and prevent rigid contact of the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

F. Floor Pipe Penetrations

1. Provide water stops for new cored openings for piping where such openings are above grade in laboratories, toilet rooms and similar wet service areas and in mechanical rooms, penthouses, and pipe chases.
2. Provide water stops for existing pipe floor openings that do not have sleeves extended above the floor.
3. Provide either a sleeve or angle water stop. Sleeve may be used if the firestop sealing method selected by Division 07 allows the use of a sleeve, otherwise provide angle water stop.
4. Sleeve Water Stop: Construct of Schedule 40 galvanized steel pipe, length as required for 1 inch above floor and 1 inch below underside of floor. Provide 1 inch by 1 inch by 1/8 inch galvanized angle clips welded to sleeve at 90 degree intervals and securely fastened to underside of floor. Caulk space between floor opening and sleeve water tight with soft setting waterproof silicone sealant.
5. Angle Water Stop: Construct of standard weight pipe 1 inch long welded to a 1/4 inch circular steel base plate ring fastened to floor with expansion anchors. Base plate ring width as required for anchor clearance from edge of cored opening. Seal between base ring and floor and caulk all edges of base ring with waterproof silicone sealant.
6. Floor penetrations through concrete slabs on grade shall be sleeved as required by the plumbing code. For hydrostatic floor slab penetrations provide Link Seal as specified under exterior wall pipe penetrations.

G. Pipe Penetrations Through Roof

1. Work by Division 07 will provide flashing for piping not subject to vibration and/or thermal movement. Provide counterflashing of 16 ounce copper for sleeves through roof openings provided under Division 22 to provide a completely weather tight installation.
2. For piping subject to vibration and/or thermal movement, provide pipe sleeve as detailed on the drawings, or use pipe curb where curb is sized to accommodate both required overall pipe and insulation diameter and thermal movement.

H. Exterior Wall Pipe Penetrations

1. Provide compressible synthetic rubber seal with connecting bolts and pressure plates, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Provide sleeve and install seal in accordance with the manufacturer’s recommendations to provide air and water tightness above ground and hydrostatic sealing below grade. Caulking or other type mastic is not acceptable.

3.3 ALTERATIONS OF UTILITIES AND SERVICES

A. Not in plumbing scope.

3.4 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

A. Refer to Division 01 Sections "Execution" and “Alteration Project Procedures” and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Make all necessary alterations to existing Division 22 systems as required for removing or for connecting or extending these systems to new work and for revisions in existing work as indicated and as required, whether indicated or not. Match new materials in altered systems with existing materials unless otherwise indicated.

C. Continuity of Existing Services

1. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for shutdown activities, coordinate with Architect, Owner and other trades, and obtain written approval from Owner prior to proceeding with the work. Include work scheduled for off hours, when Owner requires that shutdown and interruption of facilities occur during unoccupied times.
2. Prepare and set notices on services and equipment that are temporarily shut off or disconnected.

D. Provide shutoff valves to isolate new work from existing and temporary or permanent connections to new work as required for proper testing and cleaning of new work.

E. All relocations of existing work shall be accomplished using new materials and accessories unless specifically noted otherwise.

F. Where equipment, and/or piping is removed or disconnected under Division 22, perform the work in such a manner that no damage is done to the structure or remaining portions of the existing systems. Do not under any circumstance place stress on existing pipe and fittings that are to be reused. Be fully responsible for and repair, at no additional expense to the Owner, any leaks developing in existing piping due to failure to take proper precautions when making alterations.

G. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Do not abandon any piping in place unless specifically noted to do so. Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
6. All materials and equipment removed or disconnected by Division 22, which is not to be reused or delivered to Owner, shall be removed from the premises.

H. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

I. Remove all piping, and equipment hangers and supports.

J. Cap tight unused connection at mains and risers behind finished surfaces.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install all piping in accordance with best practices of trade and latest code requirements. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Use uniform system materials throughout building.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum headroom. Cut piping accurately to measurements established at building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible without sags between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.

F. Pitch all systems for proper venting at high points and to drain at low points where the systems can be completely emptied. Install vents at all high points and drains at all low points, including where offsets and bends in horizontal pipe runs create a low point. Provide drain points with bronze hose end drain valves.

G. Do not install piping above or through electrical rooms, telecommunication rooms, or similar room having a large collection of electrical equipment.

H. Keep pipe and fittings clean from cutting burrs, foreign matter and defects in structure and threading. Make all cuts square. Ream after cutting. Bevel plain ends of steel pipe. Clean off scale and dirt inside and outside before assembly. Remove welding slag or other foreign matter inside and outside.

I. Install piping within building concealed in walls, furred spaces, pipe spaces or above suspended ceilings. Do not build in or bury horizontal piping within partitions. Install exposed piping as closely as possible to walls, ceilings and columns, allowing space for installation of insulation and access for valve operation.

J. Install piping sections using greatest length possible in all cases. The use of short lengths socketed together will not be allowed.

K. The use of lampwick or other material for packing threads, caulking or wrapping of joints to stop or prevent leaks or correct faults is not permitted. The use of long screws having right and left hand threads or couplings is not permitted.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. Install piping to permit valve servicing and application of insulation.

N. Provide offsets and loops as required for piping crossing a building expansion joint to accommodate building movement, whether or not shown on the drawings. Provide seismic joints for piping crossing building seismic joints to accommodate building movement, whether or not shown on the drawings. Piping seismic joints shall be designed to accommodate maximum building seismic joint movement. Piping seismic joints shall be Metraflex or equal.

O. Changes in Pipe Size and Direction

1. Make reduction or increase in pipe size with fittings. Use eccentric reducing fittings in horizontal piping. Use reducing tees in pressure piping for side outlet reduction only, not on run. Bushed fittings, notched or straight runs to form tees, or any similar fabrication method will not permitted.
2. Make changes in direction with standard fittings. Mitering of pipe to form elbows or similar fabrication method will not be allowed. Bending of piping will not be permitted.

P. Chromium Plated and Stainless Steel Piping: Friction wrenches and clamps must be used exclusively in the installation of chromium plated and stainless steel pipe and fittings. Pipe which is cut, dented or otherwise damaged shall be replaced with new pipe.

Q. Drain Pans

1. Provide drain pans under entire length of any piping, joints or fittings for soil, waste, rainwater or drain piping system which is installed over operating and delivery rooms, nurseries, ICU, food preparation centers, food serving facilities, food storage areas, central services areas and electronic data processing areas.
2. Fabricate each drain pan not less than 2 inches deep, with width to extend no less than 2-inches beyond pipe outside wall and provide 3/4 inch drain pipe to discharge at nearest convenient drain line, floor drain or other approved drain point. Construct of not less than 18 gauge galvanized steel.

R. Electrolysis Control

1. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
2. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric union to prevent electrolytic action between the ferrous and nonferrous metals. At branch connections off mains, provide shut off valve upstream of dielectric union in order to isolate downstream union.
3. Where copper or brass piping, tubing or fittings are anchored to, supported by, or come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, plastic or equivalent material to assure prevention of electrolysis.

S. Equipment Piping

1. Verify final locations of equipment for rough in of piping connections.
2. Provide shut off valves in the supply and return to each item of equipment. Suitably locate equipment isolation valves to facilitate removal of equipment.

3. Provide piping from pump glands, drain pans, relief valves or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge, terminating with plain end cut at a 45 degree angle.

T. Expansion and Contraction of Piping

1. The piping installation shall be free of stress. Run all piping with full allowance for expansion or contraction. Base expansion calculations on 50 degree F. installation temperature to 140 degree F. for hot water systems.
2. Evaluate the complete piping layout and notify Architect of additional anchors or expansion joints and any deviations required to compensate for expansion.
3. Make connections to equipment in such a manner as to eliminate undue strains in piping and equipment. Install sufficient number of elbow swings to allow for proper expansion and contraction of piping at the point of connection to mains and equipment.
4. Fabricate expansion loops with long radius welded fittings in steel piping and with long radius copper sweat fittings in copper piping.
5. Provide adequate pipe guides as close as possible on each end of the expansion device to preserve alignment and pitch.
6. Install pipe hangers and supports in such a manner as to not cause an anchor condition in any direction.

U. Pipe Anchors

1. Install anchors where required to direct pipe expansion properly into expansion joints, loops or offsets and to prevent transfer of loading and stresses to connected equipment.
2. Pipe anchors may consist of heavy steel clamps bolted or welded to piping and provided with lugs and bolts for clamping and attaching anchor braces. Design anchors to restrict pipe movement and fasten to main members of building structure in most effective manner to secure desired results.
3. Do not attach supports, anchors or stays in places or in such a manner that will damage construction or integrity of the structure, either during installation, by weight of the pipe, or by expansion and contraction of the pipe.

V. Pipe Insulation Inserts and Shields

1. Refer to Section of Division 22, “Plumbing Insulation” to coordinate specific insulation thicknesses and requirements. At hanger locations for insulated piping 1½ inches and larger where hanger support is outside the insulation, provide inserts of exploded silica pipe insulation between pipe and hanger. Density and compression strength suitable for pipe size and support spacing as required by MSS SP-58, Paragraph 9 and MSS SP-69, Table 3. Provide inserts as required for smaller piping to prevent deformation of insulation. Inserts of equal thickness to adjoining insulation, provided with vapor retardant seals, and of proper length to fully support pipe at each hanger location. Manufactured by Value Engineered Products Max Span; or equivalent.
2. At all hanger locations for insulated piping where hanger is outside of insulation, provide galvanized sheet steel shield formed to fit insert/insulation, extending up to pipe centerline. Length 12 inch minimum when insert is not required. Where inserts are provided, length of shield 4 inches less than insert length. Provide shields 16 gauge for piping up to 4 inches, 12 gauge for piping 6 inches and larger.

3. Preformed insulated pipe saddles may be used in lieu of insert and shield where appropriate. Thickness of insert or pipe saddle same thickness as pipe insulation.

3.6 VALVES

A. General

1. Provide valves at locations shown, where specified and where required to properly control piping systems. Provide valves recommended or required by equipment manufacturers and codes for proper operation of equipment and shutoff valves to allow isolation of each main and branch service line, whether or not indicated or specified.
2. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
3. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
4. Examine threads on valve and mating pipe for form and cleanliness.
5. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
6. Do not attempt to repair defective valves; replace with new valves.
7. Install valves in horizontal piping with stem at or above the center of the pipe.
8. Install valves in a position to allow full stem movement.

B. Check Valves: Provide lift check type in steam, air, gas or vapor service lines and after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.

C. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.

D. Provide chromium plated valves in chromium plated piping. Provide steam valves in chromium plated piping with composition hand wheels which shall remain reasonably cool in service.

3.7 WELDING, SOLDERING AND BRAZING

A. Do not employ workers who have not been fully qualified and certified for the specified procedures.

B. Pipe Welding, Black or Galvanized Steel Pipe: Perform all welding of black or galvanized steel pipe by shielded metallic arc method of fusion welding, in accordance with welding procedures of AWS (American Welding Society) D10.12 recommended procedures for welding low carbon steel pipe, or other approved procedure, conforming to requirements of ASME/ANSI B31.1 for high pressure steam boiler piping and B31.9 elsewhere.

C. Pipe Welding Stainless Steel Pipe: Refer to other Sections of Division 22 for welding requirements.

D. Structural Steel Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

E. Soldering: Comply with the requirements of the AWS Soldering Manual.

F. Brazing: Comply with the requirements of the AWS Brazing Manual and AWS A5.8 specification for filler materials for brazing.

3.8 UNIONS

A. In Screwed Steel Pipe, 2 inches and smaller: Screwed, Class 250 malleable iron, brass to iron seat, ground joint union with brass seat ring pressed into head piece. Provide galvanized unions in galvanized pipe.

B. In Welded Steel Pipe, 2 inches and smaller: Class 3000 carbon steel socket welded union, steel to steel seat and ground joint. Provide stainless steel in stainless steel piping.

C. In Copper tubing, 2 inches and smaller: Class 200 wrought copper, solder type, brass ground joint union.

D. In Brass Piping, 2 inches and smaller: Class 250 cast bronze, screwed ends, brass ground joint unions. Provide chromium plated unions in chromium plated piping.

E. Provide companion flanges in piping 2-1/2 inch and larger.

3.9 PIPING CONNECTIONS

A. Refer to other Sections of Division 22 for additional requirements.

B. Flanged Connections: Make with non-asbestos gaskets of 1/8 inch thick best quality material as recommended by manufacturer for the service application. For steam piping, factory manufactured for flange/connection size/type as manufactured by Flexitallic. For other piping services either Flexitallic or gaskets factory cut for flange size as manufactured by Garlock Packing Division, Colt Industries, or equal. Align flange surfaces parallel. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

C. Mechanical Couplings: Prepare pipe and install in accordance with manufacturer's instructions. Standard wall steel pipe either roll or cut grooved at Contractor's option, all sizes, except provide cut grooved as required to accommodate thermal expansion and contraction. Heavy wall steel pipe cut grooved all sizes. Light wall steel pipe roll grooved all sizes. Copper tubing roll grooved.

D. Soldered Joints: Unless noted otherwise, make with appropriate flux and solder. Clean tubing ends and fittings before assembly. For piping 2 inch and larger tin tubing and fittings before assembly. For tubing 2-1/2 inch and larger use circular flame torch for soldering. The use of lead flux or solder and finishing with 50-50 solder is prohibited.

E. Threaded Pipe: Make full, clean-cut standard ANSI/ASME B1.20.1 taper pipe threads using sharp dies. Carefully cut, ream or file out to size or bore, removing all chips. Use Schedule 80 pipe for all screwed close and shoulder nipples. Do not use all thread nipples. Provide teflon tape or other approved nontoxic joint compound, applied to male thread only.

F. Welding Connections: Use only factory made welding fittings, same weight as piping, on welded pipe, except that Bonney Forge WELDOLET, SOCKOLET or THREADOLET, or Allied Type 1 Branchlet fittings, of same weight as connecting piping, may be used for branch takeoffs two or more commercial pipe sizes smaller than main. All elbows long radius.

G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
4. PVC Nonpressure Piping: Join according to ASTM D2855.

H. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.10 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.11 PROTECTION OF WORK

A. Clean pipe, tubing, fittings, valves, piping specialties, ductwork and equipment before installation and keep clean while the work is in progress.

B. Securely close open ends of pipe and tubing and openings in other material and equipment until installed, during installation, and until finally connected or otherwise finished, with caps, plugs or other approved closure devices designed for such service.

C. Protect factory finished equipment, fixtures and devices with approved temporary covering material where those items are installed so as to be subject to accidental damage or abuse. Contractor shall remove all temporary covering material at the conclusion of the work or as directed.

D. Protect the work of other trades and property of Owner from damage and assume full responsibility for the cost of repairing or replacing any damage to such work or property caused by the performance of the work under Division 22.

3.12 CLEANING OF SYSTEMS

A. Refer to other sections of Division 22 for additional cleaning and system flushing requirements.

B. Following completion of system testing, thoroughly clean all piping systems by flushing with water or other approved method, or as otherwise specified. Completely remove all dirt, scale, oil, grease and other foreign substances that may have accumulated in systems during installation.

C. Carefully wipe out, wire brush, or if necessary, sand blast sections of pipe lines between temporary or permanent strainers and equipment they are to protect. Replace all permanent strainer screens with temporary screens during cleaning process. Remove temporary screens and reinstall permanent screens after cleaning is completed.

D. Disconnect automatic devices that can become clogged during cleaning process and do not connect permanently until cleaning process is complete.

E. Clean all piping and equipment of dirt, scale, plaster, concrete, splattered paint and other foreign matter.

F. Clean all grease and cuttings from stainless steel piping and trim.

G. Clean all strainers, dirt pockets, drip legs, traps and other accessories that may collect foreign matter.

3.13 EQUIPMENT PADS

A. Provide reinforced concrete equipment pads for the work specified under Division 22. Be responsible for preparing equipment pad drawings and setting foundation anchor bolts in time so as not to delay the work. Equipment pads shall be of the types detailed on the drawings.

B. Reinforce concrete to suit the loads placed on them. Materials and methods shall be as specified in Division 03.

C. Unless otherwise indicated, extend equipment pads 4 inches above the finished floor and minimum 4 inches beyond the equipment base in all directions. Have the top edges and vertical corners chamfered along the full perimeter. Equipment pads shall have the same surface finish as the adjacent and surrounding floor.

D. Set with proper templates, epoxy coated anchor bolts and inserts required for proper attachment of the equipment to the concrete foundations. Provide anchor bolts of the same size and number required by the equipment or as recommended by the equipment manufacturer and in accordance with the requirements detailed. Anchor bolts shall be compatible with vibration isolation requirements specified for the equipment.

E. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, fill the annular space between the anchor bolt and the inside of the pipe sleeve completely for the full length of the pipe sleeve with nonshrink cement grout.

F. Grout any openings between the top of the concrete foundation and the base of the equipment.

3.14 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.15 GROUTING

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

B. Packaging: Premixed and factory packaged. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

C. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout.

D. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout according to manufacturer's written instructions.

3.16 HANGERS AND SUPPORTS

A. General

1. Support major piping (3 inch and above), tanks and other equipment to the structure above (beams and girders) or by means of struts or brackets to columns. Do not support from floor or roof decks. Do not overload structural members to which supports are attached. Hanger spacing not to exceed MSS SP69.

    a. Provide hangers, rollers, threaded rods, turnbuckles, deflection guides, deflection provisions, inserts, beam clamps and all miscellaneous specialties for attachment of hangers and supports to structure.
    b. Provide all rods, angles, rails, struts, brace plates, structural steel, platforms and other items required for suspension or support of piping, tanks and equipment.
    c. Provide supplemental angles, channels, plates or other reinforcement where supports are required between building structural members. Size supports for weight of pipe, pipe contents, equipment fittings and other items, plus a 200 pound live load. Attach supplemental supports in a manner that will not weaken or overload structural members. Weld steel according to AWS D-1.1.
    d. Attach by welding, clamping, concrete inserts, drilled in mechanical type anchors (Hilti or equal) and other approved means. Adhesive type anchors are not approved.
    e. Place grout under supports for equipment, and make a smooth bearing surface.
    f. For seismic restraint, provide double-sided beam clamp loaded perpendicularly to beam for seismic anchor point.

2. No lead shield anchors, powder or power fasteners permitted for attachments.
3. Do not use perforated strap hangers. Do not use steel strap hangers on piping.
4. Wherever possible, support shall be provided directly to main steel or concrete framing beams. If spacing of structure exceeds spacing required to support the mechanical work, supplemental channel or unistrut framing shall be designed and provided by the Contractor.
5. Support all mechanical work independently of other trades. Under no circumstances shall work be supported or suspended from ceiling grids, piping or other supports by other trades.
6. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
7. Inserts in precast concrete to support Work of Division 22 will be furnished and installed by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.

B. Inserts

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in form work in advance of concrete work. Provide reinforcement rod placed through opening on top and bent over adjacent concrete reinforcement rods.
3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
4. Where inserts are omitted, if approved by Architect, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab or provide drilled in mechanical type anchors, Hilti or equal, after concrete is completely cured.

C. Pipe Hangers and Supports

1. Unless otherwise required to avoid overloading of structural members or for seismic restraint, support horizontal steel and copper piping as follows:

Nominal Pipe Size (inch)	(a)Max. Distance Between Support (feet)		Hanger Rod Diameter (inch)
	Steel Pipe	Copper Tubing	
up to 3/4	6	5	3/8
up to 2	6	6	3/8
2-1/2 to 3-1/2	10	8	1/2
4 and 5	12	10	5/8
6	12	10	3/4
8 to 12	14	14	7/8
14 and over Trapeze Hanger	14	-	1(b)

a. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
b. As required to carry weight of trapeze channel, span of piping with contents, insulation and supports, plus a 200 pound live load.

2. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.
3. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers and expansion joints/loops.
4. Place a hanger within one foot of each horizontal elbow.
5. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
6. Unless otherwise required to avoid overloading, of structural members or for seismic restraint, support vertical piping with clamps spaced appropriately as to type and weight of piping, minimum spacing at every other floor and below roof. Support vertical soil pipe at each floor at hub. For exposed piping in stairs, walkways and finished areas, locate clamps below floor and secure to structure below floor as required.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Space hangers for smallest pipe size or provide intermediate supports for smaller pipe as specified above for individual pipes.
8. Where practical, support riser piping independently of connected horizontal piping.
9. Support pipe runs in a manner to minimize stress in the pipe or tubing and on bodies of valves and fittings.

10. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
11. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
12. For piping subject to sweating (e.g.: domestic cold water), and for insulated piping requiring roller supports, install hangers outside insulation and provide pipe insulation protection shields as specified in this section. For all other piping, hanger may be attached to the piping before insulation is applied or may be installed outside the insulation with insulation protection shields.
13. Do not support nonferrous piping with ferrous materials even on a temporary basis.
14. Do not support piping from other piping or ductwork.
15. Install hanger rods subjected to tension only. Accomplish lateral and axial movements by proper linkage in rod assembly. Secure hanger to hanger rod with two bottom lock nuts.

3.17 IDENTIFICATION

A. Identify all new and altered equipment, and new and altered exposed pipe with legible lettering, applied after finish painting, in a color to contrast with basic color in accordance with ANSI A13.1 and OSHA.

B. Identify piping by name of pipe content and direction of flow near major equipment items, adjacent to valves or flanges, adjacent to gauges or thermometers, at each tee, at changes in direction, on each side of a penetration of a wall or floor, at each access door or panel and then at maximum 20 foot centers in congested areas and 50 foot intervals elsewhere; indicate flow direction with arrows. Identification shall be by means of plastic markers or tape or painted on the finished pipe surface by using stencils. Lettering shall not be smaller than one third of the pipe diameter and directional arrows not less than 1/2-inch wide and 12 inches long.

C. Identify equipment and operating devices such as switches, starters and similar equipment, by the equipment numbers shown on Drawings or by the Owner's numbering system, if so directed.

1. Include the type of service or the name of areas served.
2. Lettering minimum 1 inch high.
3. Nameplates shall be two tone plastic, or printed white paper enclosed in a transparent, laminated plastic case with permanently sealed edges.
4. Attach securely to equipment, or where this is not practicable attach by brass link chains.
5. Do not stencil surfaces exposed in public areas.

D. Furnish for each valve, except those immediately adjacent to apparatus, a 2 inch diameter nonferrous metal tag with figures stamped on the tag.

1. Number tags for Plumbing P-1, P-2, etc.; Use Owner's numbering system if so directed.
2. Fasten tags to valves with nonferrous S hooks and nonferrous chains.
3. Where valves are located above removable acoustical tile ceilings, identify the tile section below the valves by an approved color pin system.
4. Furnish duplicate framed schedules showing the location of each valve, system or equipment it serves, manufacturer, and figure number.

3.18 TESTING OF PIPING SYSTEMS – COMMON REQUIREMENTS

A. Refer to various sections of Division 22 for additional piping system testing requirements.

B. Provide materials and equipment required for testing. Test and make tight all new piping systems and alterations and connections to existing piping system.

C. Take precautions during testing to ensure safety of personnel and equipment. Provide systems to be pressurized with appropriate gauges and blowouts or relief valve set at a pressure no more than one third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Make good at no increase in Contract sum damage to work or work of other trades caused by failure to observe proper precautions.

D. Test piping systems prior to application of insulation. Testing as stipulated herein shall be considered minimum, and where tests stipulated by lawful jurisdictional authorities exceed these requirements, such more stringent tests shall be performed. Tests shall be witnessed and approved by the authorities having jurisdiction over the work.

E. Concealed work shall remain uncovered until required tests have been completed. Provide proper sectionalizing devices so that portions of a system may be tested as appropriate.

F. Isolate and exclude from tests all in line equipment, instruments, gauge glasses, flow meters and all other devices not capable of withstanding test pressure.

G. Use ambient temperature water as testing medium, except where otherwise specified and except where there is a risk of damage due to freezing.

H. Apply soap solution to all joints of pneumatically tested systems while system is being subjected to test pressure.

I. Maintain test pressures sufficient length of time to permit thorough inspection of all joints. Where leaks are observed, replace defective work or material. Caulking of screw joints or holes is not acceptable. Repeat entire test as many times as necessary, until successful completion of test with no leaks.

J. Prepare written report of testing.

3.19 BALANCING, ADJUSTING AND PERFORMANCE TESTING OF PLUMBING SYSTEMS

A. Testing, adjusting and balancing of water systems will be provided by the Installing Contractor.

B. Installing Contractor(s) responsible for the work specified in Division 22 shall perform all work necessary to place systems in full operation prior to start of testing, adjusting and balancing work. In addition, Installing Contractor shall perform certain additional preparatory work required for testing, adjusting and balancing as specified in various Sections of Division 22.

C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are

performing properly and delivering quantities in accordance with the requirements of the Contract Documents.

D. Furnish approved manufacturer's technical data and shop drawings for equipment, including pump performance curves.

E. Balance domestic hot water systems so that hot water circulates through all branches. Domestic hot water system balancing valve flow rates shall be selected to provide a maximum of 5° F. temperature loss throughout the system.

3.20 INSTRUCTION AND DEMONSTRATION

A. Upon completion of all work and all tests, and at a time mutually agreed on by Contractor, Architect and Owner, Installing Contractor shall operate systems in all parts and at their expense for sufficient length of time to demonstrate the mode of operation and definitively determine whether the systems as a whole are in first class working condition. Immediately correct, at no cost to Owner, any defects that may develop during this period of operation and place systems in first class working condition before being finally turned over to Owner.

B. Provide experienced operating personnel to instruct Owner's authorized employees in the operation, adjustment and maintenance of systems and equipment installed under this Contract. Provide instructions for the period of time appropriate for the size and complexity of the system, or as requested by Owner.

3.21 MANUFACTURER'S SUPERVISIONS AND STARTUP SERVICE

A. Include manufacturer's supervision/startup/certification and special instruction service for equipment as specified in various Sections of Division 22. Be responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified work. Make any corrections/modifications to the installation as required by the manufacturer at no additional cost to Owner.

B. The manufacturer's engineer or authorized service personnel shall check the equipment for its conformance to the Specifications, for proper installation and run the system in all modes of operation to ascertain that the unit will function properly. Make necessary adjustments to insure optimum efficiency and trouble free service.

C. After completion of the startup procedures, the manufacturer shall certify, in writing, that the equipment is installed in accordance with their requirements and is operating in accordance with the intent of the Specifications.

3.22 COMMISSIONING

A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".

B. Ensure participation of major equipment manufacturers or their representatives.

C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 22 05 00

SECTION 22 05 13 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes extent of electrical equipment and electrical wiring that is responsibility of Division 22.

B. Section includes general requirements for motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

C. Related Sections

1. Section 22 05 00, Common Materials and Methods for Plumbing Systems.
2. Variable Frequency Motor Speed Controllers furnished by Division 22 are specified in Division 26.

1.3 REFERENCE STANDARDS

A. ANSI/IEEE 112 (C50.20): Test Procedure for single Phase Induction Motors

B. ANSI/IEEE 114 (C50.21): Test Procedure for Polyphase Induction Motors and Generators

C. NFPA 70: National Electric Code (NEC)

D. UL: Underwriters Laboratories

1.4 SUBMITTALS

A. Product Data: Include with equipment submittals, data pertinent to electrical characteristics, motor size, type, power requirements, wiring requirements.

1.5 QUALITY ASSURANCE

A. Provide electrical products, including those factory mounted or factory furnished, which have been tested, listed and labeled with Underwriters' Laboratory (UL) or Electrical Testing Laboratory (ETL).

B. There shall be no field modifications made to any materials, equipment and systems that would violate the listing and labeling.

C. Comply with Division 26, NEC and NEMA as applicable to wiring methods, materials and equipment and equipment, construction and installation.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

B. Wiring Under Division 26 "Electrical"

1. Power wiring under Division 26 will include power feeders from source of building power to wiring terminals on the equipment; unit mounted disconnects, or control panels unless indicated in other sections of Division 22.
2. Where disconnect switches for equipment are provided by Division 26, power wiring under Division 26 will include wiring from disconnect to wiring terminals on the equipment.

C. Wiring Under Division 25 "Integrated Automation "

1. Except on factory packaged equipment, wiring under Division 25 shall include all connections to control devices, wiring of pressure and flow control switches, flow meters and similar plumbing-electrical devices for plumbing systems to control panels, interlock wiring, control relays, and minor power wiring to auxiliary components for major pieces of apparatus such as solenoid valves and control valve motors.
2. Wiring under Division 25 shall include all signal wiring from plumbing equipment to building automation system.

D. Provide all other power and control wiring for Division 22 systems and equipment in accordance with the requirements of Division 26, required for complete operation, including wiring that is specified for factory prewired equipment, but not so provided.

E. Short Circuit Current Rating (SCCR) for Plumbing Equipment

1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered mechanical equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the plumbing equipment

shall be equal or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

2. Plumbing equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment, and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.
3. All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned “Resubmit” or “Rejected”.
4. No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

F. Electrical Ratings

1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be submitted for approval and be completed by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 ELECTRICAL WIRING

A. Electrical wiring provided by Division 22 shall be in accordance with the requirements of Division 26.

2.2 MOTORS

A. Acceptable Manufacturers:

1. Toshiba
2. General Electric
3. Lincoln
4. Reliance
5. U. S. Electric
6. Marathon
7. Baldor

B. General Motor Requirements

1. Construct in accordance with the latest NEMA MG 1 standards and UL 1004, test in accordance with NEMA MG 1, ANSI/IEEE 112 and ANSI/IEEE 114. Except where more stringent requirements are indicated, comply with the following.
2. Single phase/3 phase (polyphase) and voltage characteristics as scheduled on drawings, 60 Hz.
3. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors that will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
4. Class B insulation unless otherwise specified.
5. Provide each motor with a conduit terminal box or factory installed cord set with molded plug as applicable.
6. Provide motors with grease or lubrication fittings. For specific applications, and at the approval of the Architect, the use of permanently lubricated or lifetime bearings will be permitted.
7. Open drip-proof (ODP) or totally enclosed fan cooled (TEFC) type with a minimum service factor of 1.15 unless otherwise specified herein or in other section of the specification.
8. Comply with IEEE 841 for severe-duty motors, with 1.15 minimum service factor.

C. Motor Characteristics

1. Duty: Continuous duty at 100% of rated capacity at ambient temperatures of 40 deg C and at altitude of 3300 feet above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

D. Polyphase Motors

1. Squirrel cage induction type conforming to the following requirements unless noted otherwise:
2. Description: NEMA MG 1, Design B, medium induction motor, unless otherwise required by starting torque.
3. Separate winding for each speed for multispeed motors.
4. Efficiency:

    a. Single speed motors larger than 75 Hp shall be of "Energy efficient" design as defined in NEMA MG-1.
    b. Single speed motors 75 Hp and smaller shall be of 'Premium efficiency" design, as defined in NEMA MG-1, Class F insulation.
    c. Motors driven by variable frequency motor speed controller (VFD) shall be "Premium" efficiency, as defined in NEMA MG-1. NEMA Design B, Class F insulation.

5. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
6. Motors drawing 1,000 watts or more at full load shall have a power factor rating of at least 85% without external capacitor correction. Verify efficiency in accordance with NEMA

MG-1. Test per NEMA MG-1, ANSI/IEEE 112. Display efficiency on nameplate in accordance with NEMA MG-1.

7. Motors used with reduced-voltage and multispeed controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
8. Special Requirements:

    a. Motors driven by variable frequency motor speed controller (VFD) shall be inverter duty rated, thermally protected, in full compliance with NEMA MG-1 for use with either:

        1) Pulse Width Modulation (PWM) inverter with insulated-gate bipolar transistors (IGBT) and, where required by actual cable length from drive to motor, provided with an output LC filter limiting voltage spikes and waveform voltage dV/dT to NEMA limits, unless other approved by motor manufacturer.
        2) Six-step transistor voltage source inverter (VVI) used in variable torque fan or pump application with maximum turn down ratio of 4 to 1. Service factor 1.0 on inverter power, 1.15 on bypass power.

    b. For motors driven by VFD, provide motor shaft grounding ring SGR to protect against electrical discharge machining (EDM) motor bearing damage.

E. Single Phase Motors

1. Motors larger than 1/20 hp shall be energy efficient capacitor start type to suit starting torque and requirements of specific motor application:
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

A. Variable frequency motor speed controllers (VFD), including line reactor and/or harmonic filter as required, shall be furnished by Division 22 in accordance with Division 26 Section "Variable Frequency Motor Speed Controller".

B. It shall be the responsibility of Division 22 Sections to properly match the motor and drive.

C. All variable frequency motor speed controllers furnished by Division 22 shall be of the same manufacturer.

2.4 MOTOR STARTERS

A. Motor starters for certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 22. All other motor starters, except variable frequency drives, shall be provided by Division 26.

2.5 POWER FACTOR CORRECTION

A. Power factor correction for certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 22. All other power factor correction shall be provided by Division 26.

B. Power factor correction with maximum rating allowed by motor manufacturer sufficient to raise overall motor power factor to 95%.

2.6 CONTROL PANELS

A. Include in control panels provided as a part of apparatus specified in Division 22, fused disconnect, circuit breaker or motor circuit protector combination starter with overload protection for each motor, contactors, and electric heaters, if required. Provide 120 volt control circuit and other required circuit protection. Where remote controls are required, they shall operate at 120 volt maximum, with properly fused control transformer provided for that purpose.

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

A. Unless otherwise stated herein or on the drawings, power wiring will be provided under Division 26 and control wiring will be provided under Division 22. Provide power and control wiring for Division 22 systems and equipment for interconnecting wiring on apparatus that has not been factory installed.

B. Coordinate power wiring requirements with Division 26 for locations of electrical panelboards to connect Division 22 system as specified.

3.2 MOTORS

A. Provide electric motors required for equipment specified in the various sections of Division 22, designed and wound for electrical characteristics shown on the Drawings.

B. Select motors for quiet operation and for sufficient capacity to operate driven devices under all conditions of operation without overloading.

C. Install motors in accordance with manufacturer's published instructions. Mount direct drive connected motors securely in accurate alignment. For belt drive motors, use adjustable mounting

bases, align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

D. Extend lubrication lines to accessible locations.

E. Startup

1. Check operating motors, both factory and field installed, for unusual conditions during normal operation. Coordinate with the balancing and commissioning of the equipment for which the motor is a part.
2. Report unusual conditions and correct deficiencies.

3.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

A. Deliver variable frequency motor speed controllers not factory mounted on equipment to Division 26 for field installation and wiring.

3.4 MOTOR STARTERS

A. Deliver motor starting equipment not factory mounted on equipment to Division 26 for field installation and wiring.

3.5 POWER FACTOR CORRECTION

A. Deliver capacitors not factory mounted on equipment to Division 26 for field installation and wiring.

END OF SECTION 22 05 13

SECTION 22 05 33 - HEAT TRACING FOR PLUMBING AND FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes heat tracing with self-regulating, parallel resistance electric heating cables and digital controls for freeze protection and domestic hot water temperature maintenance.

1.3 SUBMITTALS

A. Product Data: Include product cut sheets indicating rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings

1. Wiring Diagrams: Provide wiring diagrams indicating power, signal, and control wiring.
2. Plans: Provide plans indicating quantities, and locations of heating cables and controllers with power connection points shown.
3. Schedules: Indicate heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period. Contractor shall coordinate with owner and manufacturer to submit all necessary warranty

registration forms to the manufacturer within the manufacturer's required maximum number of days after installation.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Raychem; a division of Tyco Thermal Controls
2. Thermon Manufacturing Corporation
3. Chromalox, Inc.
4. Delta-Therm Corp
5. Nelson Heat Trace

B. Provide a complete system of heating-cables, components and controls, which shall be UL listed, FM Approved or CSA certified for the specific application (pipe freeze protection or hot water temperature maintenance) and specific system (plumbing, HVAC, etc.) for which they are used.

C. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-plated copper bus wires embedded in parallel in a self-regulating, cross-linked polymer core that varies its heat output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric inner jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin or fluoropolymer, as required per section 427-23 of the NEC, latest edition.

1. For installation on plastic piping, the heating cable shall be applied using aluminum tape (Raychem AT-180 or approved equal).

D. Power connection, end seal, splice, and tee kit components shall be applied in the field.

E. Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC, latest edition.

F. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion.

G. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable.

H. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES FOR FREEZE PROTECTION

A. Electrical Characteristics:

1. Volts: 208
2. Phase: Single
3. Hertz: 60

B. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.

C. Maximum Operating Temperature Rating (Power On): 150°F.

D. Maximum Exposure Temperature (Power Off): 150°F.

E. Heat tracing for freeze protection of water piping shall be capable of maintaining a minimum water temperature of 50°F at an ambient air temperature of 0°F.

F. The heating cable for metal-pipe freeze protection shall be sized according to the table below. The heating cable output ratings selected in this table are based on 1-inch fiberglass insulation. The given wattages refer to the nominal watts per foot rating, which corresponds to the standard heat output provided by the cable at a surrounding temperature of 50°F.

	Minimum Ambient Temperature	
Pipe Size (inches)	0°F	-20°F
3 or less	5 watts	5 watts
4	5 watts	8 watts
6	8 watts	12 watts
8	8 watts	12 watts
10	12 watts	2 strips - 8 watts
12	12 watts	2 strips - 8 watts
14	12 watts	2 strips - 12 watts
16	2 strips - 8 watts	2 strips - 12 watts
18	2 strips - 8 watts	2 strips - 12 watts
20	2 strips - 12 watts	2 strips - 12 watts
24	2 strips - 12 watts	3 strips - 12 watts

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES FOR HOT WATER TEMPERATURE MAINTENANCE

A. Electrical Characteristics:

1. Volts: 208
2. Phase: Single
3. Hertz: 60

B. The self-regulating temperature maintenance cable shall include a polymer-coated aluminum wrap between its inner jacket and its tinned copper braid.

C. The self-regulating temperature maintenance cable's outer jacket shall be color-coded for temperature identification.

D. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 70 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.

E. Temperature maintenance cable shall have a nominal temperature maintain rating of 115°F.

2.4 SINGLE CIRCUIT LOCAL DIGITAL CONTROLLER

A. Local digital controller shall be DigiTrace C910-485 as manufactured by Raychem or approved equal.

1. Heating cable manufacturer shall provide a local digital controller with built-in GFPD compatible with selected heating cable.
2. Digital controller shall be capable of supporting up to two (2) RTD temperature sensors per control point. Leads can be extended using 18 AWG, 3-wire, shielded cable.

B. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP).

C. Digital controller shall be capable of operating with supply voltages from 100 V to 277 V.

D. Digital controller shall have an integrated adjustable Ground Fault Protection Device (10 – 200 mA).

E. Digital controller shall have a built-in self-test feature to verify proper functionality of heating cable system.

F. Digital controller shall be able to communicate with BMS via BACnet® protocol. Provide the controller manufacturer's recommended multi-protocol gateway (translator device) with controller as required.

G. Digital controller will also supply an isolated triac alarm relay and a dry contact relay for alarm annunciation back to the BMS.

H. The following variables shall be monitored by the digital controller and reported back to the BMS.

1. Temperature
2. Ground-fault
3. Current draw
4. Power consumption
5. Associated alarms

I. Digital controllers serving fire protection piping heat trace shall report the following alarms directly to the fire alarm panel through dry contact:

1. Loss of Power Alarm
2. Low Temperature Alarm
3. High Temperature Alarm
4. RTD (Temperature Sensor) Failure Alarm
5. Ground Fault Trip Alarm

J. Digital controller shall have c-CSA-us approvals.

K. Digital controllers serving freeze protection cables shall be configured for ambient sensing mode.

L. Digital controllers serving domestic hot water temperature maintenance cables shall be configured for timed duty cycle mode with duty cycles specifically programmed for the heating cable product to be used.

M. Provide a minimum of one (1) User Interface Terminal (UIT) per building for the programming of hot water temperature maintenance single circuit digital controllers; Raychem Model "ACS-UIT2" or approved equal. Provide additional UIT's if indicated on contract drawings. The UIT shall be c-CSA-us certified.

2.4 MULTIPLE-CIRCUIT DISTRIBUTED DIGITAL CONTROL SYSTEM

A. The distributed digital control system shall be a "DigiTrace ACS-30" heat-trace control system as manufactured by Raychem, or approved equal. All components of an approved equal system shall be supplied by a single approved equal manufacturer as a cohesive package.

B. Heating cable manufacturer shall provide a distributed digital control system with pre-programmed parameters to provide concurrent control for heating cables used for pipe freeze protection, flow maintenance and hot water temperature maintenance.

C. Provide a minimum of one (1) User Interface Terminal (UIT) per building; Raychem Model "ACS-UIT2" or approved equal. Provide additional UIT's if indicated on contract drawings. The UIT shall be c-CSA-us certified.

D. Provide Power Control Panels (PCP's) (Raychem Model "ACS-PCM2-5" or approved equal) to monitor, control and protect multiple heat trace circuits. PCP's shall be c-UL-us listed.

E. PCP's shall include power distribution (one main power feeder in, several branch circuits out).

F. Provide Single Circuit Digital Controllers (SCDC's) (Raychem Model "C910-485" or approved equal) in lieu of PCP's where indicated on contract drawings. SCDC's in such applications shall serve as single-circuit extensions of the overall heat trace distributed digital control system.

G. Provide Resistance Temperature Detector temperature sensors (RTD's) and Remote Monitoring Modules (RMM's) (Raychem Model "RMM2" or approved equal) as required for a fully functioning system.

H. All programming of the heat trace control system shall be done through the central UIT(s).

I. The heat trace control system shall be capable of assigning up to four (4) RTD temperature inputs per heat-tracing circuit.

J. The UIT shall be a color LCD touch-screen display with password protection to prevent unauthorized access to the system.

K. The UIT shall communicate with up to fifty-two (52) PCP's where each panel can control up to five (5) circuits and accept up to five (5) temperature inputs.

L. The UIT shall communicate with up to sixteen (16) Remote Monitoring Modules (RMM's), as required, where each module can accept up to 8 temperature inputs.

M. The UIT shall have a USB port to allow for quick and easy software update.

N. The UIT shall have three (3) programmable alarm contacts including an alarm light on the enclosure cover.

O. A separate offline software tool shall be made available to allow users to pre-program the digital control system and transfer program via a USB drive or Ethernet.

P. The UIT enclosure shall be NEMA 4 for indoor or outdoor locations.

Q. The PCP shall be in a NEMA 4/12 enclosure approved for non-hazardous indoor and outdoor locations.

R. The PCP panel shall provide ground-fault and line current sensing, alarming, switching and temperature inputs for five (5) heat tracing circuits.

S. Each PCP shall have five (5) 30A contactors (EMR type).

T. PCP's and SCDC's shall be capable of operating at 120 V to 277 V.

U. PCP's and SCDC's shall have an alarm contact including an alarm light on the panel cover.

V. PCP's and SCDC's shall have integrated adjustable GFPD's (10 – 200 mA) – one for each individual heat trace branch circuit.

W. PCP's and SCDC's controlling freeze protection cables shall be configured for ambient sensing mode.

X. PCP's and SCDC's controlling domestic hot water temperature maintenance cables shall be configured for timed duty cycle mode with duty cycles specifically programmed for the heating cable product to be used.

Y. The heat trace control system will have a built-in self-test feature to verify proper functionality of heating cable system.

Z. The heat trace control system shall be able to communicate with BMS via BACnet® protocol. Provide the heat trace control system manufacturer's recommended multi-protocol gateways (translator devices) as required for a fully functioning system.

AA. The following variables for each individual heat trace circuit, shall be monitored by the heat trace control system and reported to the BMS.

1. Temperature
2. Ground-fault
3. Current draw
4. Power consumption
5. Associated alarms

BB. The following alarms for each individual fire protection heat trace circuit shall be monitored by the heat trace control system and reported to the fire alarm panel via dry contact:

1. Loss of Power Alarm
2. Low Temperature Alarm
3. High Temperature Alarm
4. RTD (Temperature Sensor) Failure Alarm
5. Ground Fault Trip Alarm

2.4 SINGLE-CIRCUIT LOCAL DIGITAL CONTROLLER FOR HOT WATER TEMPERATURE MAINTENANCE

A. Local digital controller shall be HWAT-ECO as manufactured by Raychem or approved equal.

B. Controller manufacturer shall match that of the heating cable.

C. Controller shall include pre-programmed duty cycles based on ambient temperature ranging from 60 - 80°F. These duty cycles shall be programmed by the manufacturer specifically for the cable product it will control.

D. Controller shall operate at 208V, single phase.

E. Controller shall provide flexible temperature control from 105°F to 140°F.

F. Controller shall include three programmable temperature set points for maximum energy efficiency.

1. Maintain
2. Economy
3. Off

G. Controller shall have heat cycle setting.

H. Digital controller shall include 24/7 pre-programmed time based profiles specific to the selected water temperature maintenance heating cable application such as schools, hospitals, prisons, etc.

I. Controller shall have remote temperature setting through 0-10Vdc BMS interface.

J. Controller shall have a pipe temperature sensor, low/high pipe temperature alarms and high temperature cut-out.

1. To maximize the energy efficiency of the HWAT system by verifying that the hot pipe temperature is at the correct temperature (low temperature alarm).

2. To monitor and alarm if the pipe temperature is hotter than intended (high temperature alarm and cut-out).

K. Digital controller shall have c-UL-us approvals for use with the water temperature maintenance cable product that it will control.

2.5 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, aluminum tape for plastic piping, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer. Connection systems that require cutting or stripping to expose buswire, or that use crimps or terminal blocks will not be accepted.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install heat trace where indicated on drawings.

B. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.

C. Install electric heating cables according to IEEE 515.1.

D. Install electric heating cables after piping has been tested and before insulation is installed.

E. For installation on plastic piping, the heating cable shall be applied using aluminum tape.

F. Install insulation over piping with electric cables according to the respective discipline's insulation specification section. Coordinate diameter of insulation to include thickness of cable as per manufacturer's recommendations.

G. Install warning tape on 10 foot centers on piping insulation where piping is equipped with electric heating cables.

H. Set field-adjustable switches and circuit-breaker trip ranges.

I. Protect installed heating cables, including nonheating leads, from damage.

J. For heat tracing using line sensing, install temperature sensor in an area that is representative of conditions along entire length of pipe.

K. Terminate cables with water-proof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end water-tight.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. A factory-certified technician or manufacturer's representative shall perform startup and commissioning of the heat trace system and controls. Provide commissioning report to owner.

B. Coordinate all controller settings with specifying engineer prior to programming.

C. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 22 05 33

SECTION 22 05 48 - VIBRATION ISOLATION AND SEISMIC RESTRAINTS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Vibration control devices, accessories, materials and related items for new equipment, and piping as may be required to prevent the transmission of vibration to the building structure.
2. Seismic control devices, accessories, materials and related items for new equipment, and piping as may be required to keep all components in place during a seismic event and operational where this specification so requires.
3. Requirements for Certification of seismic analysis, design and installation.

1.3 REFERENCES

A. ASCE: American Society of Civil Engineers, ASCE 7, latest edition.

B. ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., Applications Handbook, latest edition.

C. ASTM: American Society for Testing and Materials.

D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association, Duct Construction Standards – Metal and Flexible, latest version.

E. SMACNA: Seismic Restraint Manual Guidelines for Mechanical Systems, latest version.

1.4 DEFINITIONS

A. Failure: For the purpose of this project, is defined as the discontinuance of any attachment point between equipment and structure, vertical permanent deformation greater than 0.125 inch and/or horizontal permanent deformation greater than 0.250 inch.

B. Isolation Manufacturer: For the purpose of this project, manufacturer of vibration isolation and seismic restraint equipment.

C. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

D. Positive Attachment: A cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps and power shots for support rods of piping, ductwork, or any other equipment are not acceptable on this project as positive attachment.

E. Restraint: Device(s) intended to keep component in place during a seismic event.

F. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

G. High Hazard Systems

1. Systems conveying material that is either toxic or potentially explosive and in significant quantity could pose a threat to the general public.
2. Nitrous oxide, natural gas, oxygen, compressed air, high pressure steam or any piping containing flammable, combustible, toxic oxidizing or corrosive material.

H. Life Safety Systems:

1. Hospital heating and air-conditioning systems required to maintain normal ambient temperature including domestic water make up.
2. Plumbing systems that support the operation of or are connected to emergency power generation equipment.

I. Refer to ASCE 7, Section 9 for additional definitions of items related to seismic restraints.

1.5 SUBMITTALS

A. Product Data: Annotate to indicate application of each product submitted and compliance with the specifications.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style material, strength, fastening provision, and finish for each type and size of seismic restraint component used.

B. Product Schedule or List: Provide schedule of all vibration isolated and restrained equipment and all restrained but not vibration isolated equipment, all vibration isolated and restrained piping systems and all restrained, but not vibration isolated piping and ductwork systems. Submit separate schedules for "Vibration Isolated and Restrained" and for "Restrained but Not Vibration Isolated". Include the following for each piece of equipment and, as applicable, for each piping and ductwork system:

1. Identification. Include equipment ID where applicable
2. Isolator type(s) with identification reference numbers of applicable product data and shop drawings.
3. Actual load for each isolator type.

4. Actual static deflection expected under actual load for each isolator type.
5. Specified minimum static deflection under actual load for each isolator type.
6. Seismic restraint(s) with identification number(s) of applicable product data and shop drawings. Include overstressed condition information, if any, as required by the Article titled "Seismic Engineer's Responsibilities" in Part 1 of this section. Do not include calculations with submittal. Calculations will not be reviewed.

    a. Initial and final deflection, anticipated movement and final floor loading for spring riser system.

C. Shop Drawings:

1. Fabrication details of steel rails, steel base frames and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method and location of equipment bolts.
2. Drawings showing methods of suspension, support guides for piping.
3. Drawings showing methods for isolation of pipes piercing walls and slabs.
4. Drawings showing number and location of seismic restraints and anchors for each piece of equipment and each piping system.
5. Specific details of restraints including anchor bolts for mounting at each location, for each piece of equipment and for pipe locations.
6. Methods and details for vertical restraints.
7. Details of housekeeping pad(s) showing reinforcement, method of attachment to structure and method of attachment of equipment restraint(s).
8. All other special details necessary to convey complete understanding of work to be performed.

D. Certification of Seismic Analysis and Design: Statement on seismic engineer's letterhead stationary with original signature of an authorized representative of the manufacturer certifying that, as required by the Article "Seismic Engineer Responsibilities" in Part 1 of this section:

1. Seismic calculations have been completed and stamped by a registered engineer in the same state as the project, including name, license number and state of registration of responsible engineer. Do not include calculations with submittal.
2. All overstressed conditions have been included in the submittal.
3. Seismic restraints and attachments are capable of safely accepting loads resulting from the specified seismic forces when installed in accordance with manufacturer's instructions.

E. Certification of Component Manufacturer Seismic Compliance:

1. For life safety and high hazard components and systems, provide component manufacturer's Approved Agency Certificate of Compliance for their equipment when used on project with Seismic Design Category C through F, including testing certification.
2. All other components, equipment manufacturer must provide certification product has been tested or analyzed to withstand the expected loads. Seismic engineer shall review products for capability to withstand project design loads.
3. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.”
b. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will remain fully operational after the seismic event.”

4. Dimensioned Outline Drawings of Unit Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
5. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

F. Certificates: All seismic components to be used in association with OSHPD projects must be submitted with OSHPD pre-approval certification stamp.

1.6 QUALITY ASSURANCE

A. It is the objective of this specification to provide the design and installation of vibration isolation equipment and devices for the avoidance of excessive noise and vibration in the building(s) due to the operation of machinery or equipment and/or due to interconnected piping, or conduit, and to provide the design and installation of restraint equipment and devices for seismic restraint for the plumbing systems.

B. All vibration isolation equipment and devices, including auxiliary steel bases and pouring forms, and all seismic restraint equipment and devices shall be the products of a single manufacturer, hereinafter called the isolation manufacturer, unless otherwise allowed in writing by the Architect, shall be certified by the isolation manufacturer and shall be furnished by the isolation manufacturer or his authorized representative, who shall be responsible for performing all work specified in this section to be performed by the isolation manufacturer or his representative and for coordination of all phases of the work.

C. This specification represents the minimum requirements for seismic consideration. All systems must be installed in strict accordance with seismic codes and component manufacturer’s standards and instructions. Whenever a conflict occurs between codes, manufacturer’s standards and requirements in this Section, the most stringent shall apply.

D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel.

E. Quality Assurance Program: The quality assurance plan shall be included when required by the applicable building codes. The design of each seismic system shall include a quality assurance plan prepared by a professional engineer registered in the same state as the project. The quality assurance plan shall identify the following:

1. Seismic systems that are subject to quality assurance:

a. Water heaters
b. Air compressors
c. Natural gas systems
d. Laboratory compressed gas systems

2. Special inspections and testing to be provided as per applicable code requirements.
3. The type and frequency of testing and special inspections.
4. The frequency and distribution of testing and special inspection reports.
5. The structural observations to be performed.
6. The required frequency and distribution of structural observation reports.

F. Contractor Responsibility Statement: When a quality assurance plan is required by the applicable building code, the Contractor responsibility statement is required. Contractor shall submit a written statement with copies to the building official and Owner indicating acknowledgement of the requirements of the quality assurance plan and identification qualifications and position of individual(s) responsible for maintaining conformance to quality assurance plan within the Contractor's organization.

G. Owner will retain and pay for services of a qualified structural/seismic engineering consultant to inspect and certify seismic restraint installation where special inspections are required by the applicable codes. The Contractor shall notify the Owner of all special inspection requirements included in the quality assurance plan. Special inspection reports shall be submitted to the Architect, seismic engineer, Owner and Contractor for record purposes.

1.7 DESIGN REQUIREMENTS

A. Refer to Section 22 05 00 Article titled “Seismic Requirements.”

B. Design isolators and restraints for equipment installed outdoors to provide adequate restraint to withstand wind loads as calculated in accordance with ASCE 7 Chapter 6, applied to any exposed surface of the isolated and/or restrained equipment. Isolators and restraints for outdoor equipment shall have bolt holes for attachment to the equipment and to the supports. Curb or roof rail mounted equipment must not only have attachment to the roof but also to the curb or rails.

C. Design seismic restraints to safely accept and resist earthquake generated external horizontal forces of not less than the following values in any direction at the center of mass without failure or permanent displacement:

1. The greater of the value calculated in accordance with the referenced building code or 0.4G for statically mounted components and 0.9G for resiliently mounted components. Life Safety equipment shall be designed to withstand a horizontal load of 0.9G and vertical load of 0.6G. The minimum horizontal restraint capability shall be 0.4G and vertical restraint shall be 0.27G for piping other than above.

D. Design of seismic restraints shall be in compliance with Section 9.6 of ASCE 7 as modified by the 2009 International Building Code.

E. Non-simultaneous vertical force shall be 66% of the horizontal force.

F. Internally isolated and restrained equipment may be used in lieu of specified external isolation and restraint provided all seismic qualification requirements are met.

G. Expected noise levels in various parts of the building shall conform to room criteria (RC) recommendations as set forth in the latest edition of the ASHRAE HVAC Applications Handbook. The midpoint range of the NC criteria curves shall apply.

H. Isolation manufacturer shall have the responsibility to determine the base type, if any, and the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration and meet the noise criteria referenced herein. Select isolation in accordance with the requirements of the latest edition of the ASHRAE HVAC Applications Handbook. The following shall apply:

1. 30 to 40 Foot (9 to 12 Meter) Floor Span: Use for locations above grade which are adjacent to sensitive occupied spaces or on lightweight or flexible construction. The span is included for reference only and shall not be the primary consideration in design.
2. 20 to 30 Foot (6 to 9 Meter) Floor Spans: Use for locations above grade as appropriate for construction.
3. Up to 20 Foot (6 Meter) Floor Span: Use for equipment on ground supported slabs adjacent to or below noise-sensitive areas.
4. Grade Supported Slab: Use for equipment on ground supported slabs which are remote or are not adjacent to or below noise- sensitive areas.

1.8 SEISMIC RESTRAINT AND VIBRATION ISOLATION MANUFACTURER'S RESPONSIBILITIES

A. Seismic Restraint and Vibration Isolation manufacturer shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Furnish vibration isolation systems and seismic restraints as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide design and application of seismic restraints in accordance with the more stringent of the requirements of the referenced building code, ASCE 7, SMACNA standards and the requirements of latest version ASHRAE Applications Handbook.
5. Provide installation instructions, drawings and field supervision to assure proper installation and performance. The installation of all vibration isolation units and seismic restraints, and associated hangers and bases, shall be under the direct supervision of the manufacturer's representative. Upon completion of installation and after system is put into operation, representative shall make a final inspection and submit his report to Architect in writing certifying correctness of installation and compliance with reviewed submittal data.
6. Provide component certification of seismic restraints and attachments capability to safely accept loads resulting from seismic forces determined by methods defined above. Certification must be substantiated by calculations or test reports verified by a licensed engineer.
7. Provide approved resilient restraining devices as required to limit equipment and piping motion in excess of 3/8 inch.
8. Advise Contractor of special size and anchor bolt requirements for foundations and housekeeping pads to develop strength equal to that for which the seismic restraints are designed to resist and certify same.

1.9 SEISMIC ENGINEER'S RESPONSIBILITIES

A. Seismic Engineer retained by the Plumbing Contractor as required shall have the following responsibilities:

1. Seismic calculations, seismic analysis and design certification.
2. Development of a seismic restraint quality assurance plan when required by the applicable building code.
3. Registered Professional Engineer in the state where the project is located.
4. Identification of any overstressed conditions and notification to Architect of overstressed conditions.
5. Review of seismic restraint manufacturer's component certifications.
6. Development of special inspection requirements for this project as required by applicable codes and standards.
7. Shop drawing review and certification of compliance with seismic analysis and design.
8. Provide calculations to determine restraint loads resulting from seismic forces presented in governing codes and project seismic requirements; with a minimum seismic acceleration applied at the equipment center of mass as specified in the "Design Requirements" Article in Part 1 of this section. Seismic calculations shall be certified by a licensed engineer, experienced in the design of seismic restraints. Submit calculations with professional engineer's stamp and signature to Owner for record purposes. Calculations included in submittal will not be reviewed.
9. Check the structural members of the building for localized stress at points of attachment for seismic restraint. The engineer shall provide to the architect the magnitude of seismic restraint force and include direction on shop drawings, together with computation of stress conditions at localized attachments only in the event that an overstressed condition is determined by the engineer. The engineer shall certify that the architect has been advised of all overstressed condition information. The architect will review only such identified locations for additional bracing or reinforcing at these localized conditions.

1.10 COORDINATION

A. Coordinate work with other trades to avoid having isolated systems coming in contact with the building. Inform other trades following this work to avoid causing any contact which would reduce the vibration isolation.

B. Coordinate size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pad.

C. Bring to the Architect's attention prior to installation any conflicts with other trades which will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.

D. Bring to the Architect's attention any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.11 INSPECTION AND INSTRUCTION

A. Notify the isolation manufacturer's representative prior to the general installation of vibration isolation devices and seismic restraints so that the isolation manufacturer's representative can instruct and demonstrate the proper installation procedures with the Contractor's foremen.

B. Obtain written and/or oral instructions from the isolation manufacturer's representative as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

C. Obtain inspection and approval from the isolation manufacturer's representative of the completed installation. Perform all work and make all adjustments as directed by the isolation manufacturer's representative as a result of the inspection.

D. Obtain inspection and approval from the isolation manufacturer's representative, and perform all directed work and adjustments, of any installation to be covered or enclosed prior to such closure.

E. Where special inspection and periodic special inspection of seismic restraints is required by the referenced building code, Contractor must submit a written statement of responsibility as part of the Quality Assurance Program including, identification of components, control procedures for all inspection and testing including frequency and method of reporting, and list of qualified personnel responsible for certifying seismic restraints.

F. The following systems require special inspection and periodic special inspection for anchorage during the course of construction:

1. All flammable combustible and highly toxic and associated systems: Periodic.
2. Equipment Using Toxic or Combustible Energy Sources: Special.
3. Reciprocating and Rotary Machinery: Special.
4. Pipe Larger Than 3 Inches: Special.
5. Tanks, Heat Exchangers, Pressure Vessels: Special.
6. Isolator Units for Seismic Isolation System: Periodic.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers :

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Mountings & Controls, Inc.
6. California Dynamics Corporation

B. General:

1. Clean and paint steel components, and zinc-electroplate all nuts, bolts and washers. Clean structural steel bases of welding slag and prime with zinc-chromate or metal etching primer.
2. All springs installed out-of-doors shall be cadmium plated, zinc electroplated or powder-coated, hardware and other metal parts installed out-of-doors shall be galvanized, zinc electroplated or cadmium plated. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
3. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
4. Isolator types are scheduled to establish minimum standards. At Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
5. All static deflections stated are not "minimal" or "rated" deflections, but are the minimum acceptable deflection for the mounts under actual load as certified by the manufacturer. Isolators selected solely on the basis of rated deflections are not acceptable and will be rejected.
6. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of compressed height of spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). All mounts shall have leveling bolts.
7. All elastomeric isolation elements shall be fabricated of neoprene or high quality synthetic rubber with anti-ozone and antioxidant additives. The formulation shall have a shore hardness of 30 to 60 $\pm$5, after minimum aging of 20 days or corresponding oven-aging. Elements used in restraints shall be bridge-bearing quality.

C. Pads:

1. Type FN (Floor Neoprene – ASHRAE Type 2):

   a. Neoprene-in-shear type with steel reinforced top and base. Cover all metal surfaces with neoprene. Ribbed top and bottom surfaces. Provide bolt holes in base. Top shall have threaded fastener. Mounts shall include leveling bolts that may be rigidly connected to equipment.

2. Type PCF (Pre-compressed Fiberglass – ASHRAE Type 1):

   a. Pre-compressed glass fiber blocks made of molded inorganic fiberglass that is individually coated and sealed with an impervious elastomeric membrane. Severely overload fiberglass during manufacture to stabilize the material into a product that is permanent and has consistent, predictable dynamic properties.

3. Type NP (Neoprene Pad – ASHRAE Type 1):

   a. One layer of 1/4 inch (7 mm) to 3/8 inch (10 mm) thick ribbed or waffle-pattern neoprene. Pads sized so that they will be loaded within manufacturer's recommended range.

4. Type DNP (Double Neoprene Pad – ASHRAE Type 1):

    a. Formed by 2 layers of 1/4 inch (7 mm) to 3/8 inch (10 mm) thick ribbed or waffled neoprene, separated by a metal plate. Plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not installed on a housekeeping pad, and may be of zinc-grip galvanized steel for indoor isolator installed on a housekeeping pad. Adhere layers permanently together. Pads sized so that they will be loaded within manufacturer's recommended range.

5. Type FN-SR (Encased Seismic Floor Neoprene):

    a. Ductile iron casting (cast iron or aluminum not allowed), with bolt holes in base, containing two separate and opposing neoprene elements compounded to bridge bearing specification. The elements shall present the central threaded sleeve and attachment leveling bolt and washer from contacting the casting during normal operation. Unit tested and rated as a seismic restraint in all directions.
    b. Subject to appropriate seismic restraint capacity certified by the isolation manufacturer for weight of supported equipment, may be substituted for Type FN where seismic restraint is required.

D. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with base plate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

F. Spring Isolators, Type FSN (Floor-Spring-Neoprene): Freestanding, laterally stable, combination coil-spring and elastomeric isolator with spring and insert in compression (ASHRAE Type 3).

1. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
2. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed

outdoors and for indoor isolator not mounted on a housekeeping pad, and may be zinc-grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.

3. If isolator is to be fastened to the building structure and a Type NP isolator is used under the bearing plate, provide grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
9. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

G. Restrained Spring Isolators, Type FSNTL (Floor-Spring-Neoprene, Travel Limited): Freestanding, laterally stable, combination coil-spring and elastomeric-insert isolator with seismic or limit-stop restraint (ASHRAE Type 4).

1. All mounts shall have leveling bolts and vertical travel limit stops to control extension when weight is removed. Travel limit stops shall be capable of serving as blocking during erection of equipment. Maintain a minimum clearance of 1/4 inch (6 mm) around restraining bolts and between limit stops and spring to avoid interference with spring action.
2. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load pad uniformly within the manufacturer's recommended range.
3. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not mounted on a housekeeping pad, and may be zinc-grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
4. If isolator is to be fastened to building structure and a Type NP isolator is used under the bearing plate, provide neoprene grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
5. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
6. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
7. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

8. Minimum Additional Travel: 50 percent of the required deflection at rated load.
9. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
10. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

H. Housed Spring Mounts Type FSNTL-SR (Combination Floor Spring and Neoprene Travel Limited Isolation and Seismic Restraint): Housed spring isolator with integral seismic snubbers.

1. Same as Type FSNTL. In addition, unit tested and rated as a seismic restraint and shall incorporate snubbing restraint in all directions.
2. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
3. Base: Factory drilled for bolting to structure.
4. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.

I. Elastomeric Hangers Type HN (Hanger-Neoprene): Single or double-deflection type compression hanger (ASHRAE Type 2).

1. General: Fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Provide neoprene neck bushing where hanger rod passes through the hanger housing to prevent rod from contacting hanger housing. Make diameter of hole in housing sufficient to permit hanger rod to swing through a 30^{o} arc before contacting hanger housing.

J. Spring Hangers Type HSN (Hanger Spring Neoprene): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression (ASHRAE Type 3).

1. General: Vibration isolation hangers consist of a freestanding, laterally stable steel spring and a neoprene element in series, contained within a steel housing. Make spring diameters and hanger housing lower hole sized large enough to permit hanger rod to swing through a 30^{o} arc before contacting housing or make equivalent alternative provisions to allow specified movement.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene with a 0.3 inch (7 mm) minimum static deflection. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Resilient Penetration Sleeve/Seal: Field fabricate from pipe or sheet metal section 1/2 inch (12 mm) to 3/4 inch (19 mm) larger in each dimension than penetrating element in all directions around the element. Use to provide a sleeve through construction penetrated. Extend sleeve 1 inch (25 mm) beyond penetrated construction on each side. Pack annular space between sleeve and the penetrating element tightly with glass fiber or mineral wool to within 1/4 inch (6 mm) of ends of sleeve. Fill remaining 1/4 inch (6 mm) space on each side with acoustical sealant to form an airtight seal. Penetrating element shall be able to pass through sleeve without contacting sleeve. Alternatively, prefabricated sleeves accomplishing same result are acceptable.

N. Grommets: Form grommets to prevent bolts from directly contacting the isolator base plate and sized so that they will be loaded within the manufacturer's recommended load range.

2.2 RESTRAINED, NON-ISOLATED ROOF CURB (Type BC-3)

A. Acceptable Manufacturers:

1. Kinetics Noise Control
2. Mason Industries
3. Vibration Eliminator Co., Inc.
4. Thybar Corporation
5. Vibration & Mounting Controls, Inc.

B. General Requirements for Restrained Non- Isolated Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to support equipment and to withstand seismic forces.

C. Lower Support Assembly: Formed sheet-metal section that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

D. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building steel.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials. Weather-protect each spring isolator.

F. Pitched Roof: Fabricate roof curb with tapered bottom designed to match roof slope where required whether or not indicated on drawings.

G. Connections: All wiring and duct connections made within perimeter of roof curb.

2.3 NON-RESTRAINED, NON-ISOLATED ROOF CURB (Type BC-4)

A. Acceptable Manufacturers:

1. Roof curb manufacturer shall be the responsibility of the roof-mounted equipment manufacturer.

B. General: Requirements for Non Restrained Non- Isolated Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to support equipment and to withstand wind forces.

C. Lower Support Assembly: Formed sheet-metal section that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

D. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building steel.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials. Weather protect each spring isolator.

F. Pitched Roof: Fabricate roof curb with tapered bottom designed to match roof slope where required whether or not indicated on drawings.

G. Connections: All wiring and duct connections made within perimeter of roof curb.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Mountings & Controls, Inc.

B. Steel Base, Type BSF (Base Steel Frame): Factory-fabricated, welded, structural steel bases and rails (ASHRAE Type B).

1. General: Consists of structural steel sections sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner which will adversely affect operation of supported equipment or vibration isolation mounts. Independent steel rails are not permitted. Size frame adequately to support basic equipment unit and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer to building structure. Depth of steel frame bases at least 1/10 the longest dimension of the base, and not less than 6 inches (15 cm). Base footprint shall be large enough to provide stability for supported equipment.
2. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support. Include side mounting brackets for attachment to vibration isolators. Locate mounting brackets on the sides of the base that are parallel to the axis of rotation of the supported requirement.

C. Inertia Base, Type BIB (Base Inertia Base): Factory-fabricated, welded, structural steel bases and rails ready for placement of cast-in-place concrete (ASHRAE Type C).

1. General: Form base of stone-aggregate concrete cast into steel pouring form with appropriate reinforcement. Build inertia base to form a rigid base which will not twist, rack, deform, deflect or crack in any manner which will adversely affect operation of supported equipment or vibration isolation mounts. Size inertia base adequately to support basic equipment unit and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer to building structure. Base depth at least 1/12 the longest dimension of inertia base, and not less than 6 inches (15 cm) or more than 12 inches (30 cm). Base footprint shall be large enough to provide stability for supported equipment. Steel frame and reinforcement pouring form with full bottom pan to be supplied by vibration isolator manufacturer. Concrete to be placed in the field and appropriately cured before installation of equipment.
2. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support. Include side mounting

brackets for attachment to vibration isolators. Locate mounting brackets on the sides of the base that are parallel to the axis of rotation of the supported requirement.

5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.5 SEISMIC-RESTRAINT DEVICES

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control
6. Loos & Co.; Cableware Division.
7. Mason Industries
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:

1. Restraints shall be capable of safely accepting external forces specified in the DESIGN REQUIREMENTS article in Part I of this section, without failure, shall maintain mechanical systems, and accessories in a captive position, and shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.
2. EXCEPT FOR TYPE I RESTRAINT, systems that incorporate vibration isolation support within seismic restraint housing are not permitted – seismic restraints must be separate from isolation mounts.
3. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Type I Restraint: Type FSNTL-SR, Type FN-SR.

D. Type II Restraint

1. All directional, double acting seismic snubber consisting of interlocking steel members restrained by shock absorbent elastomeric material compounded to bridge bearing specifications as indicated elsewhere in this section. Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
2. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Elastomeric bushing shall be replaceable and a minimum of 1/4-inch- (6-mm) thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8-inch- (3-mm) or more than 1/4-inch- (6-mm).
5. The snubber shall be constructed to allow easy inspection of snubber internal clearances.

E. Type III Restraint

1. Cable type system consisting of ASTM A 492 stainless steel cable designed for a minimum safety factor of 2, and end fastening devices, arranged to provide all-directional restraint. End fastening devices, steel assemblies with thimbles, brackets, swivel and bolts designed to swivel and clamp cable with 2 clamping bolts. All parts of system including cables and clamps, but excluding fastenings, to be furnished by a single vendor to assure seismic compliance.
2. The cable size and attachment to the restrained item and structure shall be designed and signed by a licensed engineer.
3. Submittal drawing shall indicate method of vertical restraint.

F. Type IV Restraint: Nonisolated equipment to be positively attached to structure (powder shots not acceptable) to resist seismic forces.

G. Type V Restraint: Seismic solid brace consisting of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all direction (compression, tension and torsion) restraint. Solid brace end connectors shall be assemblies that swivel to the final installation and utilize minimum 2 bolts to provide proper attachment to structure. Provide corrosion resistant coating.

H. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

I. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

J. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

L. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

M. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 VIBRATION ISOLATION THRUST RESTRAINTS (ASHRAE Type 5)

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Company

B. Consists of a spring element in series with a neoprene pad. Design unit to have the same deflection due to thrust-generated loads as specified for isolators supporting equipment. Contain and design the spring element within a steel frame so it can be pre-compressed at the factory to allow for a maximum of 1/4-inch (6-mm) movement during starting or stopping of equipment. Allowable movement shall be field adjustable.

C. Furnish assembly complete with rods and angle brackets for attachment to both equipment and adjacent fixed structural anchor. Oversize holes in the spring restraint brackets through which the restraint rods pass to prevent contact between the brackets and rods.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Provide vibration isolators of appropriate sizes and proper loading. Select in accordance with the weight distribution to provide reasonably uniform deflection.

B. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet requirements stated herein, even if not expressly specified or shown on Drawings, without claim for additional payment.

C. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

D. Should any rotating equipment cause excessive noise or vibration when properly installed on the vibration isolators, the Contractor shall be responsible for rebalancing, realignment or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for unit in question.

E. Make certain that seismic restraints do not short circuit the isolation system and that isolation system is unrestrained.

F. Adjust isolators after piping system is at operating weight.

G. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

H. Adjust active height of spring isolators.

I. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.3 SEISMIC RESTRAINT, APPLICATION

A. General

1. Seismically restrain all specified work in all directions.
2. Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

B. Equipment

1. Isolated Equipment

a. Suspended Isolated Equipment: Provide four point Type III restraints, up-stop snubbers for vibration isolators and suspension rod stiffener angles or pipe sleeves as required for the following equipment:

1) Tanks
2) Heat Exchangers

b. Other Isolated Equipment: Mount equipment on rigid steel frame unless the equipment manufacturer certifies direct attachment capability. Provide a minimum of four Type I or Type II Restraints. Locate Type II restraints as close to the vibration isolator as possible to facilitate attachment to the base and the structure. At option of Contractor, provide Unit RIRS where applicable.

2. Rigidly Mounted Non-isolated Equipment

a. Provide four point Type III or Type V restraints for overhead suspended equipment. For other equipment, provide Type IV restraints using properly sized anchor bolts.

3. Internally Isolated Equipment

a. Manufacturer assumes responsibility of meeting seismic requirements and must submit in writing, certification that equipment meets all seismic requirements of the referenced building code, signed and stamped by a registered engineer in the state where the project is located.

4. Supplementary Restraints, Isolated and Non-isolated Equipment

a. Where base anchoring for heavy equipment and for high center of gravity equipment is insufficient to resist seismic forces, provide four point Type III

restraints, connected above center of gravity, as required to suitably resist the seismic force levels. The need for such additional restraints shall be determined by the isolation manufacturer.

C. Piping

1. Piping restraints shall comply with requirements in MSS SP-127.
2. Provide Type III restraints for isolated piping in mechanical rooms. Type III or Type V seismic restraints for non-isolated piping. All other piping 2-1/2 inch (6 cm) diameter and larger, provide Type III restraints for isolated piping and Type III or Type V restraints for non-isolated piping. Provide up-stop snubbers for vibration isolators and suspension rod stiffeners as required.
3. Transverse bracing on runs of piping not to exceed a spacing of 10 feet (3.0 m) on no-hub piping; transverse bracing on runs of other piping up to size 16 inches (40 cm) not to exceed 40 feet (12.2 m).
4. Longitudinal bracing at 20 feet (6.1 m) intervals on no-hub piping; longitudinal bracing of other piping at intervals of 80 feet (24.3 m) on piping size up to 16 inches (40 cm).
5. Bracing distances for multiple pipe runs on the same support must be calculated by isolation manufacturer.
6. Hold-down clamps must be used to attach pipe to all trapeze hangers prior to installing restraint. Clamps or restraints must not impede thermal expansion or contraction of piping system.
7. Branch piping is not an acceptable means for restraining main piping.
8. All high hazard and life safety systems regardless of size such as fuel oil or gas shall be seismically restrained. Provide Type III restraints for isolated piping and Type III or Type V restraints for non-isolated piping.

D. Electrical Equipment and Conduit: Restrain electrical equipment and conduit provided under Division 22 as specified for plumbing equipment and piping.

E. Tanks and Vessels: Seismic restraints for tanks and vessels storing liquids, gases and granular solids shall be designed in accord with ASCE 7, latest edition, section 9 and referenced codes within this section.

F. Underground Utilities: Provide design for adequate flexibility to accommodate differential movement at interface of underground utilities and the structure wherever site Class E or F soil is present or the seismic coefficient S_{DS} at the underground utility or base of structure is equal to or greater than 0.33.

G. Exclusions to Seismic Restraints

1. Only systems or components specifically indicated herein are not required to be seismically restrained. High hazard systems can not be excluded in any circumstance.

    a. Clevis supported piping or conduit suspended 12 inches (30 cm) or less in length from the top of pipe to the supporting structure. All hangers must meet length requirement, any portion of pipe run suspended greater than 12 inches (30 cm) will require the entire pipe run to be seismically restrained.

b. Ductile piping in seismic design categories D, E and F designated as having an Ip = 1.5 and a nominal pipe size of 1 inch (25 mm) or smaller when protected from impact of larger piping or mechanical equipment.
c. Ductile piping in seismic design category C designated as having an Ip = 1.3 and a nominal pipe size of 2 inches (5 cm) or smaller when protected from impact of larger piping or mechanical equipment.
d. Ductile piping in seismic design categories D, E and F designated as having an Ip = 1.0 and a nominal pipe size of 3 inches (75 mm) or less.
e. Ductile piping in seismic design categories A, B or C designated as having an Ip = 1.0 and a nominal pipe size of 6 inches (15 cm) or less.

3.4 SEISMIC RESTRAINTS, INSTALLATION

A. General

1. Install restraints in strict accordance with seismic codes, building construction standards, the isolation manufacturer's written instructions and the verbal instructions of his authorized representative. Whenever a conflict occurs, the most stringent shall apply.
2. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
3. Positively attach restraints to the supporting structure and to the equipment, and piping.
4. Install seismic snubbers on equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
5. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

B. Equipment Restraints

1. Construct housekeeping pads in accordance with the reviewed submittal data.
2. Restraints shall not interfere with the performance of the vibration isolation system and shall not restrict normal vibratory movement of equipment, piping or ductwork during normal operation, startup or stopping. Install carefully and adjust carefully after system startup and with equipment in operation to insure that proper clearances are maintained.

C. Where restraints are attached to clevis hangers, provide cross bolt reinforcement.

D. Shim snubbers as required to achieve and maintain clearance.

E. Positively attach restraints to structure by field bolting or welding. Overstress of the building structure must not occur. Do not support overhead supported equipment from slab diaphragms between beams unless specifically approved. Support can occur from:

1. Flanges of structural steel beams
2. Cast-in-place inserts or drilled in mechanical type anchor, Hilti or equal, in concrete. Shot pins and adhesive type anchors are not allowed.

F. Install Type III restraints with slack as required, 1/2 inch (12 mm) maximum, to prevent excessive seismic motion for vibration isolated systems and equipment and to allow for thermal

movement where applicable. Install Type III restraints taut elsewhere. Provide two sided beam clamps when securing to steel structural members.

G. Contractor shall notify special inspection agency/engineering consultant 48 hours in advance of work being completed for required special inspections. Contractor shall cooperate with and shall provide free access to work for the special inspection agency/engineering consultant.

H. Deliver equipment roof curbs and/or rails to Roofing Contractor for installation.

3.5 VIBRATION ISOLATION, APPLICATION

A. General

1. The static deflections of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment

1. Unless otherwise shown or specified, set all floor mounted major equipment on 4 inch (10 cm) high housekeeping type concrete pad properly doweled or bolted to floor to meet acceleration criteria. Size pad to extend far enough beyond restraint to develop full rating of restraint in accordance with isolation manufacturer's instructions.
2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as as specified in the “Design Requirements” article in Part 1 of this section.

C. Miscellaneous Plumbing Equipment

1. Isolate the following miscellaneous pieces of plumbing equipment which are connected to isolated piping systems from the building structure:

    a. Heat Exchangers
    b. Storage Tanks

2. Isolate miscellaneous mechanical equipment listed with Type NP or Type HN isolators, selected for 0.1 inch (2.5 mm) static deflection unless their position in piping system requires a higher degree of isolation as called for under piping isolation.

D. Pipe Isolation

1. All domestic water, and drainage piping shall be isolated from the building structure within the following limits:

    a. Within mechanical rooms;
    b. Within 50 foot (15 m) total pipe length of connected vibration-isolated equipment pumps, etc.;
    c. All of the above piping that is 6 inches (15 cm) or larger shall be isolated everywhere.

2. Piping shall be isolated from building structure by means of vibration isolation, resilient lateral supports and, except at penetration through fire-rated construction, resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2 inch (12 mm), Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2 inch (12 mm), Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving not less than 1/4 inch (6 mm) static deflection.

4. Where lateral support of pipe risers is required within the specified areas, use resilient lateral support.
5. Isolate pipes within the specified areas that penetrate nonfire-rated building construction from the building structure by use of resilient penetrating sleeve/seals.
6. Check that drain piping connected to vibration isolated equipment does not contact the building structure or other nonisolated system unless it is resiliently mounted as described above.
7. Provide flexible pipe connections in piping systems as called for under “Division 22” and wherever shown on the Drawings.

3.6 VIBRATION ISOLATION, INSTALLATION

A. General

1. Select locations of all vibration isolation equipment for ease of inspection and adjustments, as well as for proper operation.
2. Install vibration isolation equipment in accordance with isolation manufacturer’s written instructions.
3. Prior to startup, verify that there are no isolation short circuits.
4. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Isolators

1. Align all vibration isolators squarely above or below mounting points of supported equipment.
2. Locate isolators for equipment with bases on the side of the bases which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein or shown on the drawings.
4. If a housekeeping pad is provided, isolators and the isolator base plate must rest entirely on pad.
5. For steel framed structures, connect hanger rods for vibration isolated support to structural beams or joists, not to floor slab between beams and joists. Provide intermediate support members and joist reinforcing members as necessary.

6. Position vibration isolation hanger elements as high as possible in hanger rod assembly, but not in contact with building structure, so that hanger housing may rotate a full 360° about rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze which is isolated from building. Deflections must be largest determined by provisions for pipe isolation. Do not hang isolated and nonisolated pipes on same trapeze.
8. Do not support pipes, or equipment from other pipes or equipment.
9. Resiliently isolated pipes shall not contact building construction or other equipment.
10. The installed and operating heights of isolated equipment mounted on Type FSNTL isolators or Type BC-1 bases shall be the same. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4 inch (6 mm) clearance between limit stop brackets and isolator top plate, and between travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. Equipment shall not bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by equipment manufacturer. This provision applies whether or not a base frame is called for on the schedule. In the case that a base frame is required for equipment because of equipment manufacturer's requirements and a base frame for the equipment is not specifically called for on equipment schedule, Contractor for Division 22 shall provide the base frame recommended by equipment manufacturer at no additional expense.
2. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch (25 mm) between steel rails, steel frame bases or inertia bases and the concrete housekeeping pad or floor beneath the equipment. Position isolator mounting brackets so that required clearance is maintained. Check and clean clearance space to ensure that no construction debris has been left to short-circuit or restrict proper operation of vibration isolation system.

D. Vibration Isolation Thrust Restraints: Attach thrust restraints at the vertical centerline of thrust on each side of the unit, and so that thrust rods are in tension only. Install the two rods of the thrust restraint parallel to the thrust force. This may require modified brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Adjust restraints to constrain equipment movement to the specified limit.

E. Resilient Penetration Sleeve/Seals: Install penetration seals to maintain an airtight seal around penetrating element and to prevent rigid contact of penetrating element and building construction. Fit sleeve tightly to building construction and seal airtight on both sides of construction penetrated with acoustical sealant.

F. Grommets: Where grommets are required at hold-down bolts of isolators, properly size bolt holes to allow for grommets. The hold-down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized for galvanized isolators and stainless steel elsewhere.

3.7 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 for piping flexible connections.

3.8 FIELD QUALITY CONTROL

A. Upon completion of installation of all vibration isolation devices, the isolation manufacturer's representative shall inspect the installation and certify in writing to the Contractor that all isolation devices are installed properly, or require correction.

B. All independent Special and Periodic Inspections must be performed and submitted on components as outlined in Part 1 of this Section.

3.9 PLUMBING VIBRATION-ISOLATION DEVICE SCHEDULE

END OF SECTION 22 05 48

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plumbing Piping Insulation
2. Adhesives, mastics, tapes
3. Recovering

B. Related Sections

1. Warranty, pipe insulation insert and shields are specified in Section 22 05 00, “Common Materials and Methods for Plumbing Systems”.

1.3 DEFINITIONS

A. Cold Surfaces: Normal operating temperatures less than 75^{o} F.

B. Density: Is expressed in pcf (pounds/cu. ft.).

C. Dual Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

D. Hot Surfaces: Normal operating temperatures of 100^{o} F. or higher.

E. Thermal Conductivity ("K" value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of (Btu x inch)/(h x sq. ft. x ^{o} F.).

F. Through Resistivity ("R" value): Represents the reciprocal of thermal conductivity ("K" value).

1.4 REFERENCES

A. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

B. ASTM E84 Surface Burning Characteristics of Building Materials.

C. MICA Standards: National Commercial & Industrial Insulation Standards published by the Midwest Insulation Contractors Association. Endorsed by National Insulation Contractors Association (NICA) and its regional associations.

D. NFPA 255 Test of Surface Burning Characteristics of Building Materials.

E. UL 723 Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, as applicable).

B. Product Schedule or List: Prepare a summary of products required and clearly indicate location of their intended use.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. For products where color is specified, show the full range of colors available for each type of finish.

1.6 QUALITY ASSURANCE

A. Materials, job conditions and installation shall be in compliance with the applicable Building and Plumbing Codes.

B. Installation shall be done in a workmanlike manner by skilled and experienced workers who are regularly employed in commercial/industrial insulation work, in accordance with manufacturer's recommendations and instructions and best practices of the trade.

C. Comply with the more stringent of the requirements of this specification or the requirements of the MICA standards.

D. Insulation materials manufacturing facilities must be certified and registered with an approved registrar for conformance with ISO 9000 quality standard.

E. Fire Performance Characteristics

1. Insulation, jacketing materials, PVC covers, tapes, adhesives, mastics, cements and finish coatings shall have a composite noncombustible fire and smoke hazard rating and label, as tested in accordance with United States Public Health Service requirements, ASTM E84, NFPA 255 and UL 723 not exceeding Flame Spread 25 and Smoke Developed 50.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Deliver materials to job site in original nonbroken factory packaging, labeled with manufacturer's density and thickness and store in a safe, dry place.

B. No insulation material shall be installed that has become damaged in any way.

C. Do not install and remove from the site, any insulation material that has become wet because of transit or job site exposure to moisture or water. Remove insulation from piping and/or equipment which has become wet. Reinsulate as required.

1.8 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Common Materials and Methods for Plumbing."

B. Coordinate clearance requirements with installing contractor for insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing of piping systems. Insulation application may begin on segments that have satisfactory test results.

B. Schedule insulation application on water piping prior to activation of system. Do not install insulation to surfaces where condensation is present.

1.10 ALTERNATIVES

A. Alternative insulations are subject to Architect's approval. Alternatives shall provide, at normal conditions, thermal resistance within 5% of resistance of materials specified.

B. Where alternative thermal conductivity ("k") differs from specified thermal conductivity by more than 5%, increase or decrease insulation thickness as follows:

$$\text{New thickness} = \frac{\text{Actual "k"}}{\text{Specified "k"}} \times \text{specified thickness}$$

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armstrong World Industries
3. Owens-Corning Fiberglass
4. Knauf Insulation
5. Certain Teed

B. Insulation Type P1:

1. Piping: Fine fibrous glass insulation, with factory applied vapor barrier jacket, molded to conform to piping, "k" value at 75° F. maximum 0.23. Johns Manville "Micro-Lok AP-T Plus" with jacket of white Kraft reinforced with fiberglass yarn and bonded to aluminum foil, and having a pressure sensitive tape closure system bonded to the longitudinal lap.
2. Valves and Fittings:

    a. Factory molded fibrous glass fitting covering for fittings of equal thickness to adjacent pipe insulation. Cover with 6 ounce canvas on concealed piping and 8 ounce canvas on exposed piping.
    b. Mitered sections of pipe covering for valves.

C. Insulation Type P2:

1. Piping: For indoor, in wet environment application, Type P1 insulation with additional PVC jacket Zeston 2000 PVC or equal with minimum thickness of 0.030 inches. Seal with permaweld adhesive.
2. Valves and Fittings: Mitered sections of Type P2 piping insulation with miter seals and snap-straps.

D. Insulation Type P4: Piping, Valves and Fittings: Asbestos free hydrous calcium silicate colored gold throughout, molded to conform to piping, "k" value at 200° F. and 500° F. maximum 0.42 and 0.50 Btu/in./sq.ft./° F./hr. respectively. Johns Manville "Thermo-12 Gold" throughout.

E. Insulation Type P5 Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

PART 3 - EXECUTION

3.1 PREPARATION

A. Determine clearances required for installation of work and review such requirements with trades responsible for installing various piping systems, and equipment to be insulated. Where it is determined that working clearances between equipment and material to be insulated and adjacent work will restrict or prohibit proper installation of work, immediately report such conditions to all interested parties and arrange to have affected material relocated or preinsulated before erection, as approved. Failure to so comply will not relieve Contractor of full responsibility for providing specified insulation.

B. Do not install covering before piping, and equipment has been tested and approved.

C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with applicable requirements of Division 22 Section, “Common Materials and Methods for Plumbing”. Where insulation requirement indicated for domestic water piping shall also apply to industrial or non-potable water piping system in scope of work.

B. Adhesives and mastics materials shall be compatible with insulation material, jackets and substrates. Apply insulation and adhesives in accordance with manufacturers' instructions.

C. Do not install any insulation before building is adequately closed in. Where it is necessary to install insulation in any section of building that is not adequately closed in, secure prior permission and, where permission is granted, such insulation shall be in place to form a waterproof covering. Remove and replace all insulation installed that becomes water saturated because of failure to comply with this requirement, at no increase in the Contract sum.

D. Clean excess adhesive, mastic or cement used in performance of work from all exposed surfaces of insulation jacketing materials. Clean smudges and dirt from all exposed surfaces of insulation jacketing materials at conclusion of this work.

E. Apply insulation on all cold surfaces with a continuous, unbroken vapor seal. Install hangers outside of insulation for all piping subject to sweating (e.g., domestic water piping, storm water drainage, cold USP water piping) and provide inserts - refer to and coordinate with Section 22 05 00, Part 3, Article titled "PIPING SYSTEMS – COMMON REQUIREMENTS", paragraph titled "Pipe Insulation Inserts and Shields". For all equipment subject to sweating, insulate and vapor seal hangers, supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.

F. Extend all surface finishes to protect all surfaces, ends and raw edges of insulation.

G. Install insulation on and at access doors to allow easy use of access door without damage to insulation.

H. Finish insulation neatly at hangers, supports and other protrusions.

I. Install insulation with least number of joints practical. Locate insulation, or cover seams, in least visible locations.

J. Finish installation with systems at operating conditions. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

K. Be responsible for proper curing of insulation, etc., in accordance with manufacturers' requirements.

3.3 PENETRATIONS

A. Refer to Division 22 Section “Common Materials and Methods for Plumbing” for additional requirements.

B. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

C. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

D. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

E. Insulation Installation at Non-Rated Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.

F. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07. Coordinate requirements for sleeves and clearance between finished surface of penetrating item and penetrated construction to achieve proper installation of through-penetration fire-stop system.

G. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Carry pipe insulation through sleeves and through hangers which are specified to be installed outside insulation.

C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation of same material and thickness as used for adjacent pipe. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
10. Do not insulate flexible connections and expansion joints. Install insulation on flanges, valves and unions so that it can be removed and replaced without damaging adjacent insulation.

D. Strainers, temperature control valves, safety valves, relief valves, flanges and unions in hot piping 1 inch and smaller in size in equipment rooms and 2 inches and smaller in size elsewhere. Finish insulation neatly at flanges, leaving space for access to both.

E. Terminate insulation neatly and finish all exposed ends with plastic material troweled on bevel.

F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

G. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

H. Insulation Type P1

1. Seal longitudinal laps of jackets and wrap butt joints with 3 inch wide strip of jacketing material securely sealed in place.
2. Where factory-molded fibrous glass fitting covering is used, finish insulation on concealed and exposed hot piping with same jacketing material as adjacent insulation lap-sealed and finished with Foster 30-36, Childers CP-50A or equal. Finish insulation on cold piping same as for hot piping except that sealer shall be Foster 30-35 or Childers CP-30LO vapor sealer.
3. Finish valve covering in hot and cold piping systems same as specified above for fittings.
4. Recover exposed piping in finished areas with 0.02 mil thick PVC jacket with 0.02 mil thick PVC jacket or aluminum jacket, except use Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, adhered and then finished with Foster 30-36 or Childers CP-50A at steam pressure reducing stations and when piping systems are specified to be painted.

I. Insulation Type P2

1. Secure PVC jacket in place by a continuous longitudinal solvent weld type joint.
2. Use mitered sections of PVC jacketed insulation for valves and fittings. Seal joints with solvent weld compound
3. Entire installation of PVC and/or aluminum jacketed insulation shall be weatherproof.

3.5 PIPING INSULATION SCHEDULE

A. Thickness Schedule (TS)

TABLE 1 Plumbing Piping and Drainage Minimum Insulation Thickness for Pipe Sizes*					
Schedule No.	Water Temp. Range	Less than 1-inch	1-inch to 1½-inch	1-1/2 to 8 In.	Over 8 In.
	Deg F.	in.	in.	in.	in.
TS-10	141-200	1.5	1.5	2.0	2.0
TS-11	105-140	1	1.5	1.5	1.5
TS-12	40-60	0.5	0.5	1.0	1.0
*Refer to Article titled "Alternatives". *Comply with ASHRAE 90.1 - 2016					

B. Type: Unless otherwise specified use Insulation Type P1 on indoor piping and Insulation Type P2 on outdoor piping, except as follows:

C. Plumbing and Drainage Piping System Insulation Requirements

Service	Thickness Schedule
Chilled Drinking Water	None
Deionized Water	None
Distilled Water	None
Domestic Cold Water, Above Ground	
1. General Service	1- Inch
2. In exterior walls or otherwise subject to freezing	TS-12 Plus 1 inch
3. Chrome Plated Piping	None
Domestic Hot and Recirculating Water	
1. General Service	TS-11
2. Kitchen or Laundry Service greater than 160 deg. F.	None
3. In exterior walls or subject to freezing otherwise to freezing otherwise	Listed schedule above plus 1 inch
4. Chromium Plated Piping	None
5. Temperature maintenance Heat Traced Piping	TS-11
Drainage and Vent. Insulate Only the following:	
1. Roof drain, vertical connection between drain and horizontal piping, and all above Ground horizontal storm drainage piping. Exposed	1 inch

Service	Thickness Schedule
storm piping insulation shall be colored black and white as required to match exposed painted ceiling spaces.	
2. Above ground floor drain service ice maker, refrigeration and air conditioning system Including vertical connection between drain and horizontal piping and connected horizontal piping.	½ inch
3. Electric water cooler and chilled drinking water branch drain, including trap	½ inch
4. Refrigerator drain piping	½ inch
5. Ice maker drain piping	½ inch
Lawn Sprinkler Inside Building, Above Ground	None
Purified Water	None
Cold Water	1 Inch
Hot Water	TS-11

END OF SECTION 22 07 00

SECTION 22 10 00 - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following plumbing materials and equipment for domestic water, fuel gas and drainage systems:

1. Pipe and fittings
2. Valves
3. Water heaters
4. Drains
5. Mixing valves
6. Pressure regulators
7. Backflow preventers
8. Water Filters
9. Leak Detection
10. Trap primers
11. Cleanouts
12. Enclosure with freeze protection

B. Related Sections include the following:

1. Section 22 11 00: Disinfection of Domestic Water Lines
2. Section 22 05 00: Basic Materials and Methods
3. Section 22 07 00: Plumbing Insulation
4. Section 22 11 23: Plumbing Pumps
5. Section 22 05 13: Electrical Equipment and Wiring for Plumbing Systems
6. Section 22 05 48: Vibration Isolation and Seismic Restraints for Plumbing Equipment
7. Section 22 60 00: Special Systems
8. Section 22 40 00: Plumbing Fixtures and Trim
9. Section 21 00 00: Fire Suppression
10. Division 25: Integrated Automation
11. Division 26: Electrical
12. Division 40: Process

1.3 REFERENCES

A. AGA - Installation of Gas Appliance and Gas Piping

B. ASME A112.26.1M, ASSE 1010, PDI - WH201 - Water Hammer Arresters

C. ASME - Boiler and Pressure Vessel Code

D. ASSE 1018 - Trap Seal Primer Valves, Water Supply Fed

E. ASTM C478 - Precast Reinforced Concrete Manhole Sections

F. NEMA MG-1 - Motors and Generators

G. IFC, 2021 International Fuel Gas Code

H. NFPA 54, 2018 National Fuel Gas Code

I. NFPA 58, 2020 Liquified Petroleum Gas Code

J. NFPA 70 - National Electrical Code

K. AGA - Plastic Pipe Manual for Gas Service

L. Nevada State Department of Labor & Industry Regulations Governing Boilers and Unfired Pressure Vessels

M. ASCE/SEI 7 - Seismic Performance Criteria

N. NSF 61 - Standard for Potable Domestic Water Piping and Components

1.4 SUBMITTALS

A. Product data for the following:

1. Pipe, valves and fittings
2. Drains, cleanouts and trap primers
3. Water heating equipment
4. Backflow preventers
5. Mixing valves/high temperature alarm
6. Pressure regulators
7. Decontamination holding tank with related accessories

B. Welding certificates.

1.5 WARRANTY AND CONTRACT CLOSEOUT

A. Warranty

1. Refer to BIDDING AND CONTRACT REQUIREMENTS and to warranty and contract closeout requirements specified in DIVISION 00.

B. Contract Closeout

1. Comply with requirements of Division 1, Contract Closeout.
2. Include information for all products specified in this section, in the operating and maintenance manual.
3. Provide the following as specified in this section or Section 22 05 00.

a. Testing and cleaning reports certified by contractor for each system.
b. Balancing report for domestic hot water recirculation system. Include certificate stating degree of accuracy of instruments.
c. Portable flow measuring instrument for automatic flow control valves.
d. Insurance inspection certificate for direct fired storage domestic water heater.
e. Qualification certificates for plastic piping system installers/solvent welders.

1.6 PRODUCTS FURNISHED BY OTHERS

A. Provide rough-in, traps and final drain and water connections for following.

1. Laboratory furniture and equipment.

1.7 WORK PROVIDED FOR PLUMBING SYSTEM UNDER OTHER SECTIONS

A. Vent/flue for direct fired gas domestic hot water heater will be provided by the Contractor for Division 23.

1.8 WORK IN OTHER DIVISIONS

A. Underground storm drainage pipe and fittings 5 feet beyond the building wall will be provided under Division 31, EARTHWORK, including all manholes, inlets and headwalls.

B. All footing drainage pipe and fittings will be provided under Division 31, EARTHWORK.

1.9 ENERGY PERFORMANCE CRITERIA

A. Rating temperatures and conditions, Coefficient of Performance (COP) and Energy Efficiency Rate (EER) of all equipment and components provided under this section shall meet the requirements of the State Energy Code or latest issue of ASHRAE Standard 90.1, or of the latest issue of the Standards for Equipment in the National Energy Policy Act, whichever is more stringent.

1.10 SEISMIC DESIGN

A. Refer to Section 22 05 00, Article 1.10.

1.11 PLASTIC PIPE EXPANSION DESIGN CRITERIA

A. Base expansion calculations on 50^{o} F. installation temperature to 140^{o} F. for the laboratory waste and RO/DI system.

1.12 QUALIFICATION OF PLASTIC PIPE INSTALLERS AND WELDERS

A. Obtain and pay for the services of an authorized representative of the plastic pipe manufacturer to qualify and certify plastic pipe installers and plastic pipe solvent and electric fusion welders. For plastic gas piping systems, qualification instruction shall comply with the AGA plastic pipe manual for gas service.

B. Qualification: Procedures shall be as recommended by the plastic pipe manufacturer and the AGA plastic pipe manual for gas service and shall include the following as a minimum:

1. Plastic Pipe Installers: Educational material in the expansion and contraction of plastic pipe and comparison to expansion and contraction of metallic pipe materials. Instructions for determining need, location and sizing of expansion loops, offsets and legs to accommodate the expansion and contraction of the plastic pipe.
2. Solvent and Electric Fusion Welders: Instruction on the manufacturer's recommended welding procedures, observation and inspection of a sufficient number of test welds by each welder to be reasonably assured that the welder is capable of producing acceptable welds.

C. Certificates: Provide a written statement by the manufacturer's authorized representative listing the names of personnel who the manufacturer's authorized representative has qualified as a plastic pipe installer and/or a plastic pipe solvent and/or electric fusion welder.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of the following manufacture:

1. Automatic Trap Primer

a. Jay R. Smith Mfg. Co.
b. Josam Mfg. Co.
c. Precision Plumbing Products, Inc.
d. Zurn Industries, Inc.
e. Watts Drainage

2. Backflow Preventer

    a. Watts Regulator Co.
    b. Zurn Wilkins Division
    c. Ames
    d. Febco

3. Cleanouts, Carriers, Drains, Interceptors

    a. Watts Drainage
    b. Enfield
    c. Jay R. Smith Mfg. Co.
    d. Josam Mfg. Co.
    e. Wade Div. Tyler Pipe Industries, Inc.
    f. Zurn Industries, Inc.
    g. Mifab
    h. Blucher

4. Domestic Water Heaters (Gas Instantaneous Type)

    a. Navian
    b. Rennai
    c. Bradford White
    d. A.O. Smith

5. Hot Water Temperature Control Valve

    a. ITT Lawler
    b. MCC Powers
    c. Holby
    d. Leonard

6. Pipe and Fittings

    a. General Pipe and Fitting Materials, No Specified Manufacturer

        1) Any manufacturer whose products are manufactured in the United States and comply with the reference standards.

    b. Basic Pipe and Fitting Materials and Accessories not Specified in this Section: Refer to Section 22 05 00.

    c. CPVC and PVC Pipe and Fittings

        1) Chemtrol
        2) Plastic Piping System.
        3) R & G Sloan
        4) Charlotte

d. Ductile Iron Retainer Glands

1) American Cast Iron Pipe Co.
2) Fire Protection Equipment Co.
3) U. S. Pipe.

e. Polypropylene (PP) Drainage Pipe and Fittings

1) Lab-Line/Enfield Industrial Corporation
2) R & G Sloane "Fuseal"
3) Sani-Tech, Inc.
4) Orion

f. Polyethylene (PE) Pipe and Fittings (underground gas)

1) Polypipe
2) Control Plastics
3) George Fischer
4) Perfection Corporation
5) R. W. Lyall

g. PEX Crosslinked Polyethylene

1) Uponor

7. Rainwater Conductor Shoes

a. Neenah Foundry Co.
b. J. R. Smith
c. Josam
d. Zurn

8. Valves

a. Basic Valve Types not Specified in this Section: Refer to Section 22 05 00.

b. Type V14, Ball Check Valve

1) Flygt

c. Type DUWV, Underground Water Main Service Valves

1) 2 Inch and Smaller: Mueller Co. style as listed or approved equal.
2) 3 Inch and Larger: Stockham figure numbers as listed or approved equal by:

a) Crane
b) Kennedy
c) Mueller Co.

d. Type GSV, Natural Gas System Valves

1) 2 Inch and Smaller

a) Apollo
b) Grinnell
c) Jamesbury
d) Nibco
e) Watts
f) Worcester
g) Jomar

2) 2-1/2 Inch and Larger

a) ACF
b) Homestead
c) Rockwell
d) Dresser DMD Roots
e) Jomar

9. Water Pressure Regulating Station

a. Watts Regulator
b. Zurn-Wilkins Regulator Division
c. Watson McDaniels
d. Clayton Valve Co.

10. Natural Gas Pressure Regulators

a. Fisher
b. Maxitrol
c. Rockwell
d. Invensys
e. Pietro Fiorentini

11. Natural Gas Flexible Appliance Connectors

a. T&S Brass
b. Dortmund

12. Water Hammer Arrestors

a. Josam
b. J. R. Smith
c. Precision Plumbing Products
d. Sioux Chief
e. Wade
f. Zurn
g. Watts Drainage

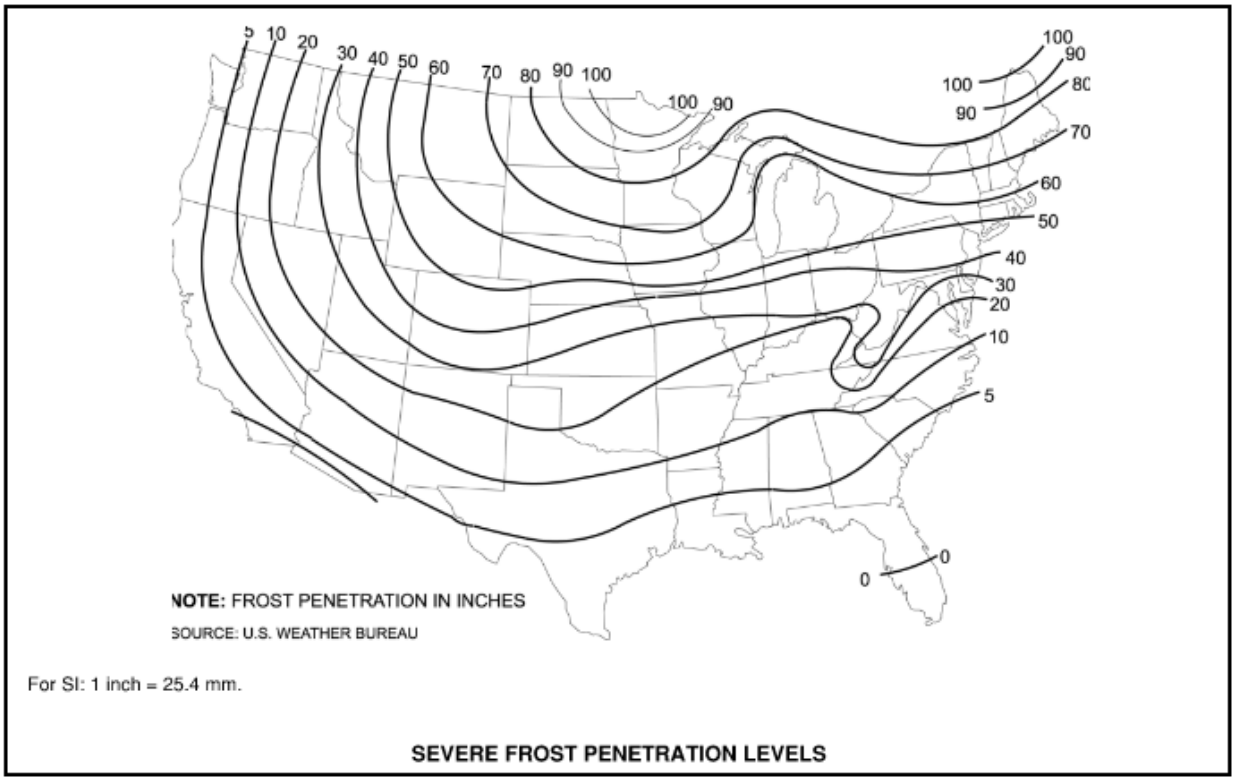
2.2 AUTOMATIC TRAP PRIMER

A. ASSE 1018, water-supply-fed type, with the following characteristics: 125-psig minimum working pressure; bronze body with atmospheric-vented drain chamber; 1/2-inch NPS threaded, union, or solder joint inlet and outlet connections; 1/2-inch NPS threaded or solder joint gravity drain outlet connection; chrome plated finish except rough bronze for units used with pipe or tube that is not chrome finished.

B. ASSE 1044, electronic solenoid actuated trap priming manifold assembly mounted in surface or flush cabinet with stainless steel door and cylinder lock. Provide 5/8 inch compression fittings for the quantity of primed traps as indicated on plans. Unit shall be Precision Plumbing Products Prime-Time or Mini-Prime, wired for 120 volt power supply. See schedule for additional requirements.

C. Coordinate with drawings and provide outlet type for trap primer lines to floor drains.

D. Where trap primer water lines are installed outdoors and/or has potential to freeze, trap primer lines shall be installed no less than 12-inches below the established frost depth in the area. Consult local weather service for established frost depth.



SEVERE FROST PENETRATION LEVELS

2.3 BACKFLOW PREVENTER

A. Complete factory assembly including resilient seated shutoff valves before and after device, resilient seated test cocks and protected by strainer having a resilient sealed blowdown valve.

Provide pressure differential relief valve located between two positive seating check valves. All bronze body. All internal parts stainless steel. Meet requirements of American Society of Sanitary Engineering Standard 1013 and University of Southern California Foundation for Cross Connection Control and Hydraulic Research, and so certify. Meet local code requirements. Include solenoid shut down where flooding potential exists should use parallel BFPs when solenoid issued for critical buildings such as hospitals.

2.4 WATER FILTERS

A. F-1: Single filter housing and cartridge unit. Filter unit shall be polypropylene, 10" single cartridge assembly with integrated inlet/shut-off valve and pressure gauge. Assembly shall be able to flow 2-gpm and filter to 5-microns. Filter unit shall be similar to Costguard CGS-10 and filter shall be able to remove chlorine taste and reduce odor and sediments similar to Costguard CG5-10.

B. Contractor shall furnish to owner six (6) replaceable filters with make/model for owner's stock.

2.5 LEAK DETECTION

A. Provide leak detection system to sense water on floor or in drip pan being monitored and send signal to notify personnel of pending water issue. Leak detection system shall have module that will receive power for system and send required signal/alarm, modular leader cable, sensing cable, splices, end terminations, relays, etc, for complete and operational system.

1. Sensing module shall have 12-24 volts AC power input, shall have separate relays for leak and trouble alarms and built-in audible alarm. The leak relay shall have (2) two sets of contacts to: (1) annunciate alarm and (2) provide direct control linkage to local devices. Module shall be able to adjust sensitivity to leaks, adjust time delay before leak alarm relay trips, have manual reset when leak is detected, be able to monitor any cable break or power loss in cable and shall indicate a trouble light when this occurs and shall have a NEMA-1 enclosure, similar to TraceTek/Raychem #TTC. Module shall be installed on wall or vertical structure in a non-hazardous location.
2. Sensing module shall be connected into the BMS system to notify signal when leak is detected.
3. Sensing cable shall be of conductive-polymer and fluropolymer construction able to detect the presence of water and shall be similar to TraceTek/Raychem model #TT1000-10FT-PC.

B. Leak detection system shall monitor leaks forming in area around decontamination holding tank and BSL-3 decontamination drainage piping discharging into holding tank and to notify building personnel of impending issues. Sensing module shall be located in close proximity to holding tank and sensing cable shall be located on floor, in containment area.

2.6 DRAINS

A. Provide roof drains with aluminum dome, deck clamp and drain receiver. (Similar to J. R. Smith types scheduled on drawings).

B. Provide overflow roof drains with aluminum dome, interior trimmable standpipe, deck clamp and drain receiver. (Similar to J. R. Smith types scheduled on drawings).

C. Provide area drains similar to the J. R. Smith types scheduled on drawings.

2.7 CLEANOUT AND CLEANOUT ACCESS COVER

A. Provide cleanouts with brass, screw-in type plugs as listed below. Model numbers shown are for standard of quality.

1. Finished Floors: Duco cast iron body with bronze plug, gasket seal, internally threaded extension with adjustable head, round scoriated nickel bronze top secured with vandalproof screws, Jay R. Smith 4020 Series.
2. Vinyl or Composition Tile Floors: Same as above, except square top with 1/8 inch recess to receive flooring material, Jay R. Smith 4160 Series.
3. Terrazzo or Ceramic Tile Floors: Same as 1. above, except square top with recess of sufficient depth to receive flooring material, Jay R. Smith 4200 Series.
4. Carpeted Floors: Same as 1. above with adjustable carpet clamping frame, Jay R. Smith 4020X Series.
5. Finished Walls: Cast iron cleanout plug or cleanout tee, bronze hex head plug, round nickel-bronze frame and secured cover with vandalproof screws, Jay R. Smith 4720.
6. Exposed Piping in Unfinished Areas: For cast iron pipe, provide a ferrule caulked into the hub of fitting and a heavy rough brass plug screwed into ferrule. For screwed piping, provide heavy rough brass plug screwed into pipe fitting.
7. Driveways and Yards: Duco cast iron spigot body with cutoff grooves and bronze plug. Double flanged housing with heavy-duty scoriated cast iron cover secured with vandalproof screws, Jay R. Smith 4251-U.
8. Plastic Drainage Piping: Duco cast iron housing, less cleanout, with heavy-duty secured scoriated cast iron cover with lifting device. Housing is to be completely free of piping so no load is transmitted to pipe, Jay R. Smith 4880. Provide plastic cleanout and plug.
9. Unfinished Floors: Duco cast iron body with round adjustable scoriated cast iron top secured with vandalproof screws, bronze plug. Jay R. Smith 4220 Series

B. Provide flashing clamp for cleanout installed in waterproof construction.

2.8 DOMESTIC WATER HEATER (GAS FIRED, INSTANTANEOUS TYPE)

A. Water heater(s) shall be provided to produce hot water for domestic (potable) and laboratory (non-potable) hot water systems.

B. Water heater(s) shall be fully modulating, on-demand, condensing gas fired tankless water heater(s), similar to A.O. Smith model CT-199, having a maximum input rating of 199,000

Btu/h. Water heater shall have ¾ in. male NPT water and gas connections. The inlet gas supply pressures shall be 4.0 in. WC (min.) up to 10.5 in. WC (max) for natural gas and shall incorporate an integrated temperature controller that will provide diagnostic information, fault history, and heater set temperature. The temperature remote controller shall provide diagnostic information, fault history, and heater set temperature. Water heater(s) shall operate using 120 V / 60 Hz power source with a factory installed power cord.

C. Water heater(s) shall be vented with 3" or 4" diameter schedule 40 PVC, CPVC, ABS, or Category IV vent pipe with a length not to exceed 70 ft. (equivalent) for 3" vent or 100 ft. (equivalent) for 4" vent, terminating horizontally or vertically. The intake pipe may use material such as PVC, ABS, aluminum, or Category IV pipe and cannot exceed 70 ft. (equivalent) for 3" vent or 100 ft. (equivalent) for 4" vent; flue/venting scope of work shall be coordinated with mechanical engineers.

D. Water heater(s) shall have commercial-grade copper, fin-tube primary heat exchanger with quick release brass or bronze waterways. The secondary heat exchanger shall be constructed from stainless steel 316L. Water heater(s) shall be controlled by an on-board solid-state printed circuit board which uses the following factory installed components: thermistors to monitor water temperature and exhaust temperature; a flow sensor to measure flow rate; a flame sensor to monitor combustion; an Air-Fuel Ratio Rod to measure and adjust air input in order to maintain optimal combustion efficiency. The heater also consists of in-line fusing and surge absorbers for electrical surge protection, an electronic spark igniter, aluminized stainless steel burners, hi-limit temperature switches to monitor water and exhaust temperatures, modulating gas valve, dual freeze protection that will automatically fire the heater and use heating blocks to protect the heat exchanger, and an overheat cutoff fuse.

E. Water heater(s) can manifold to Easy-Link up to 4 heaters to provide additional capacity. The Easy-Link controls shall be built onto the on-board solid state printed circuit board and does not require external controls. The linking control wire shall be supplied with the water heater. Water heater(s) can use a Multi-Unit controller, 100112691, to manifold 5-20 heaters. The Easy-Link and Multi-Unit Controller shall modulate the system for the most efficient performance. The Easy-Link and Multi-Unit Controller shall rotate the priority heater every 12 hours of operation time or 100 starts for balanced duty/cycle operation.

F. Water heater model shall have a minimum uniform energy factor of 0.93, meet energy efficiency requirements of the U. S. Department of Energy and ASHRAE 90.1, compliant with SCAQMD Rule 1146.2 and other air quality districts with similar requirements for low NOx emissions of 14 ng/J or 20 ppm, and shall be certified to NSF 5 standards.

F. Seismic Design: Refer to Section 22 05 00, Article 1.10.B.

2.9 UNDERCOUNTER SINGLE FIXTURE TEMPERED WATER MIXING VALVE ASSEMBLY

A. Provide a thermostatic mixing valve assembly consisting of a Powers Model LFLM-495-1-A lead free mixing valve with union inlet strainer checkstops. Valve capacity shall be 12 gpm at 45 psi pressure drop. Valve shall be CSA 8125 certified and meet the requirements of ASSE 1016 and ASSE 1070. Valve shall have copper silicon alloy body with paraffin-based actuation

technology. Valve shall have lockable adjustable outlet temperature range of 80° F. to 120° F. with 105° F. setting. Valve must have union connections to permit servicing of filters.

2.10 PIPE AND FITTINGS

A. General

1. Pipe and fitting materials and joint types are specified in the following "Piping Class" paragraphs. Application material and joint type which will be permitted for specific services are specified hereinafter in the Article titled "Piping System Requirements". Refer to pipe material scheduled, on plumbing drawings, for direction on where to provide pipe and fittings types, in project scope of work.
2. Pipe and fittings shall conform to the latest issue of the standards referred to hereinafter. Each length of pipe and each fitting shall be marked with the manufacturer's name brand and specification code designation to which it belongs.

B. Piping Class BR1: Water distribution and branch pipes routed exposed in finish space.

ITEM	LIMITS	DESCRIPTION
PIPE		Brass pipe Schedule 40, Nipples Schedule 80, Chromium Plated
JOINTS		Screwed
FITTINGS		Class 125 cast bronze threaded, Chromium Plated
UNIONS		Class 250, chromium plated

Reference Standards

1. Brass Pipe: ASTM B43 Grade A red brass, ANSI H27.1. Chromium plated. All pipe must be marked with trademark of manufacturer and with grade letter "A".
2. Cast Bronze Threaded Fittings: ANSI B16.15, Classes 125 and 250. Chromium plated.

C. Piping Class CI1: Sanitary, waste & vent and storm, for underground drainage.

ITEM	LIMITS	DESCRIPTION
PIPE & FITTINGS	2 inch thru 15 inch 16 inch thru 54 inch	Cast iron soil pipe, extra-heavy weight, hub and spigot pipe and fittings, Ductile iron water pipe and fittings
JOINTS	2 inch thru 15 inch	Caulked joint with lead and oakum: Caulked joints shall be firmly packed with oakum or hemp and filled with molten lead to a depth of not less than 1 inch

		(25.4 mm) in one continuous pour. The lead shall be caulked thoroughly at the inside and outside edges of the joint. After caulking, the finished joint shall not exceed 1/8 of an inch (3.2 mm) below the rim of the hub. No paint, varnish, or other coatings shall be permitted on the joining material until after the joint has been tested and approved. Compression joint: Elastomeric gasket for cast-iron hub and spigot pipe.
JOINTS	16 inch thru 54 inch	Rubber gasket push on or mechanical

Reference Standards

1. Cast Iron Soil Pipe and Fittings, Hub and Spigot: ASTM A74, Commercial Standard CS-188. Pipe shall bear Commercial Standard symbol. Piping shall bear CISPI collective trademark and NSF international listing.
2. Ductile Iron Water Pipe and Fittings: Pipe - Class 52 ANSI A21.51; Fittings - Class 250 rated cast iron or ductile iron, ANSI C110; Joints - either rubber gasket push-on type or mechanical type, ANSI 21.11.
3. ASTM C1563: Standard test method for gaskets for use in connection with hub and spigot cast iron soil pipe and fittings for sanitary drain, waste, vent and storm piping application.
4. ASTM A74: Cast Iron Soil Pipe and Fittings.
5. ASTM C564: Rubber gaskets for cast iron soil pipe and fittings.
6. Provide wrap or encasement 0.008 inch thick with loose polyethylene, for installation in corrosive soils.

D. *Piping Class CI2: Sanitary, waste, vent & storm, for above ground drainage.

ITEM	LIMITS	DESCRIPTION
PIPE & FITTINGS	2 inch thru 12 inch	Cast iron soil pipe, no hub pipe and fittings
JOINTS	2 inch thru 12 inch	Compression type couplings shall be Heavy-duty couplings ASTM C1540 Husky SD-4000 or equal

* For use only above ground where allowed by codes.

Reference Standards

1. Cast Iron Soil Pipe and Fittings, No Hub: ASTM A888, CISPI 301. Joints, ASTM C564. Piping shall bear CISPI collective trademark and NSF international listing.
2. ASTM C564: Rubber gaskets for cast iron soil pipe and fittings.
3. ASTM A888: Standard specifications for hubless cast iron soil pipe and fittings.
4. ASTM C1563: Standard test method for gaskets for use in connection with hub and spigot cast iron soil pipe and fittings for sanitary drain, waste, vent and storm piping application.

5. CISPI 301: Hubless cast iron soil pipe and fittings for sanitary and storm drains, waste and vent piping application.

6. CISPI 310: Couplings for use in connection with hubless cast iron soil pipe and fittings for sanitary and storm drain, waste and vent piping application.

E.

E. Piping Class CU1: Domestic water, industrial water and indirect waste.

ITEM	LIMITS	DESCRIPTION
PIPE	All sizes	Copper tubing Type L. CU1: Hard/drawn temper
JOINTS	All sizes	Soldered
FITTINGS	All sizes	Wrought copper, except cast brass only in sizes where wrought copper is not available
UNIONS	2 inch and smaller 2-1/2 inch and larger	Class 200 Companion flanges
FLANGES	2-1/2 inch and larger	Class 150 cast bronze

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. Soldered Fittings for Copper Tubing: Wrought copper, ANSI B16.22 for pressure fittings and B16.29 for drainage fittings; Cast brass for larger sizes where wrought copper is not available, ANSI B16.18 for pressure fittings and B16.23 for drainage fittings.
3. Flanges for Copper Tubing: Cast bronze, ANSI B11.24, Classes 150 and 300, solder joint.

Installation shall be in accordance with manufacturer's instructions.

F.

F. Piping Class CU2: Domestic water service, underground; Domestic/Industrial water branch

ITEM	LIMITS	DESCRIPTION
PIPE	2 inch and smaller*	Copper tubing, Type K, soft, in rolls
JOINTS	2 inch and smaller*	Soldered except flared at valve, underground branch and equipment connections
FITTINGS	2 inch and smaller*	Wrought copper for soldered, cast bronze for flared
UNIONS	2 inch and Smaller	Class 200, for soldered joint piping

*NOTES:	1. No joints allowed for lengths under: 95 foot for 1-1/4 inch and smaller 55 foot for 1-1/2 inch 40 foot for 2 inch 2. No underground joints allowed below floors, driveways and the like.
EXCEPTIONS:	Where branches are required underground, flared connections are to be used.

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. Soldered Fittings for Copper Tubing: Wrought copper ANSI B16.22; Cast brass for larger sizes where wrought copper is not available, ANSI B16.18.
3. Flared Fittings for Copper Tubing: Cast bronze, ASTM B62, ANSI B16.26.

G. Piping Class CU3: Waste and vent drainage, storm water drainage, indirect waste, trap priming pipe.

ITEM	LIMITS	DESCRIPTION
PIPE	Less than 1-1/4 inch 1-1/4 inch & larger	Copper tubing, Type L, Hard Urinals (2") copper tubing Type K, hard; elsewhere DWV copper drainage tubing and fittings, hard.
JOINTS	All sizes	Soldered
FITTINGS	All sizes	DWV Pattern wrought copper except cast brass only in sizes where wrought copper is not available
FLANGES		Class 150 cast bronze

Reference Standards

1. Copper Tubing: ASTM B88, ANSI H23.1
2. DWV Copper Drainage Tube: ASTM B306, ANSI H23.6.
3. Flanges for Copper Tubing: Cast bronze, ANSI B11.24, Classes 150 and 300, solder joint.
4. Soldered Drainage Fittings (DWV): Cast bronze, ANSI B16.23.
5. Soldered Fittings for Copper Tubing: Wrought copper ANSI B16.29; Cast brass, for larger sizes where wrought copper is not available, ANSI B16.23.

H.
H.

H. Piping Class DI1 and DI2: Underground Water Service

ITEM	LIMITS	DESCRIPTION

PIPE & FITTINGS	4 inch thru 54 inch	Ductile iron water pipe and fittings, 250 psig. Class DI1 to be cement lined Class DI2, no cement lining for sanitary sewer applications.
JOINTS	4 inch thru 54 inch	Rubber gasket push on or mechanical
JOINT RESTRAINT	4 inch thru 54 inch	Ductile iron retainer glands at all changes in direction and bends

Reference Standards

1. Ductile Iron Water Pipe and Fittings: Pipe - Class 52 ANSI A21.51; Fittings - Class 250 rated cast iron or ductile iron, ANSI C110; Joints -either rubber gasket push-on type or mechanical type, ANSI 21.11.
2. Cement Lined Ductile Iron Water Pipe and Fittings: Same as ductile iron water pipe and fittings specified above except cement lined per ANSI A21.4.

I.
I.

I. Piping Class PE1: Underground natural gas, outside building.

ITEM	LIMITS	DESCRIPTION
PIPE, FITTINGS	1/2 inch thru 8 inch 100 psi max. pressure	Polyethylene ASTM D2513, SDR 11
JOINTS	1/2 inch thru 8 inch	Socket type or butt type, electric heat fusion
ADAPTERS	1/2 inch thru 8 inch	Steel piping to polyethylene transition fittings ASTM D2513, Category 1
ANODELESS RISER	1/2 inch thru 8 inch	
Tracer Wire	Buried piping distribution.	An electrically continuous corrosion-resistant tracer shall be buried with the plastic pipe to facilitate locating.

Reference Standards

1. PE1 (Polyethylene) Pipe and Fittings: ASTM D2513, D2683, D3261 and D2774
2. ASTM D2513: Standard specification for polyethylene (PE) gas pressure pipe, tubing, and fittings

J.

J. Piping Class PP2: Laboratory/chemical waste and vent drainage

ITEM	LIMITS	DESCRIPTION

PIPE, FITTINGS & TRAPS	1-1/2 inch thru 6 inch 8, 10, 12 inch	Flame retardant polypropylene drainage pipe, Schedule 40. Piping installed in plenum spaces must be plenum rated. Nonflame retardant polypropylene, Schedule 40 (below grade only)
JOINTS	1-1/2 inch thru 12 inch	Electric fusion, except mechanical at equipment and traps.
ADAPTERS	1-1/2 inch thru 12 inch	As recommended by manufacturer

Reference Standards

1. PP (Polypropylene) Pipe and Fittings: ASTM D635, D4101, D3311, D1599, D2122, F1290 and F1412

K. Piping Class PVC3: Underground/Buried, gravity waste and vent drainage, storm water drainage

ITEM	LIMITS	DESCRIPTION
PIPE	All sizes	Schedule 40, PVC, Schedule DWV
JOINTS		*PVC Solvent Cement
FITTINGS		Schedule DWV

Reference Standards

1. PVC DWV Pipe and Fittings: ASTM D1784, D1785 and D2665; ASTM D2665 and ASTM F1866

L. Piping Class PVC4: Sanitary and storm sewers, installed below grade, 5-feet beyond building

ITEM	LIMITS	DESCRIPTION
PIPE	4 inch and larger	PVC gravity sewer pipe
FITTINGS	4 inch and larger	Bell and spigot type rubber gasketed joints

Reference Standards

1. PVC Sewer Pipe and Fittings: ASTM D3034 (SDR-35); ASTM F794.

M.
M.

M. Piping Class S1: Natural gas, low pressure (<1.5psi), above ground.

ITEM	LIMITS	DESCRIPTION
PIPE	2-inch and smaller	Schedule 40 Black Steel pipe, ASTM A53, ERW, Class B

	2-1/2 inch and larger	Schedule 40, Black Steel Pipe, ASTM A53, ERW, Class B
JOINTS	2 inch and smaller 2-1/2 inch and larger	Screwed or welded Welded
FITTINGS	2 inch and smaller 2-1/2 inch and larger	Class 150 malleable iron threaded or socket welded Butt weld type, same thickness as pipe except Weldolet as specified
UNIONS	2 inch and smaller 2-1/2 inch and larger	Class 250 malleable iron threaded, Class 3,000 socket welded. Companion flanges
FLANGES	All sizes	Class 150 forged steel

Reference Standards

1. Steel Pipe: ASTM A53, ERW, Grade B, black carbon steel.
2. Malleable Iron Threaded Fittings: ASTM A197 black malleable iron. ANSI B16.3 Class 150, with ANSI B1.20.1 standard taper pipe threads.
3. Welded Fittings for Black Steel Pipe: 2 inch and smaller - Class 3000 forged steel socket welded fittings, ASTM A105 and ANSI B16.11; 2-1/2 inch and larger - ASTM A234, Grade A and ANSI B16.9. All elbows long radius.
4. Flanges for Welded Black Steel Pipe: Forged steel, ASTM A181 Class 60, ANSI B16.5 for Class 150.
5. Malleable Iron Threaded Fittings: ASTM A197 malleable iron. ANSI B16.3 Class 150, with ANSI B1.20.1 standard taper pipe threads. Use air tested fittings on gas piping.
6. Provide wrap or encasement 0.008 inch thick with loose polyethylene, for installation in corrosive soils.

N. Piping Class S6: Natural Gas, low pressure and high pressure (>1.5psi) gas

ITEM	LIMITS	DESCRIPTION
PIPE	10 inch and smaller 12 inch and larger	Steel pipe Schedule 40 Schedule 80, Black Steel
JOINTS	All sizes	Welded, except: equipment prepiped at factory, screwed 2 inches and smaller at connections to equipment and accessories
FITTINGS	2 inch and smaller 2-1/2 inch and larger	Socket welded, except Class 150 malleable iron threaded at connections to valves and equipment Butt weld type, same thickness as pipe,

		except Weldolet as specified and flanged at valves and equipment
UNIONS	2 inch and smaller 2-1/2 inch and larger	Class 3,000 socket welded, except Class 250 malleable iron threaded at connections to equipment and accessories. Companion flanges
FLANGES	All sizes	Class 150 forged steel

Reference Standards

1. Steel Pipe: ASTM A53, ERW, Grade B black carbon steel.
2. Malleable Iron Threaded Fittings: ASTM A197 black malleable iron. ANSI B16.3 Class 150 banded, with ANSI B1.20.1 standard taper pipe threads. Use air tested fittings on gas piping.
3. Welded Fittings for Black Steel Pipe: 2 inch and smaller - Class 3000 forged steel socket welded fittings, ASTM A105 and ANSI B16.11; 2-1/2 inch and larger - ASTM A234, Grade A and ANSI B16.9. All elbows long radius.
4. Flanges for Welded Black Steel Pipe: Forged steel, ASTM A181 Class 60, ANSI B16.5 for Class 150.
5. Gas piping installed underground shall be taped and somastic coated.
6. Gas piping installed above ground outdoors shall be either hot dipped galvanized or have exterior epoxy paint coating.

O. Piping Class SG2

ITEM	LIMITS	DESCRIPTION
PIPE	10 inch and smaller 12 inch and larger	Steel pipe Schedule 40, nipples Schedule 80, Galvanized Steel pipe 0.375 inch wall, Galvanized
JOINTS	2 inch and smaller 2-1/2 inch and larger	Screwed Screwed, flanged or grooved mechanical coupling
FITTINGS	2 inch and smaller 2-1/2 inch and larger	Class 150 galvanized malleable iron threaded Class 150 galvanized malleable iron threaded, flanged or galvanized steel grooved type
UNIONS	2 inch and smaller 2-1/2 inch and larger	Class 250 malleable iron threaded, galvanized Companion flanges

FLANGES	All sizes	Class 125 galvanized cast iron threaded

Reference Standards

1. Steel Pipe: ASTM A53, Grade B black carbon steel. Coated with ASTM B6 slab zinc inside and outside by the hot-dip process.
2. Malleable Iron Threaded Fittings: ASTM A197 black malleable iron. ANSI B16.3 Class 150 banded, with ANSI B1.20.1 standard taper pipe threads. Coated with ASTM B6 slab zinc inside and outside by the hot-dip process. Use air tested fittings on gas piping.
3. Cast Iron Threaded Flanges: ASTM A126, Class B, gray cast iron. ANSI B16.1 with ANSI B1.20.1 standard taper pipe threads. Coated with ASTM B6 slab zinc inside and outside by the hot-dip process or electro zinc plated at manufacturer's option.
4. Refer to Section 22 05 00 for Mechanical Couplings. Grooved mechanical couplings not to be used in gas piping.

2.11 PIPING SYSTEM REQUIREMENTS

Service	Valve Type/Class	Pipe Class
Acid Resistant Gravity Drainage and Vent 1) Underground		PP2
2) Above Ground and penetrating floor or fire or smoke rated wall or partition		
a) 6 inch and smaller in size		PP1, PP2,
b) Larger than 6 inches in size		PP1, PP2
3) Piping other than 1 & 2 above		PP1, PP2
Domestic Cold Water Underground		
1) 2 inches and smaller	DUWV	CU2
2) 3 inches and larger	DUWV	DI1
Domestic Water Above Ground and Laboratory Water 1) General Service 6 inches and smaller	VC-4 V-9 V-10	CU1
8 inches and larger	VC-4 V-10	CU1
2) Exposed at Plumbing Fixtures and in Laboratory and Similar Equipment	CPBV	BR1
Foundation and Under Floor Drainage		
Gas (Natural) Underground metallic	GSV	S6
Underground plastic only	GSV	PE1
Above Ground 1) Outdoor High Pressure	GSV	SG2
2) Indoor High Pressure (5# and above)	GSV	S6
3) Indoor Low Pressure Concealed	GSV	S6
4) Indoor Low Pressure Exposed	GSV	S1
Note: Mechanical joints not allowed for Pipe Class SG2		
Planting Bed Drainage		

Service	Valve Type/Class	Pipe Class
Sanitary and Combination Storm and Sanitary Gravity Drainage and Vent Underground Inside Building to approximately 5 feet beyond Building Walls Sizes 2" - 15" Size 18" and Larger		CI1, PVC3 DI2
Sanitary and Combination Storm and Sanitary Gravity Drainage and Vent Underground Outside Building		CI1, PVC4 As Noted
Sanitary and Combination Storm and Sanitary Gravity Drainage and Vent Above Ground 1) Piping, General 2) Branch Waste & Vents for Fixtures other than Water Closets and Urinals 3) Branch Waste & Vents for Water Closets 4) Branch Waste & Vents for Urinals (2 inch) 5) Indirect drainage 6) Exposed Piping at Fixtures & Equipment *If allowed by codes. If not allowed, use CU3. **Piping less than 1-1/4 inch in size		 CI1, CI2, CI1, CI2, CU3 CI1, CI2 PVC3* CU1**, CU3 BR1
Sanitary and Storm Pressure (Pumped) Drainage 1) Underground 2) Above Ground or in pit	 DUWV VC-4, V14	 DI1, DI2 S1 SG2
Storm Gravity Drainage Underground 1) Inside of Building to approximately 5 feet beyond Building Walls Sizes 2" - 15" Sizes 18" and Larger 2) Outside of Building		 CI1, PVC3 DI2 CI1, PVC4 As Noted

Service	Valve Type/Class	Pipe Class
Storm Gravity Drainage Above Ground Inside of Building		CI1, CI2
Domestic water heater direct vent intact & exhaust		CPVC1

2.12 RAINWATER CONDUCTOR BOOTS

A. Provide cast iron boots at bottoms of exterior downspouts, round or rectangular, to suit downspout. Refer to schedule on drawings.

B. Design boots with cast iron lugs for anchoring to building and integral offsets to conform to building wall contour. Include transition or round offset bottom. Boots for discharge above grade shall have open bottoms turned outward. Boots shall be Neenah Foundry Co. Series R-4924 through R-4928 or approved equal as applicable.

2.13 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 22 to assure that all general service valves throughout the work of Division 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for Classes 200 and 300, copper-silicon bronze stem.
5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.
6. All valves used in domestic water applications shall comply with NSF/ANSI 61 for lead free construction.

B. Refer to Section 22 05 00 for specifications for basic valve types not specified in this section.

C. Type V14 Ball Check Valve: Nonclog, unobstructed, free flow type. Ball shall be out of the flow in the open position, directed to and from the body seat by guide rails integral with the valve body. Function satisfactorily in a vertical, horizontal or inverted position. Capable of direct burial without the use of a vault or other enclosure. Ball actuated by the flowing medium, system pressure, or gravity without the use of springs, levers, weights or external power source. Body of gray cast iron construction for sizes 2-1/2 inch and larger, flange ends integral with the body casting, flat faced and drilled to ANSI B16.1, Class 125 cast iron, standard. Body shall be cast bronze with threaded connections conforming to N.P.T. for 2 inch size. Ball shall be a

hollow steel sphere with a smooth covering of nitril rubber. Valve shall be suitable for 150 psig working pressure and a temperature of 185°F. Flygt HDL ball check valves.

D. Type GSV, Gas Natural System Valves

1. Valve must meet requirements of and be of manufacture approved by Utility Company providing gas service.
2. 2 Inch and Smaller in Screwed Piping: Type V9 ball valves, screwed ends.
3. 2-1/2 Inch and Larger in Welded Piping: Iron body, bronze trimmed, flanged ends, wrench operated plug.
4. Valves shall be AGA certified or UL listed for natural gas and L.P. gas service.
5. Provide valve boxes and bases for underground valves.
6. Natural gas piping system check valves shall be disc type Eclipse Series 1000.
7. Polyethylene valves shall conform to ANSI B16.40 for use in underground lines only.
8. Laboratory table outlet valves shall be as specified in Section 22 60 00 or Division 12.

E. Type CPBV, Chrome Plated Brass Valves: Similar to Type V2 and V3 except chrome plated brass finish and black composition wheel handle.

F. Type DUWV, Underground Water Main Service Valves: For shutoff service in underground main or where underground main enters and leaves meter pit.

1. 2 Inch and Smaller: AWWA compression or flanged end curb cock. Mueller Co. Mark II Oriseal. Provide cast iron service box and base when not accessible in pit.
2. 3 Inch and Larger: AWWA iron gate valves, Class 200 WWP, IBBM, NRS, double disc, O-Ring packing. Provide hand wheel when accessible in pit, valve box and base when not accessible in pit. Mechanical, flanged or combination ends as required. Stockham G-743-0, G-745-0, G-746-0.

G. Type PPSV, Plastic Piping System Valves: Valve body of the same material as piping system in which installed with Teflon seats and Viton seals. NSF approved for potable water service. Listed by NSF for use in potable water. Celanese Piping System figure numbers are listed.

1. Shutoff Valves:

a. 1/2 inch through 2 inch - True union ball valves, Series TU.
b. 3 inch - Double entry ball valve Series DE.

2. Check Valves: 1/2 inch through 3 inch - Double union ball check, Series BC.

SERVICE	LIMITS	ALLOWABLE VALVE TYPES
SHUTOFF	Copper Tubing	V9\V10
	Steel Pipe	V9, V10
THROTTLING (BYPASS)	Copper Tubing	V4 globe, V9, V10
	Steel Pipe	V4 globe, V9, V10

BALANCING		Calibrated type Class 125 bronze body. Bell & Gossett circuit setter or equal. See Section 20 05 00.
CHECK	Copper Tubing Steel Pipe	V1 swing check or V14 at storm water or sanitary pump discharge, V1 & V4 elsewhere V2 swing check or V14 at storm water or sanitary pump discharge, V2 & V4 elsewhere
*Not allowed for pump discharge balancing service.		

2.14 WATER HAMMER ARRESTERS

A. ASME A112.26.1M, ASSE 1010, or PDI-WH 201, stainless steel bellows with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M sizes A through F and PDI-WH 201 sizes A through F. Piston type are not permitted for applications that exceed 60 psi.

2.15 WATER PRESSURE REGULATING STATION

A. For sizes 2 inches and smaller, provide pressure regulator of all bronze body construction, renewable stainless steel seat, sensitive spring and large diaphragm area for accurate pressure control, bronze strainer with stainless steel perforated strainer screen. Watts Series 223S. Provide pressure gauges on inlets and outlet.

B. For sizes 2-1/2 inches and larger, epoxy coated cast iron body construction with renewable stainless steel seat, pilot actuated diaphragm type with low flow bypass. Watts #115-74, provide a strainer on inlet and pressure gauges on inlet and outlet.

2.16 NATURAL GAS SYSTEM

A. Provide UL listed flexible gas appliance connectors for all movable gas fired commercial kitchen equipment, including, but not limited to, fryers, ranges, griddles, convection ovens, dishwashers, steamers and kettles. Flexible connectors are to have end fitting welded to carrier hose. Carrier hose shall be coated gas hose with smooth extruded thermoplastic outer covering. Hose ends shall be food service quick disconnect by free spinning male threaded end. Gas flow shall be automatically stopped when quick connector is removed from appliance. Hose assembly minimum lengths shall be equal to the front to back depth of the appliance plus 18 inches. Hose assemblies shall be T&S Brass Co. Safe-T-Link Model HG-4. Connectors shall conform to ANSI Z21.69.

B. Provide UL listed flexible gas appliance connectors for all movable commercial gas dryers, kilns and similar gas fired appliances. Flexible connectors are to have end fittings welded to carrier hose. Carrier hose shall be coated with smooth extruded thermoplastic outer covering. Hose ends shall be free spinning male threaded ends. Hose assembly minimum length shall be equal to the front to back depth of the appliance plus 18 inches. Hose assembly shall be T&S Brass Co. Safe-T-Link Model HG-2. Connectors shall conform to ANSI Z21.45.

C. Provide wall mounted gas outlet box, where shown on plans. Outlet boxes shall be Burnaby #G0 101-SS stainless steel surface mounted box with 3/8" quick disconnect plug. Box shall be 7" x 5-1/2" x 2-3/8" deep.

2.17 NATURAL GAS, LINE PRESSURE REGULATOR

A. Where gas supply pressure exceeds the max. allowable pressure required by appliance and/or equipment, where outlet pressure is set to 2-psi or less, a line pressure regulator shall be provided. Regulator shall be balanced design, lock-up type (bubble tight), conforming to CSA Z21.80, with integral vent limiter conforming to CSA Z21.80. Regulator construction shall be aluminum alloy body with polyurethane exterior coating, inlet filter, double diaphragm construction and O-ring shall be nitrile rubber, diaphragm pan shall be aluminized steel, with field modified, color indexed spring for outlet pressure range, similar to Pietro Fiorentini Governor Standard Model

B. Where natural gas is greater than 2-psi supply to appliance and/or equipment that requires gas pressure of 14-inch/WC or less, overpressure protection type, gas regulator shall be provided. Regulator shall be balanced design, lock-up type (bubble tight), conforming to CSA Z21.80, with integral vent limiter conforming to CSA Z21.80. Regulator construction shall be aluminum alloy body with polyurethane exterior coating, inlet filter, double diaphragm construction and O-ring shall be nitrile rubber, diaphragm pan shall be aluminized steel, with field modified, color indexed spring for outlet pressure range, similar to Pietro Fiorentini Governor Over Pressure Device (OPD)

2.18 ENCLOSURE (for outdoor equipment)

A. Provide manufactured enclosure assembly with heating element for freeze protection.

B. Enclosure manufacturer shall be specialized in the manufacturing of assembly enclosures with at least 5 years of successful experience designing and selling enclosures to various customers in different climatic regions; Safe-T-Cover or acceptable manufacturers.

C. Store products in shipping containers and maintain in dry place until installation.

D. References

1. ASTM B209.
2. ASSE 1060 (Class I or Class II). -Performance Requirements for Outdoor Enclosures for Backflow Prevention Assemblies.

E. Materials of Fabrication

1. Material of fabrication shall be 5052-H32 marine grade aluminum (.050/18 gauge), mill finish and shall meet ASTM B209.
2. Insulation shall be 1.5" (9.0 "R" value) minimum thickness polyisocyanurate foam laminated to a glass fiber reinforced facer (each side). The insulation shall have the following properties:

    a. Dimensional Stability-Less than 2% linear change, ASTM D-2126;
    b. Compressive Strength-20PSI, ASTM D-1621;
    c. Water Absorption-Less than 1% by volume, ASTM C-209;
    d. Moisture Vapor Transmission-Less than one (1) perm, ASTM E-96;
    e. Product Density-Nominal 2.0 lbs. per cubic foot, ASTM D-1622;
    f. Flame Spread=25, ASTM E-84;
    g. Service Temperature= -100°F to +250°F maximum.
    h. The insulation shall be of uniform thickness.

F. Roof and Walls

1. Roof and walls enclosure shall be constructed of 5052-H32 (.050/18 gauge) marine grade aluminum, mill finish, ASTM B209 outside with insulation 1 1/2" (9.0 "R" value) thick in the walls and roof.
2. The enclosure shall have a hinged roof and hinged drop down access panel in the front of the enclosure for testing and maintenance.
3. The complete assembly shall be protected by being inside the enclosure.
4. Clear opening drain panel area shall be 17 1/4"W x 4"H.
5. Drain flap, as required, shall have a stainless steel hinge and a stainless steel light strength spring as a positive means of closure so that it will not be activated by wind.
6. The drain flap shall be constructed of the same materials that is used in the walls and roof of the enclosure.

G. Heating Equipment

1. Heating equipment shall be furnished and designed by the manufacturer of the enclosure to maintain an interior temperature of +40°F with an outside temperature of -30°F. Install heating equipment as per manufacturer's instructions and governing local and national codes.
2. UL or ETL listed heating element shall be provided that has been independently certified to meet the UL-2021 “Rain Test” for damp or wet conditions.

H. Mounting Hardware

1. Mounting hardware shall be furnished and shall be constructed of 5052-H32 aluminum.
2. All masonry fasteners shall be metal hit anchors.
3. All necessary drill bits shall be furnished.
4. All mounting brackets shall be on the inside of the enclosure. The enclosure shall be mounted in such a way that removal will be by removal of interior mounting brackets.

I. Installation

1. Enclosure shall be mounted on a concrete pad, extended 6” beyond exterior wall x 4" Thick.
2. Enclosure shall be assembled and mounted to concrete pad according to manufacturer's instructions.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Refer to and comply with Section 22 05 00 for basic requirements.

B. Refer to Section 22 05 48 for vibration isolation and seismic restraints, penetration seals and the like.

3.2 BACKFLOW PREVENTERS

A. Install backflow preventers on industrial/non-potable water system, on makeup water connections to mechanical equipment (boilers, cooling towers, hot water and chilled water systems). See detail on Drawings.

3.3 CLEANING OF SYSTEMS

A. Refer to Section 22 05 00 for basic requirements.

B. Refer to Section 22 11 00 for Disinfection of Water Lines.

3.4 CLEANOUTS

A. Provide cleanouts on all drainage piping at 50 foot intervals on piping 4 inches and smaller and at not more than 100 foot intervals on larger pipe sizes, at each change in direction of more than 45^{o}, at the base of drainage stacks and at other locations shown. Cleanouts full size for pipes up to 4 inches and not less than 4 inches for larger pipes except where code requires cleanouts larger than 4 inches. Cleanout sizes shall comply with applicable plumbing code.

B. Install cleanouts in driveways and yards flush with top of a 16 inch by 16 inch by 8 inch concrete pad set flush with grade or road. Where cleanouts are provided in vitrified clay below ground, last 5 foot length of vertical riser shall be cast iron.

C. Lubricate non-plastic cleanout plugs with mixture of graphite and linseed oil or provide Teflon tape on threads. Sealants for plastic cleanout plugs shall be compatible with plastic piping materials. Prior to building turnover remove cleanout plugs, relubricate and reinstall using only enough force to ensure permanent leakproof joint.

3.5 DOMESTIC WATER HEATER

A. Install on minimum 4 inch high concrete pad in accordance with manufacturer's instructions. Read manufacturers installation instructions and comply with manufacturers recommendations.

B. Provide shutoff valves in hot, cold and recirculation water connections and, at hot water outlet before the shutoff valve, a thermometer, pressure gauge and ASME rated temperature and pressure relief valve with extension to floor drain.

C. Provide installation clearances as required by manufacturer and all local codes.

3.6 DOMESTIC WATER PIPING

A. Install inside domestic water distribution piping with sufficient pitch and in a manner that entire system may be drained at a central point, if possible. Otherwise provide drainage points for each portion of system.

B. Support risers and stacks by metal brackets attached to building construction or by other approved methods.

C. Provide a riser shutoff valve at all water supply risers in nearest accessible location.

D. For each toilet room with two or more plumbing fixtures provide shutoff valves on hot and cold water supply piping within access panel or other accessible location.

E. For domestic hot water recirculating systems, manually adjust calibrated type balancing valve to provide flow of hot water in each branch with flow rates selected for a maximum temperature drop of 5° F.

F. Provide 3/4 inch tap with hose end valve for pipe disinfection where water main enters building downstream of backflow preventer.

G. Provide isolation valve in new piping where new piping and existing piping interconnect. Provide 3/4 inch tap with hose end valve for pipe disinfection downstream of isolation valve.

3.7 DRAINS

A. Flash drains installed in waterproofed floor or in toilet rooms and mechanical equipment room above grade with 2 foot, 6 inch square, sheet membrane clamped into clamping device of the drain and mopped into waterproofing or cast into concrete. Membrane shall be thermoplastic elastomeric, ASTM D4068, Chloraloy 240, as manufactured by the Noble Company. Installation shall be in strict accordance with the manufacturer's recommendations.

B. For trench drains provided under Division 31, provide the trap and extend drainage piping as indicated.

C. For built-in-place shower receptors, provide a sheet membrane of material specified for floor drain flashing, formed without seams and turned up a minimum of 6 inches. Clamp membrane into drainage flange of drain.

3.8 ELECTRICAL WORK

A. Refer to Section 22 05 00 or 22 05 13 for general requirements.

B. Power wiring will be provided under Division 26, Electrical, to the following:

1. Domestic (potable) and Laboratory (non-potable) electric hot water heater
2. Backflow preventer solenoid shut down.
3. Domestic hot water solenoid shutdown.
4. Electronic automatic trap primer.

3.9 MANHOLES

3.10 Not in scope of work.PIPING CONNECTIONS

A. Refer to Section 22 05 00 for basic requirements.

B. Bell and Spigot, Cast Iron Pipe Joints: Caulk firmly with oakum or hemp and fill with molten lead not less than 1 inch deep and not to extend more than 1/8 inch below rim of hub; no paint, varnish or other coatings permitted on jointing material until after joint has been tested and approved. Neoprene gasketing system or gasket and clamp type mechanical fastener where specified.

C. Plastic Piping and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the manufacturer's printed instructions.

D. Plastic Pipe and Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment according to manufacturer's printed instructions.

1. Plain-End Pipe and Fittings: Butt joining
2. Plain-End Pipe and Socket Type Fittings: Socket joining

3.11 RAINWATER CONDUCTOR SHOES

A. Caulk rainwater conductor shoes directly into bell of drain piping below grade, with lead and oakum caulking.

3.12 SANITARY, STORM AND ACID RESISTANT DRAIN PIPING

A. Set true to line and even slope using grade boards and targets or grade lines. Install cast iron soil pipe and fittings and make joints in accordance with "Cast Iron Soil Pipe & Fittings Handbook".

B. Slope suspended sanitary and storm piping downward minimum 1/4 inch per foot where possible for pipes 3 inch and smaller, and 1/8 inch per foot for piping 4 inch diameter and larger, and in all cases, conform to code requirements.

C. Slope underground sanitary and storm piping downward a minimum of 1/4 inch per foot for 3 inch pipe and less; a minimum of 1/8 inch per foot for piping larger than 3 inch diameter, and in all cases, conform to code requirements.

D. Install all piping in accordance with manufacturer's recommendations regarding connections, hangers, hanger spacing, underground installation, etc. Support suspended horizontal soil pipe near each hub, with maximum spacing between hangers of 5 feet for pipe fabricated in 5 foot lengths and 10 feet for pipe fabricated in 10 foot lengths. Underground PVC piping shall be installed in accordance with ASTM D2321 latest edition. Provide sway braces and anchorage on horizontal drainage piping sizes 5” and larger at changes of direction, where required by code and/or where recommended by coupling manufacturer and or CISPI standard 4 inch pipe size. Shall be included when required by the plumbing code.

E. Install buried sewer and water piping in separate trenches.

F. For corrosive soil conditions, metallic underground piping shall be provided with loose polyethylene encasement 0.008" thick.

G. Provide ball joint connections at foundation wall where piping exists building, EBAAron flex-tend or equal.

3.13 GAS SYSTEM

A. Entire system of gas piping, including pipe sizes, valves, materials, equipment, installation and testing shall comply with rules and regulations of Utility Company providing gas service, and AGA, and the International Fuel Gas Code.

B. Protect underground gas piping, after installation is complete and pressure tested, with coating approved by the Utility Company, Somastic or equal, or machine-wrap piping with Scotchwrap.

C. Pitch gas piping system within the building downward and provide drip pockets at all low points. Make final valve connection with union to all gas consuming equipment, except as noted.

D. Vent gas regulators, safety valves, etc., to outdoors as required by utility providing the gas service. Provide individual vent for each item unless manifolding is allowed by utility company.

E. Gas shutoff valves are to be installed at an accessible location beneath the ceiling.

F. Provide tracer wire and/or tape above underground polyethylene gas mains. Tracer wire or tape shall be electrically continuous, corrosion resistant and shall be terminated above grade at building or riser.

G. Above ground gas piping shall be electrically bonded in accordance with NFPA 54.

H. Threaded joints shall be sealed with polytetrafluoroethylene tape ASTM D3308 or joint sealing compound as listed in UL gas and oil dir., Class 20 or less.

I. Provide on gas service to building seismically actuated gas shut-off valve. Valve shall be UL Listed and State of California certified.

3.14 SERVICE CONNECTIONS

A. Coordinate with site civil engineer for new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with water meter and valves, pressure reducing valve, backflow preventer. Make all arrangements with local Water Company and pay all charges, including cost of water meter, in connection with installation of new water service, including connections to street main with curb shutoff valve and valve box.

C. Provide 3/4 inch tap with hose end valve for pipe disinfection on service main downstream of wet tap. Valve and nipple to be removed after disinfection of main and pipe plugged.

D. For corrosive soil installations, provide water service main encasement 0.008 inch thick with loose polyethylene.

3.15 TESTING OF PIPING SYSTEMS

A. Refer to Testing of Piping Systems, General in Section 22 05 00.

B. Field Quality Control

1. Do not enclose, cover, or put into operation water distribution piping system and drainage and vent piping system until each has been inspected and approved by the authority having jurisdiction.
2. Reinspections: When the representative of the authority having jurisdiction finds that piping system will not pass test or inspection, make required corrections and arrange for reinspection by authority having jurisdiction.
3. Reports: Prepare inspection reports signed by the representative of the authority having jurisdiction.
4. Test in accordance with the more stringent of the requirements of the authority having jurisdiction or the following:

C. Gravity Drainage Systems

1. Combination Water/Air Test

a. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open-jointed drain tile, test new and/or altered piping of plumbing drainage and venting systems on completion of roughing in piping installation. Tightly close all openings in piping system and fill with water to point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before inspection starts through 15 minutes after completion of inspection. Inspect all joints for leaks.

b. Finished Plumbing Test Procedure: After plumbing fixtures have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves the building and introduce air into the system equal to pressure of 1 inch water column. Use a U tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period beginning 15 minutes before inspection starts and 15 minutes after completion of inspection. Inspect plumbing fixture connections for gas, air and water leaks.

2. Air test only

a. Rough Plumbing Test Procedure: If tests are made with air, apply a pressure of not less than 5 psig with a force pump and test as specified above. Use mercury-column gauge registering 10 inches in height in air test. Use air tests only when air temperatures around tested system are 32^{o} F. or below and temporary heat is not available.

b. Finished Plumbing Test Procedure: Test as specified above.

D. Domestic/Laboratory Hot and Cold Water:

1. For water distribution to be utilized in Phase 1 scope and there after, test hydrostatically upon completion of the rough-in and before insulating or setting fixtures. Maintain pressure for not less than 4 hours without leakage.

2. All future piping distribution installed in Phase 1, that will not be utilized until Phase 2 scope, shall be air pressure tested, only.

E. Gas System: Test in accordance with NFPA 54, local codes and/or local gas company requirements.

3.16 VALVES

A. Refer to Section 22 05 00 for basic requirements.

B. Equip each main and each major branch valve in Mechanical Room installed in a line over 7 feet above floor and other valves indicated as chain operated with appropriate size babbitt

adjustable sprocket rim, chain and chain guide. Continuous chain shall reach within six feet of floor. Use only valves available with chain operators. Install with wheel in vertical plane.

3.17 WATER HAMMER ARRESTERS

A. Provide water hammer arresters at ends of all branches in hot and cold supply piping, at each group of flush valve operated fixtures, at equipment having quick closing valves (such as washers) and elsewhere as required and/or indicated on Drawings. Size and install each arrester according to manufacturer's instructions. Where pressure exceeds 60 psi, use next size larger where required by unit manufacturer. Install in an upright position and above ceiling in pipe chase in an accessible location.

3.18 WATER PRESSURE REGULATING STATION

A. Install station in accordance with detail on Drawings.

3.19 GAS SERVICE CONNECTION

A. Make arrangements with local gas company for new gas service extended into the building and pay all charges.

END OF SECTION 22 10 00

SECTION 22 11 00 - DISINFECTION OF DOMESTIC WATER LINES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

1.2 SUMMARY

A. This section includes the disinfection and laboratory testing of domestic water piping systems to certify disinfection of system.

B. Related Sections: Division 22.

1.3 DEFINITIONS

A. Disinfectant Residual means the quantity of disinfectant in treated water.

B. pH Factor means the measure of alkalinity and acidity in water.

C. Ppm means parts per million.

D. CFU/mL means colony forming units per milliliter.

1.4 QUALITY ASSURANCE

A. Water Treatment Contractor: At least 5 years' experience performing Work specified herein.

B. Bacteriological Laboratory: Certified by State of Nevada and by federal and local authorities having jurisdiction.

1.5 REFERENCE STANDARDS

A. Comply with State of Nevada and local Health Department requirements.

B. AWWA Specification C-651 - Disinfecting Water Mains.

C. Centers for Disease Control and Prevention (CDC) Standard Methods #9260J.

1.6 SUBMITTALS

A. Water Treatment Contractor's evidence of certification: Submit four copies.

B. Water Treatment Contractor's evidence of experience: Submit four copies.

C. Bacteriological Laboratory's evidence of certification: Submit four copies.

D. Tests Reports: Submit four copies as follows:

1. Disinfection Report, include:

a. Date issued
b. Project name and location
c. Treatment Contractor's name, address, and phone number and name of person executing disinfection
d. Type and form of Disinfectant used
e. Time and date of Disinfectant injection start and completion
f. Test Locations
g. Initial and 24 hour Disinfectant Residuals in ppm for each outlet tested
h. Time and date of flushing start and completion
i. Disinfectant Residual after flushing in ppm for each outlet tested

2. Bacteriological Report; include:

a. Date issued
b. Project name and location
c. Laboratory's name, certification number, address and phone number
d. Time and date of water sample collection
e. Name of person collecting samples
f. Test locations
g. Time and date of laboratory test start
h. Coliform bacteria test results for each outlet tested
i. Certification that water conforms or fails to conform to bacterial standards or fails to conform to bacterial standards of Federal Safe Drinking Water Act.
j. Bacteriologist's signature

3. Legionella Report; include:

a. Date issued
b. Project name and location
c. Laboratory's name, certification number, address and phone number
d. Time and date of water sample collection
e. Name of person collecting samples
f. Test sample point location
g. Initial flow temperature of sample
h. Stabilized flow temperature of sample
i. Time and date of laboratory test start
j. Legionella test results for each test sample
k. Test method used
l. Bacteriologist's signature

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg F. and 80 deg F.

1.8 PROTECTION

A. Provide necessary signs, barricades and notices to prevent any person from accidentally consuming water or disturbing system being treated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. DISINFECTANT

1. Sodium Hypochlorite; liquid, powder, tablet, or gas.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to starting Work verify that domestic water system is completed and cleaned.

B. Notify General Contractor about defects requiring correction.

C. Do not start Work until conditions are satisfactory.

3.2 SYSTEM TREATMENT

A. New or repaired potable and non-potable water systems shall be disinfected prior to use where required by the Authority Having Jurisdiction. Prior to utilization of newly constructed or altered potable water piping systems, all affected potable water piping shall be disinfected using procedures prescribed in Plumbing Code. The method to be followed shall be that prescribed by the Health Authority or in case no method is prescribed by it, the following:

1. The pipe system shall be flushed with clean, potable water until potable water appears at the points of the outlet.
2. The system or parts thereof shall be filled with a water-chlorine solution containing not less than 50 parts per million of chlorine and the system or part thereof, shall be valved-off and allowed to stand for 24 hours or part thereof shall be filled with a water-chlorine

solution containing not less than 200 parts per million of chlorine and allowed to stand for 3 hours.

3. Following the allowed standing time, the system shall be flushed with clean, potable water until the chlorine residual in the water coming from the system does not exceed the chlorine residual in the flushing water.
4. The procedure shall be repeated where it is shown by a bacteriological examination made by an approved agency that contamination persists in the system.

B. Potable and non-potable water distribution piping that will not be implemented after Phase 2 work shall not go through disinfection process. Disinfection of piping system shall take place during Phase 2 scope of work.

C. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

D. Maintain disinfectant in system for 3 hours with 200-PPM chlorine; or 24-hrs with 50-PPM chlorine.

E. At the end of retention period, test for Disinfectant Residual at each of the following locations:

1. Ends of piping runs
2. Remote outlets
3. Tanks
4. At least 15% of outlets on each floor where directed by Architect, but in no case less than 2 outlets

F. If Disinfectant Residual is less than 10 ppm, repeat system treatment.

3.3 FLUSHING

A. Remove disinfectant by flushing system with clean water until residual rate is reduced to less than 1.0 ppm.

3.4 BACTERIOLOGICAL TEST

A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.

B. Consult local sewage treatment facility and insure that pH levels of disinfectant to be disposed is satisfactory prior to disposal. Provide all means and methods necessary to meet disposal requirements of authorities having jurisdiction.

C. Take water samples at each of the following locations:

1. Where water enters system
2. Ends of piping runs
3. Remote outlets
4. Tanks

5. At least 10 % of outlets on each floor other than those used for testing Disinfectant Residual, where directed by Architect, but in no case less than 2 outlets.

D. Analyze water samples in accordance with AWWA Standard Methods for the Examination of Water & Waste Water, 14th edition.

E. If bacteriological test proves water quality to be unacceptable, repeat disinfection of system until satisfactory bacteriological results have been obtained.

3.5 LEGIONELLA TEST

A. Instruct bacteriological laboratory to take water samples no sooner than 24 hours after flushing system.

B. Take water samples at each of the following locations:

1. Incoming water supply
2. Domestic water heater drain valve
3. Ends of piping runs
4. Remote outlets
5. At least 10% of faucets and 10% of showers on each floor other than those used for testing disinfectant residual, where directed by Architect, but in no case less than 2 outlets.

C. Analyze water samples in accordance with CDC Standard Method #9260J, or other internationally recognized test method as recommended by groups such as Special Pathogens Laboratory of the VA Medical Center, Pittsburgh, Pennsylvania.

D. Samples shall be delivered to the laboratory and analyzed within 48 hours of collection. Samples shall be protected from extreme temperature variations during transport.

E. Sample collection: Collect samples utilizing the methodology described as follows:

1. Faucets: Moisten the outlet by allowing water to trickle through the opening. A sterile Dacron swab is inserted and rotated four times around the inner circumference and moving up the faucet as far as the swab will reach. Replace the swab into the container. If the swab system does not contain a transport medium, then allow 0.5 ml of water to flow from the faucet into the container to keep the swab moist. The Culturette II System (Becton Dickinson) has a self-contained transport medium, and it is not necessary to add outlet water to the swabs.
2. Shower Head: Moisten the shower head by allowing water to trickle through the opening. Rotate the swab over the entire surface of the shower head 4 times. Place swab into the container. If the swab system does not contain a transport medium, then allow 0.5 ml of water to flow from the shower head into the container.
3. Hot Water Tank: Open the drain valve at the base of the tank. Collect 10 to 50 ml immediately into a sterile specimen container. Then let the water drain out of the pipe for 15-30 seconds to flush out residual water within the drain pipe and then collect another 10 to 50 ml into a second specimen container. This procedure ensures that both residual water in the drain pipe and water from the tank are sampled. Scale and sediment often harbor Legionella bacteria, so it is worthwhile to obtain scale or sediment from tanks or

distal sites. Heavy "syrupy" specimens from the bottom of hot water tanks, however, often will not yield the organism.

a. Samples should be refrigerated at 2-8^{o} C. until processing. Swab specimens generally give higher yields than water taken from the same site.
b. BCYE medium with dyes, glycine, vancomycin and polymyxin will be used (Remel #01338, BBL #99648). Plates overgrown with microflora will undergo acid treatment.

F. Action Limits: Test results indicating the Legionella CFU/mL shall be acted upon as follows:

1. Individual Sample Test of less than 10 CFU/mL: Report results with recommendation for monthly follow-up testing. After 6 months of follow-up testing with no test above 10 CFU/mL, testing may be suspended. If samples from 30% or more of tested outlets test positive for Legionella, report results with recommendation for prompt cleaning and/or biocide treatment.
2. Individual Sample Test Result Between 10 and 99 CFU/mL: Report results with recommendation for prompt cleaning and/or biocide treatment.
3. Individual Sample Test Result of 100 CFU/mL or Higher: Report results and recommend immediate cleaning and/or biocide treatment with prompt steps to avoid exposure.

3.6 ALTERATIONS TO EXISTING SYSTEMS

A. Unless required otherwise by Codes or authorities having jurisdiction, new branch piping not exceeding 75 total linear feet that is connected to existing systems need not be disinfected. Thoroughly flush this piping with system water and then test for coliform and Legionella organisms. If tests indicate presence of coliform organisms, or Legionella organisms, treat piping as described above and retest for coliform and Legionella. Provide all necessary valves, drains, piping and accessories required to isolate new piping from existing systems during treatment.

END OF SECTION 22 11 00

SECTION 22 11 23 - PLUMBING PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following Plumbing Pumps:

1. Centrifugal Pump, Inline, Close Coupled
2. Domestic Water Constant Pressure System (Type VFD)

B. Related sections include the following:

1. Section 22 05 00 COMMON MATERIALS AND METHODS FOR PLUMBING
2. Section 22 05 13 ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT
3. Section 22 05 48 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING EQUIPMENT

1.3 PERFORMANCE REQUIREMENTS

A. Pump Selection

1. Ensure pump operates at specified system fluid temperatures without vapor binding and cavitation, has nonoverloading motor in parallel or individual operation, operates within 25% of midpoint of published maximum efficiency curve.
2. Select pump so that ratio of impeller diameter used to maximum impeller diameter shown on pump curve shall not exceed 0.85. Impeller diameter may be increased to not greater than 85% of casing cut-water diameter provided that submittal includes either certified letter from factory or published literature listing pump cut-water diameter.
3. Pump working pressure construction shall be greatest of: 125 psig WWP; 1.5 times actual working pressure (sum of pump shutoff head and system static pressure) at pump; specified working pressure.

1.4 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.5 REFERENCES

A. ASTM A36 - Specifications for Structural Steel

B. ASTM A48 - Specification for Gray Iron Castings

C. ASTM A532 - Specification for Abrasion-Resistant Cast Irons

D. ASTM B36 - Specification for Brass Plate, Sheet, Strip and Rolled Bar

E. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings

F. ASTM B548 - Specification for Copper Alloy Sand Castings for General Applications

1.6 SUBMITTALS

A. Product Data: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

B. Manufacturers Seismic Qualification Certification: Submit Certification that pump(s) components and accessories will withstand seismic forces defined in Division 22 Section "Vibration Isolation and Seismic Restraints for Plumbing Systems."

C. Certificates:

1. Manufacturer's start up certificate for Base Mounted Pump
2. Certified factory test report, manufacturer's startup certificate and harmonic test report for Variable Volume Domestic Water Pumping System

1.7 MANUFACTURER'S SUPERVISION AND STARTUP

A. Base-Mounted Centrifugal Pump: Provide startup service supervised by manufacturer's representative, who shall certify in writing that pump operates in accordance with the intent of the specifications and has been checked, and corrections made, when necessary, for:

1. Rotation
2. Lubrication
3. Absence of pipe strain
4. Suction and discharge pressures
5. Current and voltage readings
6. Alignment, Flexible Coupled Only: $\pm$ 0.005 Inch, 4 ways

B. Variable Volume Domestic Water Pumping System: Provide startup service as specified above for base mounted pumps. In addition, test and adjust controls, perform electric line noise test and furnish test report, certify in writing that system is performing as specified and instruct Owner for not less than eight hours in operation and adjustment of system.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain pumps through one source from a single manufacturer

B. Electrical Components, Devices, and Accessories: Shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Standards: Comply with the requirements of the following:

1. "Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps" for design, manufacture and installation
2. NEMA MG-1: Motors and Generators
3. NEMA ICS-6: Enclosures for Industrial Control and Systems
4. NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum)
5. NFPA 70: National Electrical Code

D. Finish: Manufacturer's standard paint, factory applied.

E. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surface and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings and nozzles with wooden flanges or screwed inserts.

F. Casing and Impeller Construction: Unless otherwise specified or required or recommended by pump manufacturer, materials of construction shall be as follows:

1. Cast iron pump casing: ASTM A48, minimum class as specified. Class as recommended by pump manufacturer where not specified.
2. Cast bronze pump casing or impeller: ASTM B124.
3. Cast brass impeller: ASTM B36 or B62 as recommended by pump manufacturer for application.

G. Mechanical Pump Seals: Mechanical seal suitable for continuous duty with water/liquid and temperature specified. Fabricate mechanical seals with carbon rotating seal face ring, Type 316 stainless steel springs and, as required and recommended for application.

1. Ni-Resist ceramic or tungsten carbide stationary seat
2. Brass or Type 316 stainless steel retainer
3. Buna N or EPT elastomers

H. Slingers: Provide for close coupled pumps so that leakage past pump seal cannot enter motor bearings

I. Statically and dynamically balance all rotating parts.

J. Pump bearings shall be re-greasable ball type with grease fitting unless otherwise specified.

K. All pumps shall have drain and vent ports on casing

L. Motor and Starting Equipment

1. Motor and starting equipment shall comply with requirements of Section 22 05 13 ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT
2. Motor sizes shown are maximum. Select pump so as not to require larger motor for operation 25% beyond design point on pump curve. Smaller motor acceptable under condition that nominal horsepower of smaller motor exceeds 100% of brake horsepower required for operation of pump provided at 125% of design flow rate on pump curve.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of the following manufacture:

1. Inline Closed Coupled Pumps

    a. Xylem
    b. Armstrong
    c. Taco

2. Domestic Water Pressure Booster Systems

    a. Grundfos
    b. Quantum FGW
    c. Synchroflow
    d. Paco
    e. Goulds
    f. Ebara
    g. Canariis

2.2 REQUIREMENTS FOR CENTRIFUGAL, BASE MOUNTED PUMPS

A. Refer to Quality Assurance article in Part 1 of this section.

B. All pumps used for domestic service shall be certified. Lead free construction NSF 61/372 compliant.

C. Provide pump casing with inlet and outlet gauge tappings.

D. Unless otherwise indicated or specified, provide bronze statically and dynamically balanced impeller keyed to shaft, replaceable bronze case wear rings.

E. Provide mechanical seals for Pumps BP-1.

F. Mechanical Seal and Shaft: Metallic parts of seal stainless steel with 225^{o} F. seat for general hot and cold water service. Shaft of carbon steel with either Type 316 stainless steel or bronze sleeve and O-ring gasket between sleeve and impeller hub unless otherwise specified hereinafter.

G. Coupling for Flexible Coupled Pump: Flexible, capable of absorbing torsional vibration and shaft misalignment. Provide flexible-spacer type, with flange and sleeve section that can be disassembled and removed without removing or moving pump or motor.

H. Mounting Frame: Welded-steel frame and cross members, factory-fabricated from ASTM A 36 channels and angles. Fabricate for mounting pump casing, coupling guard, and motor. Grind welds smooth before application of factory finish. Field-drill motor-mounting holes for field-installed motors.

1. Option: Frame may be cast iron instead of steel.

I. Motor: Secured to mounting frame, with adjustable alignment.

J. Provide manufacturer's startup service as specified in Part 1 of this section.

K. Vibration Isolation and Seismic Restraints: Refer to Section 22 05 48 Vibration Isolation and Seismic Restraints for Plumbing Systems.

2.3 DOMESTIC WATER VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Variable Speed Packaged Pumping System

1. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.
2. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer. The system shall be similar to Canariis Corporation, as scheduled on drawings.
3. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.
4. The complete packaged pumping system shall be NSF61 Annex G listed for drinking water and low lead requirements.
5. Pump package shall comply with ASHRAE Standard 90.1-2010.
6. All welding shall be performed by certified welders in accordance with ASME Section IX.

B. Reference Standards: The work in this section is subject to the requirements of applicable portions of the following standards:

1. Hydraulic Institute
2. ANSI – American National Standards Institute
3. ASTM – American Society for Testing and Materials
4. IEEE – Institute of Electrical and Electronics Engineers
5. NEMA – National Electrical Manufacturers Association
6. NEC – National Electrical Code
7. ISO – International Standards Organization
8. UL – Underwriters Laboratories, Inc.

C. Packaged Pumping System

1. The booster system shall be factory assembled on a steel skid including pumps, motors, valves, Type "L" Copper suction and discharge manifolds, and all interconnecting piping, wiring and controls. Manifold connections will be grooved at one end. Branch piping and tank piping (if applicable) shall be the same material as the suction and discharge manifolds. Provide isolation valves on the suction and discharge of each pump. The valves shall be full-port ball valves. Provide a thermal purge valve on the discharge of each pump. Provide two 4 1/2" ASME grade A, panel mounted gauges for indicating system suction and system discharge pressure. All skid mounted components shall be factory finished in a high-quality enamel paint.
2. Individual pumps, motors and check valves may be serviced with the booster system in operation and all components shall be suitable for the maximum working pressure and temperature in the system.

D. Pumps

1. All pumps shall be ANSI/NSF 61 Annex G listed for drinking water and low lead requirements.
2. Horizontal mounted, close-coupled, end suction, centrifugal pumps.
3. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.
4. System shall be multiplex, horizontal mounted, close-coupled, end-suction centrifugal pumps with ANSI flanged connections. Pump features to include foot supported casing, back pull-out design, top centerline discharge and hydraulically balanced impeller. Pump shall be cast iron bronze fitted construction with a replaceable shaft sleeve and mechanical seal suitable for a working pressure of 175 PSIG. Motor shall be NEMA close-coupled type with a JM shaft.
5. Small Vertical In-Line Multi-Stage Pumps (Nominal flow from 3 to 125 gallons per minute) shall have the following features:

    a. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.
    b. The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.
    c. Pump Construction

1)	Suction/discharge base, pump head, motor stool:	Cast iron (Class 30)
2)	Impellers, diffuser chambers, outer sleeve:	304 Stainless Steel
3)	Shaft	316 or 431 Stainless Steel
4)	Impeller wear rings:	304 Stainless Steel
5)	Shaft journals and chamber bearings:	Silicon Carbide
6)	O-rings:	EPDM

Shaft couplings for motor flange sizes 184TC and smaller shall be made of cast iron or sintered steel. Shaft couplings for motor flange sizes larger than 184TC shall be made of ductile iron (ASTM 60-40-18).

Optional materials for the suction/discharge base and pump head shall be cast 316 stainless steel (ASTM CF-8M) resulting in all wetted parts of stainless steel.

d. The shaft seal shall be a balanced o-ring cartridge type with the following features:

1)	Collar, Drivers, Spring:	316 Stainless Steel
2)	Shaft Sleeve, Gland Plate:	316 Stainless Steel
3)	Stationary Ring:	Silicon Carbide
4)	Rotating Ring:	Silicon Carbide
5)	O-rings:	EPDM

The Silicon Carbide shall be imbedded with graphite.

e. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

E. Variable Frequency Drives (Panel Mount)

1. The VFD shall convert incoming fixed frequency single-phase or three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.
2. The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.
3. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.
4. The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.
5. VFD shall automatically boost power factor at lower speeds.
6. The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.
7. An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation.
8. Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.
9. Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.
10. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.
11. VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.
12. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.
13. VFD to be provided with the following protective features:

a. VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.
b. VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.
c. VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
d. VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.
e. VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.
f. The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

14. VFD to be provided with the following interface features:

a. VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.
b. VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.
c. All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.
d. VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.
e. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
f. A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.
g. VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.
h. All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.
i. There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.
j. The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.
k. One programmable analog output shall be provided for indication of a drive status.

l. The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.
m. The VFD shall store in memory the last 5 faults with time stamp and recorded data.
n. The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The bus communication protocol for the VFD shall be the same as the controller protocol.

15. VFD service conditions:

a. Ambient temperature operating range, -10 to 45ºC (14 to 113□F).
b. 0 to 95% relative humidity, non-condensing.
c. Elevation to 1000 meters (3,300 feet) without derating.
d. VFD's shall be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -15% variations. Line frequency variation of ± 2% shall be acceptable.
e. No side clearance shall be required for cooling of the units.

F. Pump System Controller

1. The pump system controller shall be a standard product developed and supported by the pump manufacturer.
2. The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a color display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.
3. The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.
4. The controller shall have the ability to be connected to a battery to maintain power on controller during periods of loss of supply power.
5. The controller shall have built in data logging capability. Logged vales shall be graphically displayed on the controller and able to be exported to computer via standard connection. A minimum of 3600 samples per logged value with the following parameters available for logging:

a. Estimated flow-rate
b. Speed of pumps
c. Inlet pressure
d. Discharge pressure
e. Power consumption
f. Controlling parameter (process value)

6. The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

a. Current value of the control parameter, (typically discharge pressure)
b. Most recent existing alarm (if any)
c. System status with current operating mode
d. Status of each pump with current operating mode and rotational speed as a percentage (%)

e. Estimated flow-rate, (not requiring flow meter connection)

7. The controller shall have as a minimum the following hardware inputs and outputs:

   a. Three analog inputs (4-20mA or 0-10VDC)
   b. Three digital inputs
   c. Two digital outputs
   d. Ethernet connection
   e. Field Service connection to PC for advanced programming and data logging

8. Pump system programming (field adjustable) shall include as a minimum the following:

   a. Water shortage protection (analog or digital)
   b. Transducer Settings (Suction and Discharge Analog supply/range)
   c. PI Controller (Proportional gain and Integral time) settings
   d. High system pressure indication and shut-down
   e. Low system pressure indication and shut-down
   f. Low suction pressure/level shutdown (via digital contact)
   g. Low suction pressure/level warning (via analog signal)
   h. Low suction pressure/level shutdown (via analog signal)
   i. Flow meter settings (if used, analog signal)

9. The system controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module may be required).
10. The controller shall have advanced water shortage protection. When analog sensors (level or pressure) are used for water shortage protection, there shall be two indication levels. One level is for warning indication only (indication that the water level/pressure is getting lower than expected levels) and the other level is for complete system shut-down (water or level is so low that pump damage can occur). System restart after shut-down shall be manual or automatic (user selectable).
11. The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (typically pressure) by measuring an additional parameter. (Example: Lower the system pressure set-point based on a flow measurement to compensate for lower friction losses at lower flow rates).
12. The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.
13. The controller shall be able to adjust the ramp time of a change in set point on both an increase or decrease change in set point.
14. The pump system controller shall store up to 24 warning and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

a.	High System Pressure	Low system pressure
b.	Low suction pressure (warning and alarm)	Individual pump failure
c.	VFD trip/failure	Loss of sensor signal (4-20 mA)
d.	Loss of remote set-point signal (4-20mA)	System power loss

15. The pump system controller shall be mounted in a UL Type 12 rated enclosure. A self-certified NEMA enclosure rating shall not be considered equal. The entire control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.

    Control panel options shall include, but not be limited to:

    a. Pump Run Lights
    b. Audible Alarm (80 db)
    c. Emergency/Normal Operation Switches
    d. Qty (9) Configurable Digital Outputs available for monitoring
    e. System Fault Light
    f. Surge Arrestor
    g. Service Disconnect Switches

16. The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).
17. The controller shall have a pump "Test Run" feature such that pumps are switched on during periods of inactivity (system is switched to the "off" position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of two to three (3-4) seconds every 24 hours, 48 hours or once per week and at specific time of day (user selectable).
18. The controller shall be capable of changing the number of pumps available to operate or have the ability limit the maximum power consumption by activation of a digital input for purposes of limited generator supplied power.
19. The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).
20. The controller shall be capable of displaying instantaneous specific energy use (kw/gpm), (optional flow meter must be connected).
21. The actual pump performance curves (5th order polynomial) shall be loaded (software) into the pump system controller or be able to input manually into controller based on three points on pump curve of pumps controlled.
22. The controller shall be capable of displaying an estimated flow-rate on the default status screen.
23. The controller shall have the ability to compensate for pipe friction loss by decreasing pressure set-point at lower flow-rates and increasing pressure set-point at higher flow-rates without the requirement of a flow meter.
24. The controller shall have the ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside controller.
25. The controller shall have a built in Ethernet connection allowing controller to connected to network and access of controller via web browser and internet anywhere around the world where internet communication is available.
26. The controller shall have a programmable Service Contact Field that can be populated with service contact information including: contact name, address, phone number(s) and website.

G. Sequence of Operation

1. The system controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure (system set-point). The system controller shall receive an analog signal 4-20mA from the factory installed pressure transducer on the discharge

manifold, indicating the actual system pressure. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure. When the operating pump(s) reach 96% of full speed (adjustable), an additional pump will be started and will increase speed until the system set-point is achieved. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds. As flow demand decreases the pump speed shall be reduced while system set-point pressure is maintained. When all pumps in operation are running at low speed the system controller shall switch off pumps when fewer pumps are able to maintain system demand.

2. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.
3. All pumps in the system shall alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week. The interval and actual time of the pump change-over shall be field adjustable.
4. The system controller shall be able to control a pressure maintenance pump, (jockey pump), in the system. The set point of the pressure maintenance pump shall be able to be any value above or below the pump system's set point. The pressure maintenance pump shall be able to be staged on as back-up pump when capacity of pump system is exceeded.

H. Low Flow Stop Function

1. The system controller shall be capable of stopping pumps during periods of low-flow or zero-flow without wasting water or adding unwanted heat to the liquid. Temperature based no flow shut-down methods that have the potential to waste water and add unwanted temperature rise to the pumping fluid are not acceptable.
2. Standard Low Flow Stop and Energy Saving Mode: If a low or no flow shut-down is required (periods of low or zero demand) a bladder type diaphragm tank shall be installed with a pre-charge pressure of 70% of system set-point. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When only one pump is in operation the system controller shall be capable of detecting low flow (less than 10% of pump nominal flow) without the use of additional flow sensing devices. When a low flow is detected, the system controller shall increase pump speed until the discharge pressure reaches the stop pressure (system set-point plus 50% of programmed on/off band). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band). Upon low flow shut-down a pump shall be restarted in one of the following two ways:

    a. Low Flow Restart: If the drop in pressure is slow when the start pressure is reached (indicating the flow is still low), the pump shall start and the speed shall again be increased until the stop pressure is reached and the pump shall again be switched off.
    b. Normal Flow Restart: If the drop in pressure is fast (indicating the flow is greater than 10% of pump nominal flow) the pump shall start and the speed shall be increased until the system pressure reaches the system set-point.

I. System Construction

1. Suction and discharge manifold construction shall be in way that ensures minimal pressure drops, minimize potential for corrosion, and prevents bacteria growth at intersection of piping into the manifold. Manifold construction that includes sharp edge transitions or interconnecting piping protruding into manifold is not acceptable. Manifold construction shall be such that water stagnation cannot exist in manifold during operation to prevent bacteria growth inside manifold.
2. The suction and discharge manifolds shall be constructed of 316 stainless steel. Manifold connection sizes shall be as follows:

    a. 3 inch and smaller: Male NPT threaded
    b. 4 inch through 8 inch: ANSI Class 150 rotating flanges
    c. 10 inch and larger: ANSI Class 150 flanges

3. Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.
4. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the check valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2" and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.
5. For systems that require a diaphragm tank, a connection of no smaller than ¾" shall be provided on the discharge manifold.
6. A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.
7. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.
8. Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.
9. The base frame shall be constructed of corrosion resistant 304 stainless steel. Rubber vibration dampers shall be fitted between each pumps and baseframe to minimize vibration.
10. Depending on the system size and configuration, the control panel shall be mounted in one of the following ways:

    a. On a 304 stainless steel fabricated control cabinet stand attached to the system skid.
    b. On a 304 stainless steel fabricated skid, separate from the main system skid
    c. On its own base (floor mounted with plinth)

J. Testing

1. The entire pump station shall be factory tested for functionality. Functionality testing shall include the following parameters: Dry Run Protection, Minimum Pressure and Maximum Pressure alarms (where applicable), Setpoint Operation, and Motor Rotation.
2. The system shall undergo a factory hydrostatic test at the end of the production cycle. The system shall be filled with water and pressurized to 1.5 times the nameplate maximum pressure. Systems with 150# flange connections shall be tested at 350 psig, and systems with 300# flange connections shall be tested at 450 psig. The pressure shall be maintained for a minimum of 15 minutes with no leakage (slight leakage around pump(s) mechanical seal is acceptable) prior to shipment.

K. Warranty

1. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

L. Accumulator Tank

1. Provide factory precharged, ASME code stamped132 gallon, 50 psig rated accumulator tank with ASME relief valve, air fill valve, air pressure gauge, drain valve and replaceable flexible membrane to separate air and water. Tank shall be bottom fed, capable of 100% draw down, shipped precharged to the proper design conditions and capable of storing a minimum of 15 gallons of usable water with the scheduled pump(s) and design conditions. Locate tank with pump.
2. Provide minimum 3/4 inch feedline piping from main pumps to tank, Include spring loaded nonslam check valve and isolating valve in each pump discharge connection to prevent leaks back to suction.

M. Motors and starting equipment shall comply with the requirements of Section 22 05 13.

N. Warranty Service: System manufacturer or his representative shall provide one year warranty service for the pumping system. Warranty service shall include same day telephone response and on site troubleshooting and repair of the system within 48 hours.

O. Provide manufacturer's startup service as specified in Part 1 of this section.

P. Refer to Section 22 05 48 for vibration isolation and seismic restraint requirements.

2.4 IN-LINE PUMP, CLOSE COUPLED

A. Centrifugal, close coupled in-line, supported by piping system in which it is installed, back pullout design for complete servicing without disturbing piping, suitable for horizontal or vertical operation.

B. Cast iron casing Class 30 minimum, except bronze casing for domestic water service, with inlet and outlet gauge tappings, rated for 175 psig working pressure with air vent plug, drain plug, flanged suction and discharge.

C. Bronze or brass impeller keyed to shaft, removable bronze case wear rings, mechanical seal with 225 deg F. Ni-Resist Seat and stainless steel metallic parts, internal or external seal flush, either carbon steel shaft with bronze shaft sleeve and O-ring gasket between sleeve and impeller hub or Type 316 stainless steel shaft, grease lubricated ball bearings.

D. Refer to Quality Assurance article in Part 1 of this section.

E. Seismic Design: Refer to Section 22 05 00, Article 1.10, Paragraph B.

PART 3 - EXECUTION

3.1 GENERAL

A. General

1. Refer to, and comply with, Section 22 05 00 for basic requirements.
2. Refer to Section 22 05 48 for vibration isolation and seismic restraints, penetration seals and the like.

B. Manufacturer's Supervision/Inspection: Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer's supervision/inspection services and manufacturer's written certification as specified in Part 1 of this section, and shall at his own expense make any corrections/modifications to his installation work as required by the manufacturer.

C. Install all equipment as recommended by manufacturer and in accordance with recommendations of Hydraulic Institute.

D. Align and verify alignment of base mounted pumps.

E. Where pump connection is smaller than pipe size indicated, valves, strainers and other pipe line accessories shall be line sized.

F. Support piping adjacent to pump such that no weight is carried on pump casings.

G. Suspend in-line pump independent from piping.

H. Provide drains for bases piped to floor drains.

I. Provide air cock and drain connection on horizontal pump casings.

J. Use eccentric suction reducer at pump suction and concentric discharge increaser at pump discharge.

K. Where elbows must be used at pump suction, provide long radius reducing type.

L. Provide line sized shutoff valve and strainer and pressure gauge on suction line and line sized soft-seated check valve, shut-off valve and pressure gauge on discharge line.

M. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over and on smaller sizes as shown or necessary.

N. Where pump is installed on a concrete pad or concrete filled inertia base, grout pump to pad on base after concrete has cured.

3.2 COMMISSIONING

A. Commissioning will be provided by the Contractor for Division 1, Testing, Adjusting, Balancing and Commissioning of Mechanical Systems, hereinafter called the TAB Contractor. Project commissioning requirements are described in Division 1. Cooperate and participate in the commissioning work.

B. Ensure participation of major equipment manufacturers or their representative.

C. Equipment and systems/subsystems installed or provided by the contractor for this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the TAB Contractor when any specified piece of equipment or specific system/subsystem is ready for commissioning.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require recommissioning. The Contractor for this section shall be fully responsible for his incomplete or noncomplying work, shall make all necessary corrections to such work at his own expense and shall pay the TAB Contractor's per diem rate stated in the TAB Contractor's proposal for recommissioning such incomplete or noncomplying work.

3.3 DOMESTIC HOT WATER CIRCULATING PUMP

A. Provide in hot water return piping, ahead of circulator, an immersion aquastat, similar to Honeywell L-6006A, for controlling circulator.

3.4 SERVICING OF EXISTING PUMPS

A. Where noted on the pump schedule on the drawings as "PROVIDE NEW SEALS AND SHAFT SLEEVE. WHERE EXISTING PUMP HAS PACKED TYPE SEALS, REPLACE WITH MECHANICAL SEALS", replace seals on existing pumps with mechanical seals and provide new shaft sleeves in compliance with requirements of Article 2.02, paragraph A of this Section. In addition, provide the following services for these pumps:

1. Provide new bearings
2. Verify dynamic balance of impellers and rebalance as required
3. Verify that casing rings and impeller rings are within manufacturer's tolerance and replace if not
4. Provide manufacturer's startup service and certificate as specified in Part 1 of this section

B. All work other than field removal of existing parts and installation of serviced and new parts, shall be done in the shop of an authorized representative of the pump manufacturer.

3.5 STARTUP WORK

A. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Lubricate bearings.
2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's recommendations.
3. Disconnect coupling of flexibly coupled pump and check motor for proper rotation that matches direction marked on pump casing.
4. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.
5. Check that pump controls are correct for required application.
6. Where applicable, set pump controls for automatic start, stop and alarm operation as required for system application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power:

1. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
2. Open warmup valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
3. Open circulating line valves if pumps should not be operated against dead shutoff.
4. Start motors.
5. Open discharge valves slowly.
6. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
7. Check general mechanical operation of pumps and motors.
8. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

C. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.

3.6 VARIABLE WATER VOLUME PUMPING SYSTEM

A. Differential Pressure Sensor/Transmitter(s): Field mount as per pump manufacturer recommendations. Provide pair of R22 gauge or larger wire between transmitter(s) and system controller in accordance with requirements of Section 22 05 13.

B. Flow Sensor/Transmitter: Field mount near pump unit. Provide Belden Type 9320 (two conductor shielded) cable as required in accordance with requirements of Section 22 05 13.

C. Field mount all other devices not factory installed and shipped loose by manufacturer.

D. All other wiring required shall be provided by Contractor for DIVISION 22.

3.7 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Section 22 05 00 "Common Materials and Methods for Plumbing."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

END OF SECTION 22 11 23

SECTION 22 13 13 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings
2. Pressure-type pipe couplings.
3. Expansion joints and deflection fittings.
4. Cleanouts.
5. Encasement for piping.
6. Manholes.
7. Concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Submit manufacturers catalog data on pipe to be supplied.
2. Submit affidavit of compliance with this spec and all reference specifications signed by authorized representative of the manufacturers.
3. Non-pressure/pressure couplings.
4. Clean-outs.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings:

1. Pipe and Fittings: Shall conform to ASTM D 3034 or ASTM F 679, shall be SDR 35, with ends suitable for elastomeric gasket joints. Pipe shall meet requirements of UNI-B-10-88.
2. Joints and Jointing Material: Utilize an integral bell and spigot with a solid cross section rubber gasket. Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F477.
3. Pipe Stiffness: Minimum pipe stiffness (@ 5% deflect) shall be 46 for all sizes when tested in accordance with ASTM D 2412.
4. Flattening: There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:

    a. Flatten specimen of pipe, six inches long between parallel plates in a suitable press until the distance between the plates is forty percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes.

5. Manufacturer:

    a. Ring-tite greenbell PVC sewer pipe, Johns-Manville, Denver, Colorado;
    b. Fluidtite PVC sewer pipe, Certainteed Corporation, Anaheim, California; or equal.

2.2 PRESSURE-TYPE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cascade Waterworks Mfg. Co.
2. Dresser, Inc.
3. Ford Meter Box Company, Inc. (The).
4. JCM Industries, Inc.
5. Romac Industries, Inc.
6. Or Equal.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

D. Center-Sleeve Material: Stainless steel.

E. Gasket Material: Natural or synthetic rubber.

F. Metal Component Finish: Corrosion-resistant coating or material.

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Watts; a Watts Water Technologies company.
    e. Or Equal.

3. Top-Loading Classification(s): Heavy Duty and Extra-Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Canplas LLC.
    b. IPS Corporation.
    c. NDS Inc.
    d. Plastic Oddities.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Or Equal.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

C. Cleanout Enclosure:

1. Cleanout located outside traveled way provide 6” ID concrete enclosure with concrete cover marked “SEWER” per City of San Diego Standard Drawing SDS-1-2
2. Cleanout located in paved road, sidewalk, or other areas subject to traffic provide standard cleanout box with cover marked “SEWER” per City of San Diego Standard Drawing SDS-102

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Sheet.

D. Color: Black.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch-minimum-width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch minimum cover.
4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install PVC corrugated sewer piping according to ASTM D2321 and ASTM F1668.
7. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Expansion joints and deflection fittings.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join PVC corrugated sewer piping according to ASTM D2321.
5. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
6. Join dissimilar pipe materials with nonpressure-type, flexible[or rigid] couplings.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Unshielded flexible[or rigid]couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible[or rigid]couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic areas.
2. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye

fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease, oil and sand interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

    a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.

6. Manholes: Perform hydraulic test according to ASTM C969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 221313

SECTION 22 40 00 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section is intended to describe the plumbing fixtures and devices for the plumbing work.

B. This section includes the following:

1. Plumbing fixtures and trim
2. Thermostatic mixing valves
3. Electric water coolers
4. Hydrants
5. Emergency showers/eye wash/face wash
6. Miscellaneous plumbing accessories

C. Related sections include the following:

1. All applicable sections of Division 1
2. Division 7: Sealants
3. Section 22 05 00: Basic Materials and Equipment
4. Section 22 10 00: Plumbing Systems

1.3 REFERENCES AND REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

A. Provide work in accordance with all applicable codes, rules, regulations and reference standards.

B. ANSI - Z358.1 - Latest Edition: American National Standard for Emergency Eyewash and Shower Equipment.

C. NSF/ANSI 61: Drinking Water System Components.

1.4 SUBMITTALS

A. Provide submittals for all products listed in Article 2.01 of this section in accordance with Section 01 33 00, Submittal procedures in sufficient detail to verify full compliance with the requirements of the contract documents.

B. For each plumbing fixture category and type specified, include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment and supports. Indicate materials and finishes, dimensions, construction details and flow-control rates.

C. Submit wiring diagrams from manufacturer for electrically operated units.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating and covering.

B. Store plumbing fixtures on elevated platforms in dry location.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Comply with warranty and contract closeout requirements specified in Division 00.

B. Warranty

1. Refer to BIDDING AND CONTRACT REQUIREMENTS and to DIVISION 1 - GENERAL REQUIREMENTS.

C. Warranty: Standard warranty.

D. Contract Closeout

1. Include information for all products specified in this section, in operating and maintenance manual.

1.7 PROJECT/SITE CONDITIONS

A. Coordinate roughing in and final fixture locations and verify that plumbing fixtures can be installed in accordance with contract documents.

B. Check millwork Shop Drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.8 QUALITY ASSURANCE

A. Provide fixtures described herein. All trim shall be manufacturer's first grade line, perfect in all respects. "Competition" or "Reserve Grade" material will not be accepted. Manufacturers and model numbers listed are to indicate standard of quality. Equal products of acceptable manufacturers listed in Article 2.01 may be submitted for review.

B. Faucets, fittings, handles, traps, seat hinges, water and waste connections, and any other exposed parts shall be polished chrome plated brass. Provide chrome plated escutcheons for all exposed plated piping penetrating floors and walls. The metal used in castings shall be red

metal, having a copper content of not less than 85% and tubing used at plumbing fixtures, heavy seamless brass tubing, not less than No. 17 gauge.

C. Fixtures shall be product of one manufacturer.

D. Fittings of same type shall be product of one manufacturer.

1.9 GENERAL REQUIREMENTS

A. Plumbing fixtures shall be white, unless indicated otherwise.

B. Provide supports for all wall mounted fixtures.

1.10 SEISMIC DESIGN

A. Refer to Section 22 05 00, Article 1.10.B.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of the following manufacture:

1. Plumbing Fixtures (Water Closets, Urinals, Lavatories, Sinks and Baths)

a. American Standard, Inc.
b. Kohler Co.
c. Zurn Industries
d. Crane
e. Elkay
f. Just
g. Toto
h. Advance Tabco
i. Franke

2. Institutional Type Fixtures

a. Acorn
b. Castle Forge/MDT Biologic Co.
c. Metcraft
d. Bradley
e. Willoughby

3. Flushometers

a. Sloan Valve Co.
b. Coyne and Delany Co.

c. Zurn Industries, Inc.
d. Toto

4. Fixture Carriers

a. Jay R. Smith Mfg. Co.
b. Zurn Industries, Inc.
c. Wade Div. Tyler Pipe Industries, Inc.
d. Josam Mfg. Co.
e. Watts Drainage
f. Sun Drainage Products
g. Mifab

5. Toilet Seats

a. Church Seat Co.
b. Sperzel Industries, Inc.
c. Beneke Corp.
d. Olsonite Corp.
e. Bemis Mfg. Co.

6. Electric Water Coolers

a. Halsey Taylor
b. Elkay Mfg. Co.
c. Filtrine Mfg. Co., Inc.
d. Oasis Water Coolers, Ebco Manufacturing Co.
e. Sunroc, Inc.
f. Haws

7. Brassware and Trim

a. Speakman Co.
b. American Standard, Inc.
c. Kohler Co.
d. Toto
e. Chicago Faucet Co.
f. Elkay
g. T & S Brass
h. Water Saver
i. Delta Faucet Co.
j. Sloan
k. Zurn
l. Moen Commercial

8. Traps and Supplies

a. McGuire Manufacturing Co., Inc.
b. Bridgeport Brass Co.

9. Thermostatic Mixing Valves (Gang Type)

a. Leonard Valve Company
b. MCC Powers
c. Lawler ITT
d. Symmons Industries, Inc.
e. T & S Brass

10. Thermostatic Shower Valves and Shower Heads

a. MCC Powers
b. Lawler ITT
c. T & S Brass
d. Leonard Valve Co.

11. Balanced Pressure Shower Valves and Shower Heads

a. MCC Powers
b. Speakman Co.
c. Symmons Industries, Inc.
d. T & S Brass
e. Leonard Valve Co.
f. American Standard, Inc.
g. Kohler Co.
h. Delta Faucet Co.
i. Moen Commercial

12. Shower Bases

a. Fiat Products Inc.
b. Stern-Williams Co.

13. Laundry Trays

a. Fiat Products Inc.
b. E. L. Mustee & Sons, Inc.

14. Mop Receptors

a. Fiat Products, Inc.
b. Stern-Williams Co.

15. Hydrants

a. J. R. Smith Mfg. Co.
b. Zurn Industries Inc.
c. Watts Drainage
d. Josam
e. Wade
f. Mifab
g. Prier
h. Woodford
i. Hoeptner Perfected Products

16. Hose Bibbs

    a. Chicago Faucet Co.
    b. T & S Brass
    c. Speakman Co.

17. Emergency Shower/Eye Wash/Face Wash

    a. Encon Safety Products
    b. Speakman
    c. Haws
    d. Guardian
    e. Western
    f. Acorn
    g. Bradley

18. Handicapped Lav Insulation Kit

    a. Truebro, Inc.
    b. McGuire Mfg. Co., Inc.

19. Washer Boxes

    a. Guy Gray
    b. Precision Plumbing Products
    c. Acorn

2.2 GENERAL

A. All mixing valves, electronic faucets and faucets for service sinks and mop receptors shall have check valves or back checks installed in hot and cold water supply piping, branches or installed integral to faucet inlets.

B. All supply stops for lavatories, sinks, etc. shall be of lead free construction complying with NSF/ANSI 61. All flex tube risers from stops to fixtures shall be chrome plated copper. Stops shall be all brass, no plastic. Braided flex risers are not permitted.

2.3 WATER CLOSETS

A. Standards of conformance:

1. ASME A112.19.2/CSA B45.1 for water closets.
2. ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. ASME A112.6.1M for water-closet supports.
6. ICC A117.1 for ADA-compliant water closets.
7. ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.

a. ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

B. Water Closet, WC-1

1. Bowl: Wall hung, water saver, 1.28 gpf direct fed siphon jet action, vitreous china, elongated bowl, 1-1/2 inch brass top spud.
2. Flush Valve: Exposed, polished chrome plated, sensor operated, hardwired power connection, with true mechanical override, 1-inch screwdriver backcheck angle stop, vacuum breaker, metal cover, ADA compliant, escutcheon for 1-1/2: top spud connection, provide with transformer.
3. Seat: White, heavy-duty, solid plastic, elongated, open front contoured toilet seat, with check hinge, stainless steel mounting posts.
4. Carrier: To suit.

C. Water Closet B: Same as Water Closet A, except mounted at handicapped height. (Refer to article entitled "Mounting Heights" in Part 3 of this section.)

D. Water closet and flush valve shall be single manufacturer.

2.4 URINALS

A. Urinal, U-2 (Washdown)

1. Wall hung, vitreous china, integral flushing rim, ¾-inch IPS top spud inlet, 2-inch NPT outlet flange with mounting hardware.
2. Flush Valve: Exposed, polished chrome plated, sensor operated, diaphragm valve with rubber diaphragm compound and dual filtered fixed bypass, sweat solder adapter with cover tube and cast wall flange with set-screw, self-adaptive infrared sensor with indicator light, non-hold-open integral solenoid operator, fixed metering bypass and no external volume adjustment, non-hold-open true mechanical override, high back pressure vacuum breaker, flush connection with one-piece bottom hex coupling nut, spud coupling and flange for 3⁄4-inch top spud, 3⁄4-inch IPS screwdriver bak-chek angle stop with vandal resistant stop cap.
3. Carrier: Floor mounted type with steel welded base plate similar JR Smith #0636/SU-1009.
4. Urinals shall be factory flush tested.

B. Urinal fixture (urinal and flush valve) shall be from single manufacturer.

2.5 LAVATORIES

A. Lavatory, LAV-1

1. Lavatory: Wall hung, vitreous china, "D" shaped bowl, front overflow, 20 inches by 18 inches, high back, drillings on 4 inch centers, for concealed arms.
2. Trim

a. Faucet: Sensor operated lavatory faucet mixing valve assembly, chrome plated brass with 0.5 gpm flow, aerator and 4-inch trim plate, wiring box, solenoid valve, back check valves, hard wire transformer (located in ceiling).
b. Supply Assembly: Flexible tube riser, loose key control valve, escutcheon and nipple, McGuire LF167LK.
c. Trap: Adjustable cast brass "P" trap, 1-1/4 inch by 1-1/2 inch with cleanout and escutcheon, McGuire 8902.
d. Carrier: Floor mounted type, J. R. Smith Series 700-M31-Z.

3. Insulation Kit: "P" trap and angle valve assemblies shall be insulated with fully molded closed cell vinyl, conforming to ASTM D635 and C177. Fasteners shall be nylon type supplied with kit. Truebro Model 102.

2.6 SINKS

A. Hand Wash Sink, LAV-2:

1. Wall hung (21x 19 x 10”), stainless steel, single bowl sink with backsplash shroud, gooseneck electronic sensor operated faucet, thermostatic mixing valve, drain fitting, with AC plug-in power supply, basis of design.
2. Supply Assembly: Flexible tube riser, loose key control valve, escutcheon and nipple, McGuire LF167LK.
3. Trap: Elkay #LK500.
4. Carrier: Floor mounted hanger plate, J. R. Smith #0866.

B. Countertop Sink, S-1

1. Bowl: 18 x 14 x 7-1/2 inch Type 304 stainless steel, self-rimming, single compartment with undercoating, 3.5 inch crumb cup, strainer and tailpiece, 3 hole drilling in ledgeback, Elkay LR-2219.
2. Trim

a. Supply Pipes: Lead-free chrome plated pipes and hand valves when exposed, plain finish when concealed.
b. Trap: Adjustable cast brass "P" trap with cleanout and escutcheon, chrome plated when exposed to view, McGuire 8912.
c. Drain: McGuire #151M.

C. Laboratory Sink, L-1

1. Bowl: 16 x 19 x 10-1/2 inch Type 316 stainless steel, 18 gauge with undercoating punched hole(s) to accommodate faucet installation.
2. Trim

a. Supply Pipes: Lead-free chrome plated pipes and control valves when exposed, plain finish when concealed.
b. Trap: 3 inch deep seal polypropylene mechanical joint “P” trap – Enfield Model No. W501.
c. Drain: 316 stainless steel 3.5-inch flat strainer and 2-inch 17 gauge tailpiece Elkay #LK372.

2.7 MOP RECEPTORS

A. Mop Receptor, MS-1

1. Receptor: 24 x 24inch precast terrazzo, 12 inches high, 6 inch drop front stainless steel drain body cast integrally with basin, aluminum bumper guard on 2 sides, Fiat TSB #6010.
2. Trim:

    a. Faucet: Chrome plated fitting with vacuum breaker, integral stops, spring check cartridges, adjustable wall bracket, pail hook and 3/4 hose thread on spout, T&S Brass Co. #B-0665-BSTP.
    b. Hose and Hose Bracket: 30 inches long, flexible, heavy-duty, cloth reinforced hose with 3/4 inch chrome plated coupling and stainless steel hose bracket with rubber grip. Fiat 832-AA
    c. Mop Hanger: 24 inches long x 3 inches wide, 18 gauge 302 stainless steel with three (3) rubber tool grips. Fiat 889-CC
    d. Strainer: Flat type, 16 gauge 302 stainless steel attached with flat head, slotted machine screws, Fiat 1453-BB.
    e. Vinyl Bumperguard: Fiat E-77-AA.
    f. Sealant: Silicone sealant to be used between wall and unit, and floor and unit, Fiat 833-AA.

3. Wallguards: Provide stainless steel wallguard plates, MSG 2424 on 2 walls.

2.8 SHOWERS

A. Shower, SH-1

1. Shower Enclosure/Floor: By Architect.
2. Shower valve shall be thermostatic/pressure balancing type, recessed in wall with handspray and stainless steel hose, ADA grab bar with hand spray holder compliant to ASSE 1014 and ASSE 1016.

2.9 EMERGENCY SHOWER

A. Emergency Station: Barrier Free, all stainless steel construction, corrosion resistant, combination eye/face wash and shower safety station with stainless steel shower head, internal 20 GPM flow control, stainless steel eye/face wash bowl, stainless steel flag handle and floor flange, 1 ¼" IPS Schedule 40 stainless steel pipe and fittings, 1" IPS and ½" IPS U.S. made stainless steel stay-open ball valves, and polished stainless steel pull rod. Unit shall have (4) polypropylene spray heads with integral "flip-top" dust covers, filters, and 1.6 GPM flow control orifices mounted on a stainless steel head assembly. Unit shall include ANSI compliant sign.

B. Provide mixing valve at each emergency shower on supply piping set for 85^{o} F., Guardian #6040.

2.10 EYE/FACE WASH

A. Eyewash/Drench Hose D: Countertop mounted automatic stay-open twin aerated spray heads with 6 foot hose, and in line backflow preventer, Guardian G5022BP.

B. Provide at each eyewash a mixing valve on supplies set for 85° F., Lawler 911E/F.

C. Equipment and installation shall comply with ANSI Z-358.1 latest edition.

2.11 ELECTRIC WATER COOLERS

A. All water coolers shall be NSF/ANSI 61 certified.

B. Electric Water Cooler B (Multilevel)

1. Two level, two-in-one unit with one basin at standard height and the other mounted for wheelchair use. All stainless steel with steel mounting box, removable louvered grille, split-stream basin, push button control.
2. Cooling Unit: Single recessed refrigeration system serves both units; hermetically sealed, air cooled condensing unit for 115 volts, 60 Hertz, single phase, lubricated for life and equipped with electric cord and three-prong molded rubber plug, thermostat with an adjustable range of ±5° F., ARI certified, complying with Standard 1010-84. Provide five-year warranty on the refrigeration system.
3. Cooling unit shall have a high efficiency positive start compressor with pressurized counterflow cooling evaporator/ chiller with totally encapsulated EPS insulation. The manufacturer shall certify the unit to be lead free as defined by the Safe Drinking Water Act. Energy consumption not to exceed 500 watts/hr.

    1) Capacity and Manufacturer: To cool 8 gph water to 50° F. at 90° F. ambient.

2.12 HYDRANTS

A. Wall Hydrants: 1/4 turn nonfreeze type, stainless steel box type, brass casing, 3/4 inch inlet, hose end, key operated, polished brass face, with vacuum breaker and backflow preventer.

B. Ground Hydrants: Cast bronze box type, nonfreeze, minimum 48 inches deep, 1 inch inlet, 3/4 inch hose connection, vacuum breaker, hinged locking cover, T-handle key.

C. Wall Hydrant: 1/4 turn nonfreeze type, flush mounted exposed polished bronze face, with integral vacuum breaker and dual check valve.

D. Roof Hydrant: Free standing non-freezetype with vacuum breaker and 3/4 inch hose end freeze flow.

2.13 PLUMBING ACCESSORIES

A. Hose Bibb HB-A: 3/4 inch size with 3/4 inch hose thread outlet, lock shield cap, vacuum breaker, removable handle, rough chrome plated. T & S Brass B-0720-POL

B. WMF-A - Wall Mounted Faucet: Service sink faucet with wall brace, vacuum breaker, 3/4 inch hose end, built in spring check cartridges and polished chrome finish. T&S Brass B-0665-BSTP.

C. Hose Bibb HB-B: 1/2 inch inlet with 3/4 inch thread outlet in stainless steel box with hinged cover and cylinder lock, Zurn Z-1350.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect fixtures against use and damage during construction.

3.2 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. At completion, thoroughly clean plumbing fixtures and equipment.

C. Attach floor mounted water closets to floor with wax seal and lag screws. Do not use lead flashing to hold closet in place.

D. Install faucets with wrist blades requiring "push to close". Wrist blades in the "closed" position should be 45^{o} from the rear wall.

E. Provide vacuum breakers for hose bibbs and faucets with hose connections.

F. Securely bolt all fixtures to the building construction and unless special hangers are indicated, provide hangers and/or carriers designed specifically for the fixtures by the fixture manufacturer.

G. Securely bolt all chair carriers/fixture supports to floor using 4 bolts in each foot of each support. All floor bolt openings in chair carriers to be used.

H. Caulk all wall hung fixtures between fixture and wall with sealant specified in Section 07 92 00. Provide sealant at all points where mop receptor meets walls and floor.

I. Install electric water coolers with "P" trap and water shutoff valve within cabinet.

J. For ground hydrants, provide concrete mounting pad and minimum one cubic yard of crushed rock at base of hydrant.

K. For plumbing fixtures furnished and set by others, rough in piping and provide traps, valved cold and hot water connections and escutcheons. All exposed components shall be chrome plated unless otherwise noted.

L. For plumbing fixtures installed in millwork, Contractor for this section shall provide template to Contractor for General Construction for required holes. Contractor for this section shall set fixtures and provide rough-in and final connections.

M. Before installing the shower valve escutcheon in the shower cubicle, fill the entire annular space between the shower valve body and the surrounding ceramic material with sealant as specified in Section 07 92 00.

N. Set all shower faucet mixing valves or limit stops to maximum allowable temperature permitted by code for each application.

O. All plumbing fixtures and faucets shall be installed in accordance with manufacturer's recommendations.

END OF SECTION 22 40 00

SECTION 22 60 00 - PLUMBING- SPECIAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. Laboratory compressed air system
2. Laboratory cylinder gas systems
3. Pipe and fittings
4. Piping system accessories
5. Purified water systems
6. Contaminated waste holding tank

1.3 RELATED SECTIONS

A. Section 22 05 00: Common Materials and Methods for Plumbing Systems

B. Section 22 07 00: Insulation

C. Section 22 45 48: Vibration Isolation

D. Section 22 05 48: Vibration Isolation and Seismic Restraints for Plumbing Systems

E. Section 22 10 00: Plumbing Systems

F. Section 21 00 00: Fire Suppression.

G. Division 25: Integrated Automation.

H. Division 26: Electrical.

1.4 REFERENCE STANDARDS

A. ASME - Boiler and Pressure Vessel Code

B. ASTM D1126 - Hardness in Water

C. NEMA ICS-6 - Enclosures for Industrial Control and Systems

D. API/1615 - Installation of Underground Petroleum Storage Systems

E. EPA/530/UST-88/008 - Regulations for Underground Storage Tank Systems

F. Guidelines for Construction and Equipment of Hospital and Medical Facilities (2022)

G. NFPA 30, 2018 - Flammable and Combustible Liquids Code

H. NFPA 54, 2015 - National Fuel Gas Code

I. NFPA 55, 2020 – Compressed Gases and Cryogenic Fluids Code

J. NFPA 58, 2017 - Storage & Handling of Liquefied Petroleum Gases

K. NFPA 99, 2021 - Standard for Health Care Facilities

L. USPHS - Standards

M. UL - Listings of Reexamination Service

1.5 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 "Submittal Procedures" in sufficient detail to verify full compliance with requirements of the contract documents.

B. Submit detailed drawings of pipe anchors for pipe sizes 4 inch and larger, showing all forces, for review before installation.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Warranty

1. Refer to warranty and closeout requirements in Division 01.

B. Contract Closeout

1. Comply with the requirements of Division 01.
2. Include information for all products specified in this section in the operating and maintenance manual.
3. Provide the following as specified in this section or Section 22 05 00:

    a. Testing and cleaning reports, certified by contractor, for each system.
    b. Balancing reports. Include certificate stating accuracy of instruments.
    c. "Record drawings".
    d. Instructions and demonstration to the Owner's representatives for the time period specified in Section 22 05 00.

e. ASME certificate for compressed air receiver tank(s).
f. Air compressor manufacturer's certificate that compressor will deliver oil-free air.
g. Manufacturer's startup services and training for central laboratory compressed air system deionized water equipment.
h. Installation and testing certifications for laboratory compressed gas systems.
i. Framed valve number schedule.
j. Qualification certificates for plastic piping system Installers/Solvent Welders.
k. Reports and certificates for underground medical gas distribution system(s), Piping Class UGC-MG, conduit system and cathodic protection.
l. Qualification certificates for medical gas system installers complying with ASSE 6010.

1.7 CERTIFICATIONS

A. Medical Gas Systems

1. Provide certification that medical gas systems have been installed and inspected in accordance with NFPA standards referenced above.
2. Provide certification of testing as required by article titled TESTING AND CERTIFICATION OF MEDICAL GAS SYSTEMS in Part 3 of this section.

1.8 MANUFACTURER'S SUPERVISION/STARTUP SERVICES

A. Central Laboratory Air Compressor

1. Manufacturer, in his price to Contractor, shall include cost of furnishing services of a factory trained representative to supervise initial startup and testing of each unit. As a minimum, verify: motor voltage, amperes and rotation; overload heater size; control set point and functions; tightness of factory connections. Manufacturer shall certify in writing that installation is in accordance with his requirements and unit functions properly and as specified. Manufacturer shall also provide a written affidavit indicating equipment was manufactured to be in compliance with all relevant paragraph of NFPA 99 currently enforced in this jurisdiction.
2. Following test, startup, balancing and adjustment, manufacturer shall also provide services of a factory trained representative for instruction of Owner's operating personnel in operation and maintenance of equipment.

1.9 PLASTIC PIPE EXPANSION DESIGN CRITERIA

A. Base expansion calculations on 50 deg. F. installation temperature to 140 deg. F. for the RO/DI and laboratory drainage system.

1.10 PRODUCTS FURNISHED BY OTHERS

A. Laboratory service outlets will be furnished under Section . Contractor for this section to install outlets and make final piping connections. (Drilling of counter tops for outlets will be under Division 12.

1.11 QUALIFICATION OF PLASTIC PIPE INSTALLERS AND WELDERS

A. Obtain and pay for the services of an authorized representative of the plastic pipe manufacturer to qualify and certify plastic pipe installers and plastic pipe solvent and electric fusion welders.

B. Qualification: Procedures shall be as recommended by the plastic pipe manufacturer and shall include the following as a minimum:

1. Plastic Pipe Installers: Educational material in the expansion and contraction of plastic pipe and comparison to expansion and contraction of metallic pipe materials. Instructions for determining need, location and sizing of expansion loops, offsets and legs to accommodate the expansion and contraction of the plastic pipe.
2. Solvent and Electric Fusion Welders: Instruction on the manufacturer's recommended welding procedures, observation and inspection of a sufficient number of test welds by each welder to be reasonably assured that the welder is capable of producing acceptable welds.

C. Certificates: Provide a written statement by the manufacturer's authorized representative listing the names of personnel who the manufacturer's authorized representative has qualified as a plastic pipe installer and/or for a plastic pipe solvent and/or electric fusion welder.

1.12 QUALIFICATION OF COMPRESSED GAS BRAZER INSTALLERS AND WELDERS

A. Compressed gas brazers and installers shall be certified in accordance with Section IX, “Welding and Brazing Requirements” of ASME Boiler and Pressure Vessel Code or AWS B2.2 for, “Standard for Bracing Procedure and Performance Qualification” and/or ASSE 6010 Medical Gas System Installers Professional Qualification Standards 2018.

B. Certificates: Provide a written statement by authorized representative indicating medical gas system installers qualifications.

1.13 SEISMIC DESIGN

A. Refer to Section 22 05 00, Article 1.10, Paragraph B.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of the following manufacture:

1. Compressed Air System, Source Equipment Laboratory

a. Beacon Medaes
b. Nash Engineering
c. Puritan-Bennett Corp.
d. Powerex
e. Atlas Copco
f. Amico

2. Laboratory Compressed Gas Systems - Compressed Air, Nitrogen, Carbon Dioxide, Helium – Pipeline Equipment

a. Chemetron Corp.
b. Beacon Medaes
c. Puritan-Bennett Corp.
d. Amico

3. Pipe and Fittings

a. General Pipe and Fitting Materials

1) Unless otherwise specified, any United States manufacturer whose products comply with the reference standards.

b. Basic Pipe and Fitting Materials and Accessories not specified in this section: Refer to Section 22 05 00.

c. CPVC and PVC Pipe and Fittings

1) Harvel Plastics, Inc.
2) R & G Sloan
3) Charlotte Pipe Co.
4) Eslon Thermoplastics, Inc.
5) Spears

d. Polypropylene (PP) Drainage Pipe and Fittings

1) Lab-Line/Enfield Industrial Corporation.
2) R & G Sloane "Fuseal"
3) Sani-Tech, Inc.
4) Orion

e. Polypropylene (PP) Pressure Pipe and Fittings

1) Enpure/Enfield Industrial Corporation

2) PPRO-SEAL/R & G Sloane
3) Sani-Tech, Inc.
4) Orion
5) George Fischer

4. Purified Water Equipment

a. Culligan USA
b. Osmonics, Inc.
c. Seimens Corporation
d. Marcor
e. Filter and Water Technologies, Inc.

5. Valves

a. Basic Valve Types Not Specified in this Section: Refer to Section 22 05 00.
b. Type CAV, General Service Compressed Air and Vacuum System Valves

1) Stockham figure numbers listed or approved equivalent by:

a) Crane
b) Milwaukee
c) Nibco

c. Type LGV, Laboratory (Compressed air, Vacuum) Gas System Valves

1) Same manufacturer as V9 ball valves.

d. Type MGV, Medical Gas System Valves

1) Same manufacturer as Medical Gas System outlets and accessories.

e. Type PPSV, Plastic Piping System Valves

1) Asahi/American
2) Chemtrol
3) George Fischer
4) Hayward Ind. Products
5) R & G Sloane
6) George Fisher (+GF+)

f. Type SSV, Stainless Steel Valves

1) Jamesbury and Aloyco figure numbers listed.

6. Water Softener

a. Bruner Corporation
b. Culligan USA

c. Ecowater Industrial Systems
d. Seimens
e. Filter and Water Technologies, Inc.
f. Marcor
g. Marlo Inc.

7. Multimedia Filters

a. Siemens
b. Filter and Water Technologies, Inc.
c. Marcor
d. Marlo Inc.

2.2 COMPRESSED AIR SYSTEM, LABORATORY

A. Provide a skid mounted factory-packaged once-through seal system manufactured and warranted by the compressor manufacturer to include duplex, oil-less, scroll compressors with two (2) motors, duplex desiccant dryer, corrosion resistant receiver, control panel and all accessories listed below. Size and capacities as indicated on drawing. Air compressor unit shall be fully compliant to NFPA 99.

B. Compressors shall be continuous duty rated scroll type, single stage and air cooled. Compressors shall have one fixed and one orbiting scroll sealed with PTFE tip seals. Compressors shall have the following:

1. Field replaceable tip seals
2. Dust and contamination protection from two part face seal
3. Orbiting bearing and pin crank bearings are grease filled
4. Heat dissipation maximized by an integral cooling fan
5. V-belt driven compressor protected by totally enclosed belt-guard
6. Fully adjustable motor mounting base to achieve belt tensioning

C. Motor shall be NEMA rated, open drip-proof and operates at 3600 RPM with 1.15 service factor suitable for 230/460V or 208V electrical service.

D. Compressor assembly shall comprise of piped intake manifold which includes one inline inlet air filter with bleed valve and one isolation valve per compressor, and a high inlet vacuum switch to protect the compressors. The compressor discharge assembly shall include:

1. Integral air-cooled aftercooler with a maximum approach temperature of 15°F above ambient and integrated drain trap with automatic solenoid drain valve
2. Discharge lines include heat-shielded fl ex connector, safety relief valve, isolation valve and check valve
3. Integral valve per compressor provides load-less starting and rapid air evacuation at shutdown

E. Isolation system shall include four-point, heavy duty isolation system for a minimum 95% isolation efficiency, fully isolates the compressor / motor tower from the system. Finite Element

Analysis conducted to minimize vibration transfer. Seismically restrained isolators shall be provided.

F. Receiver: Vertical, welded steel construction, corrosion resistant interior coating and epoxy painted or galvanized exterior coating, carrying ASME Code Stamp and Certificate. Receiver to be designed for a working pressure of 200 psig. Receiver to be equipped with sight glass and high water level probe. Tank interior corrosion resistant coating shall be suitable for a clean air/medical air system. Air receiver assembly shall include the following:

1. Zero loss electronic drain valve, liquid level gauge glass, safety relief valve and manual drain valve.
2. Piped 3-valve by-pass assembly with flange fitted valves.
3. Pressure gauge.

G. Two regenerative desiccant dryers factory mounted. Each dryer shall be capable of handling the full capacity of two compressor(s) and produces a 10°F (-12°C) pressure dew point. Dryers shall be supplied with programmable solenoid operated drain valves and digital control panel. Dryers to be installed such that any compressor can discharge through either or both dryers. Each dryer shall operate from a demand based purge saving control system featuring re-pressurization cycles. Each dryer assembly shall include the following mounted and piped:

1. 441™ transfer valve utilizing two sliding ceramic plates with a 5-year warranty
2. High efficiency, coalescing prefilter rated for 0.01 micron with automatic drain and element change indicator
3. Fully duplexed final line particle filters rated for 1 micron with element change indicators
4. Duplexed final line regulators and safety relief valves
5. Ceramic type dew point sensor with ± 2° F system accuracy
6. CO Sensor with ± 2 PPM (at 10 PPM) system accuracy

H. Provide a NEMA 12 factory mounted, completely prewired control panel providing automatic lead/lag sequencing and automatic alternation of both compressors based on first-on/first-off principle with provision for simultaneous operation if required, with H-O-A switches and indicating lights in cover containing the following as a minimum:

1. NEMA 12 control panel enclosure
2. Circuit breaker disconnects for each motor with external operators
3. Full voltage motor starters with overload protection
4. 24V control circuit
5. 65kAIC SCCR rating.
6. Touch screen controls feature one 5.7” master screen and a 3.5” operating screen for each compressor. Screen displays and functions include:
7. Service alerts, runtime hourmeters, system status, system pressure level, dew point level, CO level
8. Visual/audible alarm indications with isolated contacts for all standard remote alarms
9. Event log recording alarms and system activity • Event log recording service warnings and service history
10. Trend graphs for outlet pressure, Dew Point, CO, and ambient temperature
11. Ethernet connectivity and embedded web page for remote monitoring
12. Electronic notifi cations of alarms and warnings

13. Integral connectivity to the TotalAlert medical gas network via Ethernet
14. Optional BACnet communication with TCP/IP protocol

I. Normal operation shall be once-through seal

J. Resilient mounts and flexible connections shall be supplied as recommended by the compressor manufacturer. Refer to Section 22 05 48 for vibration isolation and seismic restraint requirements.

K. Provide a two year warranty on the entire package. Warranty must be issued by the compressor manufacturer.

L. Motor, starting equipment and control panel shall comply with requirements of Section 22 05 13.

M. Seismic Design: Refer to Section 22 05 00, Article 1.10, Paragraph B.

2.3 CYLINDER GAS SYSTEMS – CARBON DIOXIDE, HELIUM, NITROGEN (For Laboratory, Process, Non-medical application)

A. Cylinders and regulators will be provided by Owner.

B. Fully-automatic, high-pressure cylinder, regulator manifold:

1. Manifold systems shall be cleaned, tested and prepared for indicated gas service, manufactured and prefabricated in conformance to Compressed Gas Association (CGA) guidelines.
2. Manifold shall consist of control unit, internal adjustable line regulator, two supply bank headers; one “service”- supply bank and one “secondary” bank to provide uninterrupted compressed gas supply.
3. Manifold control unit shall provide automatic changeover from depleted “service” supply bank to “secondary” supply bank while maintaining constant delivery pressure. Digital pressure readout, alarm signal connections and lights show system status and alert the need to replace depleted cylinder bank.
4. Adjustable line regulator, power supply with dry contacts for connecting remote alarm.
5. Stainless steel pigtails with inlet check valves, rigid wall-mounted header complete mounting hardware.

C. Accessories

1. Purge assembly
2. Cylinder storage rack: 3-guage steel tubing assembly, chain stays to secure each high pressure cylinder to rack, secure rack assembly to floor with anchors, black textured power coat finish, in conformance to OSHA, OSHPD, UFC,NFPA and CGA Standards, similar to Durham Mfg #GCRV Series.

2.4 PIPE AND FITTINGS

A. General

1. Pipe and fitting materials and joint types are specified in the following "Piping Class" paragraphs. Application material and joint type which will be permitted for specific services are specified hereinafter in the Article titled "Piping System Requirements". Refer to pipe material scheduled on plumbing drawings for direction on where to provide pipe and fittings in project scope of work.
2. Pipe and fittings shall conform to the latest issue of the standards referred to hereinafter. Each length of pipe and each fitting shall be marked with the manufacturer's name brand and specification code designation to which it belongs.
3. See Specification, Section 221000 Plumbing Systems for additional pipe and fittings required in project scope.

B. Piping Class CU6: Laboratory compressed gases (Air, Carbon Dioxide, Helium, Nitrogen).

ITEM	LIMITS	DESCRIPTION
*PIPE	All sizes	Drawn temper, seamless ACR copper tubing ASTM B280 or drawn temper copper tubing Type K. Piping to be continuous with minimum joints.
JOINTS	All sizes	Brazed with Copper phosphorous or Copper phosphorous silver brazing alloy with high-melting point (at least 1000^{o} F.) brazing metal and appropriate flux. Joints shall be continuously purged with Nitrogen NF.
*FITTINGS	All sizes	Wrought copper for tees only - fittings to be used only where required.
		*Pipe and fittings to be specially prepared for oxygen service by cleaning, drying, charging with nitrogen and sealing with pressure tight plugs at the factory.

Reference Standards

1. Copper Tubing: ASTM B280
2. Soldered Fittings for Copper Tubing: Wrought copper; ANSI B16.22
3. Alternate jointing and fitting system may be used: Press Fit System, Apollo Xpress, Nibco Press System, Viega ProPress; ASME B16.51.

C. Piping Class PP3: Purified water.

ITEM	LIMITS	DESCRIPTION
PIPE & FITTINGS	All sizes	Natural unpigmented virgin polypropylene pressure pipe Schedule 80
JOINTS	All sizes	Butt fusion

Reference Standards

1. PP (Polypropylene) Pipe and Fittings: ASTM D4101

D. Piping Class PP-7: Double containment, BSL-3 drainage piping to decontamination holding tank.

ITEM	LIMITS	DESCRIPTION
PIPE & FITTINGS	All sizes	Asahi Poly-Flo polypropylene co-extruded, double containment pipe system with leak detection. System shall meet the pressure and materials requirements of the specifications. Poly-Flo® co-extruded pipe has a carrier pipe rating of SDR11 rated for 150psi at 68°F, and containment pipe rating of SDR17 rated for 90psi at 68°F.
JOINTS	All sizes	Simultaneous butt fusion

Reference Standards

2.5 PIPING SYSTEM ACCESSORIES, COMPRESSED AIR

A. General: Include accessories having working pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.

B. Automatic Drain Valve: Corrosion-resistant metal body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate.

C. Breathing Air Purification System:

D. Carbon Monoxide Monitor:

E. Coalescing Filter: Capacity and type indicated or required. Equip with activated carbon capable of removing water and oil aerosols, with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.

F. Desiccant Air Dryer:

G. Filter: Two-stage, mechanical-separation type, air-line filter in sizes and ratings indicated or required. Equip with deflector plates; resin-impregnated-ribbon type filters with edge filtration, 40 micron (0.0015 inch) thick; and drain cock.

H. Pressure Regulator: Bronze body, direct-acting, spring-loaded, manual pressure-setting adjustment, and rated for 250 psig inlet pressure except where otherwise indicated. Type: Diaphragm-operated.

I. Safety Valve: ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels construction, National Board-certified, labeled, and factory-sealed; constructed of bronze body with poppet safety valve for compressed-air service. Pressure Setting: Higher than discharge pressure and same or lower than receiver pressure rating.

J. Separator: Conical-shaped, centrifugal air-line separator in size and capacity indicated or required. Equip with water-removal trap and drain. Size unit for maximum pressure drop through unit of 3 psig from air inlet to outlet.

2.6 PIPING SYSTEM REQUIREMENTS

Service	Valve Type/Class	Pipe Class
Compressed Air, Laboratory Service Including Air Intake	LGV	CU6
Cylinder Gas (Argon, Helium, High Purity Compressed Air, Oxygen, Nitrogen)		CU6

2.7 PURIFIED WATER SYSTEM

A. Deionizer: Obtain specs from manufacturer. Include seismic design where applicable. Coordinate wiring with Electrical Engineer.

2.8 VALVES

A. General

1. Valves are specified by Valve Type and, for some services, several valve types are grouped by "Valve Class" in various sections of Division 22. Application is stated in the "Piping System Requirements". Where more than one Valve Type or Valve Class is listed for a service, use any of the listed Types or Classes, unless otherwise specified or indicated, but selection must be consistent throughout the work.
2. It shall be Contractor's responsibility to coordinate the work for all sections of Division 22 to assure that all general service valves throughout the work of Division 22 are of the same manufacture and type and that all valves of the same type number/identification throughout the work of Division 22 are of the same manufacture.
3. Valve packing shall not contain asbestos.
4. Bronze Valves: Construct body of ASTM B62 for Classes 125 and 150, ASTM B61 for Classes 200 and 300, copper-silicon bronze stem.
5. Iron Valves: Construct body of ASTM A126, Class B copper-silicon bronze stem.

B. Refer to Section 22 05 00 for specifications for basic valve types not specified in this section.

C. Type CAV, General Service Compressed Air System Valves

1. 2 Inch and Smaller: Similar to Type V1, Type V2, V4 and V9 valves except that globe and check valves shall have composition discs.
2. 2-1/2 Inch and Larger: Type V8 as noted in following paragraph.
3. Use gate, ball or butterfly for shutoff duty; use globe, ball or butterfly for throttling duty.

D. Type Type LGV, Laboratory (Compressed Air) Gas System Valves

1. Laboratory compressed gas valve shall be all bronze, 3-piece, full-port, PTFE seats, stainless steel ball and stem, solder end connections. 600 psig WOG. oxygen cleaned, Milwaukee BA-350STEOC or similar.
2. Zone Valve Box Assembly (vertical piping design):

a. Valves shall be full port, double seal, ball type with three-piece bronze/brass body and a chrome plated brass ball. Valves shall consist of the following:

1) Designed for a maximum working pressure of 600 psig WOG or vacuum service to 29” Hg.
2) Valve body shall be reinforced PTFE ball seat and reinforced PTFE stem seals.
3) Valve stem shall be blowout proof.
4) The valves shall fully comply and meet all requirements of NFPA 99.
5) All valve materials shall be compatible with USP oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, argon and mixtures thereof
6) Valves shall be provided with “Type K” copper tube extensions, conforming to ASTM B88, UNS no. C12200 and H58 temper, for making connection to system piping outside the box.
7) Valves shall be three-piece design, fully serviceable in the line.
8) Valves are supplied cleaned and prepared for oxygen service.
9) 1/4 turn of the handle is required to operate the valve from open to close position.
10) All valves meet the Cv factors as required by NFPA 99.
11) Valve ports shall be provided on valve assemblies, having a total of three 1/8” NPT ports with pipe plugs.

a) One port is used as a provision for connection of a gauge, located on the terminal outlet side of the valve to register pipeline pressure or vacuum.
b) A second port, also located on the terminal outlet side, can accept a DISS connection of a gas sensor.
c) A third port is located upstream of the valve and can be used either for a DISS connection of a gas sensor, or for purging during the brazing process.

12) Ball valves shall conform to MSS SP-110, complete valve assembly (valve and tube extensions) shall be cleaned for oxygen service per CGA Pamphlet G-4.1, gauges shall conform to ANSI B40.1

b. Zone valve box shall be constructed of 18-gauge, galvannealed steel with white epoxy powder coat finish.

1) Valve box requires a rough wall opening of 14-1/4” wide x 4” deep.
2) Provided with two 18-gauge galvanized steel mounting brackets, adjustable from 3/8" thick to 1-1/2" thick drywall, for ease of installation.
3) Design shall allow for the configuration of up to 4 valves within the rough-in box assembly.
4) Gas flow is from the top of the box, in the left stub and out the right stub.
5) Valves shall be securely attached to the box, have polyethylene foam for ease of valve replacement and reorientation of valves within the rough-in box.
6) Supplied with color-coded gas identification labels.
7) Gas identification labels are also available online for printing.

8) Valve box assembly shall have a sliding, opaque door with pull ring and clear gauge window, capable of sliding horizontally to facilitate installation requirements. In an emergency, the door can snap out by pulling of the pull ring forward without exposing sharp edges. The assembly door will be labeled:

-CAUTION-
CLOSE VALVES ONLY IN EMERGENCY

9) Zone valve box shall be provided with an anodized aluminum trim frame, designed for high impact resistance, capable of adjusting to variations in wall thickness up to 1" below flush.

c. Provide zone valve box with gas specific alarm sensors within assembly using 1/8" brass NPT ports.
d. Provide zone valve box assembly(ies) as indicated on floor plans and as scheduled on drawings similar to BeaconMedaes #VZVB Series.

E. Type PPSV, Plastic Piping System Valves: Valve body of the same material as piping system in which installed with Teflon seats and Viton seals. NSF approved for potable water service. Listed by NSF for use in potable water. Celanese Piping System figure numbers are listed.

1. Shutoff Valves:

a. 1/2 inch through 2 inch - True union ball valves, Series TU.
b. 3 inch - Double entry ball valve Series DE.

2. Check Valves: 1/2 inch through 3 inch - Double union ball check, Series BC.

F. Type PPSV, Plastic Piping System Valves: Valve body of the same material as piping system in which installed.

1. PPSV-1

a. Diaphragm Valves: Weir type body, socket fusion ends 150 grit interior finish, seal Type 2 bonnet, bronze bushings and compressor, EPDM diaphragm, EPDM backing cushion and stainless steel tube nut assembly.
b. Check Valves: Ball type true union suitable for clamp type ends, 150 grit interior finish, Viton ring seal.

c. PPSV-2 - Shutoff Valves: True union ball with teflon seats and Viton seals.

G. Type SSV1 Stainless Steel Valves: Jamesbury Clincher Type 2000, screwed end ball valve, Type 316 stainless steel construction, filled TFE seat, suitable for steam service and rated at minimum 400o F. at 125 psig working pressure.

H. Type SSV, Stainless Steel Valves: Stainless steel body and trim Type 316 to match piping system, Teflon packing, flanged.

1. Ball, Jamesbury No. 5150-36TT.

2. Gate, OS&Y, Aloyco No. 111.
3. Globe, OS&Y, Aloyco No. 311.
4. Check, Aloyco No. 371.

I. Valve Classes

2.9 WATER SOFTENER

A. Duplex type, complete with softener tanks, brine tank, interconnecting piping, valves and controls, designed to remove hardness to not higher than 0.3 grain per gallon of hardness as determined by ASTM standard soap test method when operated at <Insert> gpm.

B. System capacity, each tank 300,000 grain capacity, max. flow rate of 250gpm, backwash 15gpm.

C. Mineral tanks; each approximately 24 inch diameter by 63 inches high and brine tank approximately 30 inch diameter by 60 inches high, 100 psig working pressure with a test pressure of 150 psig. Provide access handholes for service and rustproof finish inside and outside of tanks.

D. Provide all piping, valves and controls necessary for automatic operation, including a seven day timer, duplex alternator, automatic reset water meter with adjustable dial to meter softened water and initiate regeneration based on total flow between cycles an electronic sensor to compensate for flow and hardness and initiate regeneration only when required. Design is based on Hanson's Commercial Water Treatment.

E. Seismic Design: Refer to Section 220500, Article 1.10, Paragraph B.

2.10 R.O. SYSTEM EQUIPMENT (LABORATORY WATER)

A. Section Includes: This section provides for the design, fabrication and supply of a high purity water treatment system.

B. Water Chemistry

1. Design the reverse osmosis system to treat Camden, New Jersey City Water. System supplier shall sample and analyze feedwater quality.
2. Variations in source occur at different times of the year. Design the system to the least favorable water analysis so that the equipment will produce specified water quality at all times throughout the year. Make an independent analysis and discuss variations with the water department and the Owner.

C. Water Quality Requirements

1. Provide a reverse osmosis system that will deliver ASTM type I water described below as minimum level.

a. Resistivity: 18 megohm/cm at 78 degrees F.
b. pH: Effectively neutral
c. Hardness: Negative
d. Sodium: 0.1 mg/liter

D. System Capacity

1. Provide a reverse osmosis water system that has the following capacities:

a. Makeup Rate: 158 gph at 60 degrees F.
b. Distribution Loop Rate: 8 gpm
c. Water Storage Reservoir: 350 gallon conical bottom polyethylene tank with 0.2 micron vent filter
d. Maximum Daily Makeup: 3800 gpd
e. Generation Hours: 24 hours/day

E. Description of Operation

1. System shall be sized and designed to run on a domestic water feed.
2. A water softener will remove hardness from the raw water supply. The softener will be provided with a brine tank.
3. Automatic regenerable activated carbon tank/filter (with activated carbon media) will remove chlorine/chloramines, and soluble low molecular weight organics and trihalomethanes from the raw water supply.
4. A 5.0 micron filter will pretreat water. The prefilter shall be installed upstream of the reverse osmosis, storage and delivery equipment.
5. The thin film composite membrane reverse osmosis (RO) unit shall utilize the pretreated water to produce a product water at a flow rate of 2.6 gpm at 60^{o} F. and 50% recovery. The R.O. unit shall be completely automatic, self-contained package unit and shall be mounted on a stainless steel frame.
6. The reverse osmosis water shall discharge to a 350 gallon conical bottom polyethylene storage tank with angle iron stand. The storage tank will have level controls at low and high levels that will automatically operate the reverse osmosis unit. A low low-level control will turn off the distribution/recirculation pumps should the storage tank level fall to a dangerously low level. A high high-level control will signal overfilling of the storage tank. A recirculation pump will pump the reverse osmosis/DI water from the storage tank out through the post treatment and to the distribution piping.
7. The RO water shall pass through two (2) mixed bed deionization tanks to further remove residual ions. There shall be both a working and a polishing deionizer.
8. An ultraviolet light (internal to the RO module) will be used for bacterial control entering the distribution piping.
9. The reverse osmosis/DI water will pass through a filter housing containing 0.2 micron post filter cartridge in the recirculation loop.
10. The water shall then be delivered at a 8 gpm flow. The distribution loop shall return a portion of the water supply back to the storage tank. Return flow and pressure shall be regulated with a pressure regulator valve.
11. An alarm panel shall be provided to monitor the reverse osmosis system. Provide extra contacts for trouble alarm annunciation to building automation system.

F. Submit a description of the provider's experience in the design, fabrication and installation of high-purity water system of the general type and size specified herein, including a list of representative, successfully completed and currently operating installations.

G. Prior to shipment, adequately seal and protect all flanges, connections, openings and nozzles to prevent damage or contamination. Disassemble preassembled units and equipment components only to the extent necessary to prevent damage during shipment and to facilitate field handing.

H. Generally protect machined and unpainted parts subject to damage by the elements with an application or a strippable protective coating.

I. Provide pressure gauges to monitor the inlet and outlet pressures on both sides of all major equipment components.

J. Provide sampling points on both sides of all major component equipment to facilitate data gathering, such as conductivity, differential pressures, and to verify proper operation of the equipment.

K. Cartridge and housing, using Harmsco Big Blue Filter Cartridge and stainless steel filter Housing (20 inch x 4-1/2 inch dia.). Provide depth cartridge filter system to filter the pretreated feed water to a level of 5.0 micron. Provide the cartridge filter to serve to remove suspended solids resulting from fines from the carbon filter. Cartridge filter system water flow: 10 gpm. Provide the system with one filter housing constructed of polypropylene with air relief. Provide housing with one (1) 20 inch, 5.0 micron cartridge.

L. Carbon filter shall be automatically regenerable activated carbon type with 2 cubic feet of bituminous coal steam activated carbon filtration media grade BKK2000 NSF/ANSI standard 61. Vessel shall be 12 inch diameter x 48 inch high polyethylene lined fiberglass pressure vessel with 150 psi at 120^{o} F. pressure rating NSF and UL listings. Provide Noryl 3 cycle electronic control valve of rotary construction type. Regeneration control shall be electronic microprocessor based with LCD operator interface. Regeneration unit shall also permit manual regeneration control and demand initiated control.

M. The carbon filter system shall be equipped with inlet and outlet pressure gauges. The instruments shall be used to properly monitor system performance. The inlet and outlet pressure shall be monitored by use of pressure gauges constructed of stainless steel Type 316. The pressure gauges shall be of the type with 2-1/2 inch dial face. The gauges shall be mounted to the piping.

N. Reverse Osmosis System

1. The reverse osmosis unit shall be a skid mounted piped and wired packaged unit with prefilter cartridge, reverse osmosis unit, ultraviolet lamp, final filter and recirculation pumps.
2. Provide the reverse osmosis unit with one (2) spiral wound thin film composite polyamide reverse osmosis cartridges, 4 inch diameter x 40 inch long, mounted in a filament wound epoxy/glass composite membrane housing rated for 300 psi.
3. Design the reverse osmosis system to have an optimum recovery of 50 percent (product flow: feed flow) and not to exceed 50 percent (product flow: feed flow) for effective operation of the system and extended membrane life. This recovery is based on softened feed water with a silt density index of less than 5.0.

4. The reverse osmosis system shall deliver product water to the 350 gallon storage tank on demand from a tank mounted level control switch.
5. The reverse osmosis system pump shall be a stainless steel rotary vane or vertical turbine pump with stainless steel casing and impeller. Motor capacity: 1 hp at 460 volts and 3 phase, 60 hertz.
6. Control the system by means of a microprocessor-based controller housed in the control panel. The RO should also include:

    a. Auto Rinse Capability upon startup with 3-way divert valve recycling water back to the prefilter.
    b. Tank (Reservoir) Level Switch Pump Control
    c. Audio/visual alarms with adjustable settings
    d. Feed and product water conductivity monitoring
    e. RO permeate temperature monitoring
    f. Tank Level Switch for high and low alarms

7. The RO system control module shall have the following features:

    a. Internal leak detection system and distribution loop detection system
    b. Adjustable purity readout setting (resistivity or conductivity) and quality alarm set points
    c. Preheat flow rate and totalizer
    d. Concentrate flow rate and totalizer
    e. D.I. flow rate and totalizer
    f. LCD display of return loop pressure, product water quality and quantity of water in reservoir
    g. Real time clock
    h. Manually initiated automatic sanitization regime for RO and distribution loop
    i. Consumable change monitor for UV lamp, prefilter, sanitization, postfilter and reservoir vent filter
    j. Auto restart after power supply failure
    k. Contacts for trouble signal to Building Automation System

8. Input voltage: 110 volts AC, 20 amp circuit, 1 phase. Output voltage: 24 volt DC for safety. Equip the controller with a conductivity meter capable of monitoring input conductivity from 0-1000 microhms, product conductivity from 1-100 microhms and percent rejection with alarm output on percent rejection.

9. Provide storage reservoir on tank stand.

    a. Reservoir design should be conical bottom and constructed of smooth linear polyethylene which is chemically resistant. A polypropylene spray ball shall be integral to the tank.
    b. Storage tank total capacity: 350 gallon.
    c. Provide the tank with the following accessories, placed as directed:

        1) Composite vent filter rated at 0.2 micron
        2) Level switches for low level, RO on/off
        3) Level switch for low suction water level and tank overfill level

10. Provide one (1) centrifugal end suction stainless steel recirculation pump. Construct pump housing of Type 316 stainless steel tri-clamp ends. Pump shall be TriClover or equal Series C216 with Type DG ceramic seal circular casing, PTFE casing gasket sanitary 3A polished finish. Pump capacity: 8 gpm at 58 psi, 3hp at 3500 RPM 480 V. 3 phase.

O. Provide rental exchange mixed bed deionization tanks to further remove remaining dissolved solids in the reverse osmosis water. The resins should be periodically regenerated in a QSR regeneration facility.

1. System Design: The Deionization (DI) units shall consist of two (2) 10 gpm mixed bed deionizers. The DI units shall be plumbed in line in series.

a. The deionization units will also be equipped with 10 megohm QC light on the worker unit and 18 megohm QC monitor on the polisher unit.
b. Provide inlet and outlet pressures of the deionizers will be monitored by pressure gauges constructed of stainless steel with a 2-1/2 inch dial face.

P. Provide a 254 NM ultraviolet sterilizer to function to provide a 99.9 percent bacteria reduction in the water flow stream. Design the system to enable ultraviolet rays to strike bacteria, virus, yeast, molds and algae, and break through the outer membrane wall, reaching the deoxyribonucleic acid of the organism and destroying it. Provide the ultraviolet sterilizer complete with one basic ultraviolet device capable of a flow rate of 10 gpm. Aquafine Model SL-1 or equal.

Q. Provide polypropylene back pressure valve on distribution loop return line to storage tank. Valve shall be Plast-O-Matic Valves Inc. RVDT100V-PP.

R. Manufacturer shall passivate stainless steel parts as per R.O. system equipment in Part 3 of this section.

S. Seismic Design: Refer to Section 22 05 00, Article 1.10, Paragraph B.

2.11 MULTIMEDIA FILTER

A. The multimedia filters shall consist of steel pressure vessel that contains three grades of filtration media. The pressure vessels shall be sandblasted, lined and painted with a durable epoxy material. The piping is constructed of Schedule 40 galvanized steel with threaded connections. Complete piping from the inlet to the outlet of the filter vessel shall be provided. All automatic valves are actuated either hydraulically or pneumatically. Four structural steel legs designed for seismic loading support each vessel. Manual isolation valves for the feedwater and product water shall be provided.

The pressure vessel shall be designed to meet the seismic design criteria in Section 22 05 00. All control valves shall be as specified in Section 22 10 00. Pressure vessel and piping systems shall be designed for a 150 psig working pressure per ASME requirements. Provide each vessel with a pressure relief valve. Pressure vessels shall be a minimal 42 inches diameter x 60 inches high.

B. To control the operational sequences and monitor the performance of the multimedia filter, an electromechanical (time clock) controller and pilot stager shall be utilized. Opening and closing of

the process valves is accomplished using feedwater and a stager pilot valve located in the control enclosure. The day and time of backwash shall be operator adjustable. All electrical components are contained within a NEMA 1 enclosure.

C. The multimedia filter has two modes of operation, Service and Backwash. When the day and time of the preset Backwash is reached, the filter controller will automatically begin the Backwash sequence. Afterwards, the filter will return to the Service mode. The Backwash mode has 2 steps, Backwash and Rinse. Stop times for the Backwash and Rinse shall be adjustable on the controller.

Quadruplex systems shall operate in parallel fashion. In the parallel fashion all filters will be in the Service mode. At the predetermined time or event, each filter will backwash independently, maintaining at least three filters in the Service mode providing a continuous, uninterrupted supply of filtered water.

D. Filter shall be capable of a service flow rate of 12 gpm/sq. ft. and have a backwash flow rate or 15 gpm/sq. ft. Filter bed depth shall be a minimum 30 inches consisting of filter media as follows".

18 inch anthracite (0.85 to 0.95 mm)
8 inch filter sand (0.45 to 0.55 mm)
4 inch garnet (0.3 mm)

Provide a support bed of 3 inches No. 8-12 garnet and ¼ inch x 1/8 inch quartz to fill bottom head to 2 inches above laterals.

E. Carbon steel pressure vessel shall be painted with 4 to 6 mils DFT epoxy and shall be lined with 8 to 12 mils of DFT epoxy. Surface preparation shall be SSPC SP-10 for internal and SSPC SP-6 for external. Distribution piping shall be Schedule 40 galvanized steel upper point distributor and PVC slotted lateral and hub underdrain. Process piping system shall be 2-1/2 inch Schedule 40 galvanized steel with threaded fittings. For each filter for connection to a 6 inch Type L copper header, isolation valves shall be stainless steel ball valves as specified for domestic water under Section 15400. Provide one isolation valve on inlet and outlet of each vessel. Automatic process valves shall be epoxy coated cast iron angle pattern globe valves using line pressure to open and hydraulic pressure to close. Valves shall be designed for minimum 150 psig working pressure. Provide 1/4 inch brass ball valve for product water sample.

F. Provide 2-1/2 inch diameter 316 stainless steel pressure gauge with 0 to 200 psi range on service inlets. Provide automatic timeclock controller to sequence filter operation stages for all filters.

G. Manufacturer shall provide media loading, startup training and testing services for filters. Training shall include 8 hours instruction with Owner's representative. Manufaccturer shall provide a full document package including installation and operation instructions. Operating sequence parameters, shipping and spare parts list, piping and wiring P and ID. Filters shall be U.S. Filter VP Series or equal with design options and design pressure criteria as included above.

H. Seismic Design: Refer to Section 22 05 00, Article 1.10, Paragraph B.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Refer to and comply with Section 220500 for basic requirements.
2. Refer to Section 220548 for vibration isolation and seismic restraints, penetration seals and the like.

B. Manufacturers' Supervision/Inspection: Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer's supervision/inspection services and manufacturer's written certification as specified in Part 1 of this section, and shall at his own expense make any corrections/modifications to his installation work as required by the manufacturer.

C. Gas Service Connection: Make arrangements with local gas company for new gas service extended into the building and pay all charges.

3.2 COMPRESSED AIR SYSTEM, LABORATORY

A. Provide system complete with pipe, fittings, valves, gauges, outlets, air compressors, receiver and controls in accordance with manufacturer's instructions and NFPA 99, except that all joints shall be brazed. Soldered joints are not acceptable.

B. Installation of compressed air piping, shutoff valves, alarm panels and other accessories shall be identical with that specified under "Medical Gas Systems".

C. Provide where indicated or required, pressure reducing valves installed with 3 valve bypass.

D. Take makeup air from outdoors as shown on Drawings.

3.3 LABORATORY COMPRESSED GAS SYSTEMS - CARBON DIOXIDE, HELIUM AND NITROGEN SYSTEMS

A. Install system under direction and supervision of equipment manufacturer's representative. Installation of systems including piping, valves and fittings, to be in accordance with recommendations and requirements of applicable sections of NFPA 99 unless specific requirements are listed herein.

B. Connect cylinders in each bank to a high pressure header equipped with a master shutoff valve specially designed for use with medical gases, on control end and high pressure back check valves at each cylinder connection. Bolt high pressure headers to rigid supports provided with manifold.

C. Ground piping to water supply system to reduce possibility of static electric charges.

D. Piping, valves and fittings shall be specially cleaned for oxygen service and packaged by the manufacturer. On-site cleaning is prohibited except for recleaning surfaces in the immediate

vicinity of the joints prior to brazing. Material that has not been properly stored and protected that has become contaminated shall not be installed and immediately removed from the site.

E. Brazing procedures and brazer performance shall be in accordance with NFPA 99.

F. Label or paint piping, concealed and exposed, to indicate its content at minimum of 20 foot intervals along the pipe and where it enters or leaves a partition. Metal tags, stenciling or adhesive markers may be used if affixed so as not to be readily removable.

G. Number and identify each shutoff valve. Attach a four inch metal nameplate to the valve stem with an "S" hook with description of section which valve controls. Where valve is installed behind an access panel, also affix nameplate to exterior of panel door.

H. Label all valve boxes designating areas or rooms (by numbers) being served.

I. Provide a printed schedule in frame and glass cover giving each valve number with location and section which it controls. Locate frame as directed.

3.4 PIPING CONNECTIONS

A. Refer to Section 22 05 00 for basic requirements.

B. Joints in Laboratory Compressed Air and Cylinder Gas Piping Systems (Pipe Classes CU4 and CU6): Comply with the requirements of NFPA 99. Join with silver brazing alloy or similar high melting point (at least 1000^{o} F.) brazing metal. Use oil free nitrogen purge while brazing. Flux may be used only in the joining of dissimilar metals. Flared and compression joints, soldered joints and cast brass fittings are prohibited.

C. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the manufacturer's printed instructions.

D. Plastic Pipe and Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment according to manufacturer's printed instructions.

1. Plain-End Pipe and Fittings: Butt joining.
2. Plain-End Pipe and Socket-Type Fittings: Socket joining.

3.5 PURIFIED WATER SYSTEM PIPING AND ACCESSORIES

A. Provide complete system with deionizing tanks, controls pipe, fittings and valves.

3.6 PURIFIED WATER SYSTEM PIPING INSTALLATION, CLEANING AND TESTING, GENERAL

A. Make hydrostatic test of the piping system prior to cleaning. Water used for hydrostatic testing and flushing shall be at least equal to the latest ASTM proposed standard for Type III Electronics Grade Water or have a minimum resistivity of 8 megohm-cm and be filtered through a 0.45 micron absolute type filter. Water of this quality or better shall be used in all phases of cleaning and testing and shall be called Type E-III water.

B. During installation, keep all piping, fittings and valves clean, with all open ends capped. Heating and clamping surfaces shall be cleaned with a clean, lint-free cloth or towel. Piping shall be washed with an acetone soaked, clean, link-free paper towel. These towels shall be used only once and then disposed of. Washing shall include both the inside and outside surfaces of the pipe.

C. Disassemble valves and clean them with a phosphate-free, nonionic detergent, such as Alconox, Alco Jet or Triton X-100 or an approved equal. Rinse with Type E-III water and blow dry with a dry nitrogen. Nitrogen shall be filtered through a 0.2 micron or better filter.

D. Connect the piping to be cleaned to a circulating pump and tank. Remove or bypass all critical pieces of equipment that may be affected by the cleaning solutions. Fill the tank with Type E-III water and add Alconox at a rate of 25 grams per gallon or use an approved equal solution.

E. Circulate the cleaning solution through all piping for four hours, bleeding 1/2 gallon from each valve at two hour intervals.

F. Drain the system and refill with Type E-III water.

G. Test the resistivity of the system with a resistivity meter.

H. Flush with Type E-III water. If the resistivity does not come up to 1 megohm-cm within 1 hour, continue flushing until resistivity rises to 1 megohm-cm.

I. Add hydrogen peroxide (H_2O_2) at a rate of 1 gallon per 5 gallons of system volume to form at least a 5% solution.

J. Circulate the sterilizing solution through the piping system for six hours, bleeding 1/2 gallon from each valve at two hour intervals.

K. Flush out the system with water which meets the latest ASTM proposed standard for Type E-III water or water that has a resistivity greater than 17 megohm-cm and has been filtered through a 0.2 micron filter and test all discharge points with a potassium permanganate ($KMNO_4$) solution. The ($KMNO_4$) test solution is made by adding two tablespoons $KMNO_4$ per gallon of deionized water such that a purple or violet solution is formed. To test the system, draw a sample of water at each point of use in a clear glass container and add a few drops of the $KMNO_4$ solution. If the drops turn brown, hydrogen peroxide is present. Continue flushing until the drops remain purple. Flushing may take several hours.

L. Check resistivity and continue flushing with e-III water until resistivity rises to 18 megohm-cm.

3.7 PLASTIC PURIFIED WATER SYSTEM PIPING INSTALLATION

A. Refer to Part 1 Article Plastic Pipe Expansion Design Criteria.

B. Install only by certified installers/welders.

C. Provide expansion joints and/or expansion loops, offsets and legs located and sized to accommodate expansion and contraction of piping system.

D. Provide guides at expansion joints and loops, but do not provide any anchors in piping system - allow entire system to float.

E. Provide a swing joint connection at each branch connection to a main or branch main, consisting of not less than three (3) elbows after a tee connection into the main or branch main. Size length of each section of swing joint connection to accommodate expansion and contraction perpendicular to the specific swing joint section.

F. Expansion joint shall be telescoping piston joint, material of construction to match piping, of Plastinetics Inc. or equivalent manufacture.

3.8 ELECTRICAL WORK

A. Refer to Section 22 05 13 for general requirements.

B. Unless otherwise stated herein or on the drawings, power wiring will be provided under Division 26, Electrical, to the following:

1. Central Carbon dioxide, Helium, Nitrogen Manifold System
2. Central Laboratory Air Compressors
3. Purified Water System
4. Water Softener

C. Signal wiring will be provided under Division 22, Plumbing, to the following:

1. Area medical gas alarm panels to pipeline sensors/switches.

D. Provide control and alarm wiring under Division 22, Plumbing, for the following:

1. Decontamination holding tank

3.9 TESTING OF PIPING SYSTEMS

A. Refer to Testing of Piping Systems, General in Section 22 05 00.

B. Purified Water: Test hydrostatically upon completion of the rough-in and before insulating or setting fixtures. Maintain pressure for not less than 2 hours without leakage.

C. Medical Gas Systems (including Medical Air and Vacuum): Refer to previous article in Part 3 of this section.

D. Laboratory Compressed Air System and other compressed gases: Test under air pressure. Maintain pressure for a minimum of one hour without appreciable loss.

3.10 WELDING

A. Refer to Section 22 05 00 for welding of black or galvanized steel.

END OF SECTION 22 60 00

SECTION 23 05 00 – COMMON MATERIALS AND METHODS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section is intended to describe the common materials and installation methods of the mechanical work and it applies in general to all other Sections under Division 23.

B. Due to the small scale of the drawings, all work required is not shown on the floor plans and certain work is shown on flow diagrams, riser diagrams and details. Work of Division 23 shall include all required work shown on plans, riser diagrams, flow diagrams and details.

C. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Hangers and supports for HVAC system piping and equipment.
12. Identification for HVAC Piping and equipment.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 REFERENCES

A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:

1. ASME/ANSI B31: Code for Pressure Piping
2. ASME Boiler and Pressure Vessel Codes
3. AWS D1.1: Structural Welding Code-Steel
4. MSS SP58: Pipe Hangers and Supports – Materials, Design, and Manufacturers
5. MSS SP69: Pipe Hangers and Supports – Selection and Application except spacing for hangers
6. ANSI A13.1: Scheme for Identification of Piping Systems
7. Applicable NFPA Codes and Standards

1.5 SUBMITTALS

A. Provide Product List of factory fabricated items, in accordance with Section 01 60 00 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 23.

B. Provide submittals in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.

C. Product Data: Provide for each type of factory-fabricated product indicated.

D. Welding certificates.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Comply with warranty and contract closeout requirements specified in Division 00.

B. Provide Special Warranties and/or warranty service in accordance with Section 01 60 00 “Product Requirements” where specified in the various sections of Division 23.

C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 23.

D. Provide testing and cleaning reports. Indicate dates of testing and cleaning operations, procedures used and results obtained for each system. Reports shall be certified as complete.

E. Provide instructions and demonstration to the Owner’s representative for all equipment and systems installed under Division 23. Instruction and demonstration shall be appropriate for the size and complexity of the installed system.

F. Include information for all products specified in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Use welders fully qualified and licensed by the state authorities.

C. The specifications for certain products and alternative materials may appear in more than one section of Division 23. Work of Division 23 shall be coordinated for all sections of Division 23 to assure that where two or more items of any given product are furnished under Division 23 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 23.

D. Except for spacing of hangers, provide hangers and supports in accordance with the latest issue of Manufacturer’s Standardization Society (MSS) Specifications SP 58 and 69.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle all material and equipment in accordance with manufacturer’s instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. The Mechanical systems are indicated on the Mechanical Drawings. Certain pertinent information and details involving the installation of Mechanical work appear on Architectural, Structural, Plumbing and Electrical Drawings. Become familiar with all Drawings and incorporate all pertinent requirements.

B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the Mechanical work. Do not scale the Drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.

C. Arrange for pipe spaces, chases, slots, duct shafts and openings in building structure during progress of construction, to allow for HVAC installations.

D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

E. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Coordinate installation of identification labels with locations of access panels and doors.

F. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.

G. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.

H. Install identification devices prior to installation of ceilings and similar concealment.

1.7 SEISMIC REQUIREMENTS

A. Seismic Design

1. All new Mechanical systems (equipment, piping and ductwork) shall be provided with seismic restraints in accordance with the requirements of the applicable building code and site-specific seismic design parameters and Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems”.
2. Refer to Division 01 for seismic criteria to be used for this project.
3. Use a component Importance Factor, I_p, of 1.5 for all life safety systems required to function during and after an earthquake; including, but not limited to:

    a. Automated smoke control systems and/or smoke evacuation systems.

4. Use a component Importance Factor, I_p, of 1.5 for all components that contain hazardous material including, but not limited to:

    a. Lab exhaust

5. Use a component Importance Factor, I_p, of 1.5 for all systems and components required for continuous operation of the facility or whose failure could impair the continued operation of the building, including:

    a. Ductwork and piping
    b. Suspended equipment

6. Except as noted otherwise herein, use an Importance Factor, I_p, of 1.0 for all other components.
7. Employ a Professional Engineer registered in the jurisdiction for which the project is located to design all restraints necessary to meet the seismic requirements. Said Engineer shall sign and seal all drawings and calculations prepared for this purpose.
8. Prior to first Application for Payment, provide a complete listing of all components and elements that are to be seismically restrained and/or braced.
9. It is the entire responsibility of the equipment manufacturer to design their equipment so that the strength and anchorage of the components of the equipment exceeds the force level used to restrain and anchor equipment itself to the supporting structure. Factory manufactured and/or field or shop fabricated equipment shall be designed to safely accept

and resist, at its points of anchorage or suspension without failure or permanent displacement of the equipment, earthquake generated external forces required by the code.

10. The preparation and submittal of product data and shop drawings to the Architect for review shall constitute a representation by the manufacturer, contractor and vendor that all components comply with the above requirements.
11. The functional and physical interrelationship of components and their effect on each other shall be installed so that failure of an essential or nonessential architectural, mechanical, electrical component shall not cause the failure of nearby essential architectural, mechanical, or electrical components.

1.10 ENERGY PERFORMANCE CRITERIA

A. All equipment provided under Division 23 shall meet the requirements of the International, or State, Energy Code, ASHRAE Standard 90 or the latest issue of the Standards for Equipment in the National Energy Policy Act (NEPA), whichever is more stringent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. In other Part 2 articles of various sections of Division 23 where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Unless otherwise noted, substitutions of specified manufacturers shall comply with the requirements of Division 01.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F493.
2. PVC Piping: ASTM D2564. Include primer according to ASTM F656.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent- cement-joint end.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder- joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full- face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 HANGERS AND SUPPORTS

A. Acceptable Manufacturers

1. Other Than Roof Supports

    a. B-Line Systems, Inc.
    b. Grinnell Company
    c. National Pipe Hangers
    d. Penn Construction Industries
    e. Other approved United States manufacturer whose products comply with the referenced standards

2. Roof Pipe, Duct and Equipment Supports

    a. ThyCurb
    b. Pate
    c. Roof Products and Systems Co.

B. Reference Standards

1. ASTM A36 - Specification for Structural Steel
2. ASTM A123 - Zinc (Hot-Dip Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip)
3. ASTM A653 G90 - Specification for Steel Sheet, Zinc Coated by the Hot-Dip Process
4. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
5. AWS D1.1 - Structural Welding Code - Steel
6. MSS SP58 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Materials, Design and Manufacture
7. MSS SP69 - Manufacturer's Standardization Society: Pipe Hangers and Supports - Selection and Application
8. NFPA 13 - Standard for the Installation of sprinkler Systems

C. Quality Assurance

1. Steel pipe hangers and supports shall have the manufacturer's name, part number and applicable size stamped in the part itself for identification.
2. Hangers and supports shall be designed and manufactured in conformance with MSS SP58.

D. General

1. Except for spacing of the hangers, design and fabrication of pipe hangers, supports and welding attachments shall conform to ANSI B31.9 or B31.1 as applicable.
2. Except for spacing of the hangers, hanger types and supports for bare and covered pipe shall conform to MSS SP69 for the temperature range except that only flat wide band hangers shall be used for hangers installed outside of insulation and plastic pipe.
3. Except for spacing of pipe hangers and elsewhere as otherwise indicated, horizontal and vertical piping attachment shall conform to the more stringent of this specification or MSS SP58 or MSS SP69. Continuous inserts and expansion bolts may be used.
4. All ferrous hangers, supports and hardware located outdoors shall be hot dip galvanized after fabrication per ASTM A123.
5. Hangers and clamps for support of bare copper piping shall be coated with copper colored (for identification) baked on epoxy paint. Use additional PVC coating of the epoxy painted hangers where necessary.
6. Provide suitable chromium plated brass supports for chromium plated pipe with exposed heads of bolts and screws chromium plated.
7. Hangers other than described above shall be zinc plated in accordance with ASTM B633 or shall have an electrodeposited epoxy finish.
8. Strut channels shall be pregalvanized in accordance with ASTM A653 G90 or shall have an electrodeposited finish.
9. All hangers and supports shall have some form of adjustment available after installation.

E. Inserts

1. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.
2. Size inserts to suit threaded hanger rods.

F. Pipe Hangers and Supports:

1. Hangers for Pipe Sizes to 1-1/2 Inch: Adjustable carbon steel ring or clevis.
2. Hangers for Hot or Cold Pipe Sizes 2 Inches to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Adjustable carbon steel clevis.
3. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke and cast-iron roll.
4. Multiple or Trapeze Hangers: Factory-enameled steel channels with welded spacers and hanger rods or 12 gauge rolled formed ASTM A570 Grade 33 structural quality steel channels (strut), cast iron roll and stand for hot pipe sizes 6 inches and over. Cross section suitable for span and loading. Suspension by outside hanger rods sized for total load on trapeze.
5. Wall Support for Pipe Sizes to 3 Inches: Carbon steel hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and steel clamp, adjustable steel yoke and cast-iron roll for hot pipe sizes 6 inches and over.
7. Vertical Support: Steel riser clamp.
8. Floor Support for Hot Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Adjustable pipe saddle and pipe nipple attached to steel base stand, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
10. Design hangers to impede disengagement by the movement of supported pipe. Provide spring and neoprene hangers as required.

G. Beam Clamps: Forged steel C-clamps shall include retaining strap, locking nut or other device for nonslip attachment, except LOCKING NUT NOT ALLOWED for project requiring seismic restraints.

H. Hanger Rod: Steel hanger rod zinc plated per ASTM B633.

I. Roof Pipe, Duct and Equipment Support

1. 18-gauge galvanized steel, unitized construction, straight base section without cant strip and with integral base plate, all welded construction, pressure treated wood nailer, counterflashing with lag screws, internal reinforcement.
2. Unless otherwise indicated, overall height recommended by SMACNA Fig. 5-4 to provide clearance for roof maintenance. If used as pier or curb base for attachment of pipe or steel support, minimum overall height as required for top of pier or curb base not less than 12 inches above finished surface of roofing or ballast as applicable.
3. Furnish sloped curbs when installed on sloped roofs to provide a level support surface.
4. Furnish supports to Division 07 for installation.
5. Refer to other Section of Division 23, “Vibration Isolation and Seismic Restraints for HVAC Systems” where pipe, duct and/or other equipment requires vibration isolation, or combination support/isolation/restraint unit.

2.7 THERMOMETERS

A. Acceptable Manufacturers

1. Trerice
2. Taylor Instrument Company
3. U.S. Gauge
4. Weksler
5. Weiss

B. Dial Thermometer: Bi-metal type, case assembly of type 304 stainless steel, moisture proof heavy glass face, gasketed and hermetically sealed. Stem and fixed threaded connection of stainless steel, all welded construction. Provide 5-inch dial of heavy gauge aluminum with white matte finish, black graduation lines and numerals. Provide separable sockets of depth suitable for pipe size in which installed.

C. Tube Thermometer: ASTM E1, liquid in place thermometer. Cast aluminum case, black baked epoxy enamel finish, 9-inch minimum liquid filled tube, brass stem, adjustable angle type with locking device and with brass union type separable socket. Socket length to suit installation. Mercury filled thermometer not allowed.

D. Select range of thermometer to indicate normal operating temperatures at midpoint of scale. Scale division of 1 degree F for cold service and 2 degree F for hot service.

E. Install wells with stem extending to center of pipe. Fill wells with oil or graphite and secure caps.

2.8 PRESSURE GAUGES

A. Acceptable Manufacturers

1. Trerice
2. Taylor Instrument Company
3. U.S. Gauge
4. Weksler

5. Weiss

B. ASTM B40.1, Grade A phosphor bronze seamless Bourdon spring type with white face, black numerals, 4 ½-inch cast aluminum case, black baked epoxy enamel finish, brass bronze brushed movement and brass socket. Select range of gauge to indicate normal operating pressure of system at midpoint of scale.

C. Provide ¼-inch brass coil siphon for steam gauge. For liquid gauge, provide brass snubber of material suitable for system fluid. Provide with needle valve.

2.9 IDENTIFICATION DEVICES AND LABELS

A. General

1. Products specified are manufacturer's standard products of categories and types required for each application as referenced in Part 3 of this section and elsewhere on the drawings or in Division 23 specifications. Where more than single type is specified for listed application, selection is Contractor's option, but provide single selection for each product category.
2. Products shall comply with requirements of ANSI A13.1 and OSHA where applicable.

B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ANSI A13.1. Minimum letter height is 1-1/4 inches for ducts and 3/4 inch for access door signs and similar operational instructions.

1. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ANSI A13.1, except as otherwise indicated.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid snap-on, color- coded pipe markers conforming to ANSI A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure- sensitive vinyl pipe markers, with permanent adhesive conforming to ANSI A13.1.

E. Pipes/Insulation Smaller than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe/insulation at each location.

F. Pipes/Insulation 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times the letter height and of length required for label.

G. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

H. Plastic Duct Markers: Manufacturer's standard laminated plastic, duct markers in the following color code:

1. Green: Cold air
2. Yellow: Hot air
3. Yellow/Green: Supply air
4. Blue: Exhaust, outside, return, and mixed air
5. For hazardous materials exhausts, use colors and designs recommended by ASME A13.1

6. Terminology: Include direction of air flow, duct service, system identification

I. Plastic Tape: Manufacturer's standard color-coded, pressure- sensitive, self-adhesive, vinyl tape, at least 3 mils thick. Width 1-1/2 inches wide on pipes with outside diameters (including insulation) less than 6 inches; 2-1/2 inches wide for larger pipes. Color shall comply with ANSI A13.1 unless otherwise indicated.

J. Valve Tags: Stamped or engraved brass with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Provide a hole for fastener. Brass wire-link chain, beaded chain, or S-hook fasteners.

K. Access Panel Markers: 1/16 inch thick engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed device. Provide center hole for attachment.

L. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on masonry walls for each page of valve schedule. Polished hardwood or extruded aluminum frame.

M. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin- laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening. 1/16 inch thick for units up to 20 square inches or 8 inch length, 1/8 inch thick for larger units. Self-tapping stainless-steel screws or contact-type permanent adhesive.

N. Plasticized Tags: Preprinted accident-prevention tags, of plasticized card stock. Size approximately 3-1/4 by 5-5/8 inches. Brass grommets and wire fasteners.

O. Nomenclature: Large-size wording such as "DANGER," "CAUTION," or "DO NOT OPERATE", or as noted on the drawings in the specification.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

Q. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Furnish, deliver, erect, connect, and finish in every detail all materials, equipment and accessories required for the Work.
2. Include in the work and in the bid minor details not usually shown or specified, but manifestly necessary for the proper installation and operation of the various systems, the same as if specified or shown.
3. If any departures from the Contract Documents are deemed necessary, submit details of such departure and the reasons therefore to the Architect for approval.

4. Be responsible to request clarification from the Architect on any conflicts represented between the drawings and specifications.
5. Adequately guard all exposed moving parts of equipment, such that contact by operating personnel will not cause personal damage or injury.

B. Layout and Coordination With Other Trades

1. Layout Work from building and property lines and benchmarks provided, verify, and be responsible for the correctness of all measurements in connection with the Work. Any change made in major overall dimensions shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to use of equipment of a manufacturer other than that used as basis of design shall cause no interference with other Work.
2. Examine the Drawings of other trades, cooperate and coordinate with other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Where interferences may occur and departures from the arrangements shown are required, consult with other trade involved. Come to agreement as to changed locations and elevations. Furnish all necessary templates, patterns, measurements, etc., for installation and for the purpose of making adjoining work conform. Furnish setting plans and shop drawings to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required may not be shown on the drawings; provide such offsets or bends as required to meet structural or finish conditions.
4. Coordinate layout with architectural ceilings and lighting layouts and similar work.
5. Coordinate and be responsible for the required clearances in shafts, chases, furred partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review large scale composite Drawings showing space requirements that exceed those shown.
6. Install systems so that they do not interfere with any openings, doors or windows, or with other work, and so as to permit proper access.
7. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
8. Except where greater clearance is specified or required by applicable codes, rules or regulations, install piping, ductwork, fittings, valves, etc., to provide not less than 1 inch between their finished covering and the structure or adjacent work of any kind. The minimum space between finished hot piping of any kind and adjacent electrical conduit shall be 6 inches.
9. Make reasonable modifications in the layout to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the systems are to be installed in relation to the work of other trades. Issue such Drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades such that reasonable modifications cannot be made, detail and submit such deviation or conflict to the Architect for review.
11. If work is installed before coordinating with other trades so as to cause interference with the work of other trades, or as not to provide proper access for maintenance or repair, make necessary changes to correct the condition at no increase in the Contract sum.
12. For alterations to existing facilities, be fully responsible for coordinating work with all existing conditions. Verify location of existing piping, ductwork and equipment in the field. Relocate or

offset new piping and ductwork, and make reasonable modifications to existing piping and ductwork, as required to fit in available space whether or not such relocation of offset is shown on the Drawings.

C. Manufacturer's Instructions and Recommendations

1. Perform the installation, cleaning, testing, calibration, and start up of all material and equipment in accordance with the manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of the specifications.
2. Should a conflict exist between specifications and manufacturer's instructions, consult with the Architect.

D. Electrical Rooms

1. Do not install any piping, ductwork or equipment in or through an electrical room or similar room containing electrical equipment, other than piping, ductwork or equipment exclusively serving the room or equipment in the room.
2. If there is a conflict between the above requirement and the Drawings, the above shall govern. If reasonable modifications cannot be made to accommodate this requirement, obtain instructions from the Architect before proceeding with the work.

E. Painting

1. Except where specified otherwise in Division 23, Work of Division 09 will provide painting of HVAC systems, equipment and components.
2. Protect all equipment from rust, corrosion, and similar damage by either factory applied or field applied protective coatings.
3. Repair marred and damaged factory painted finishes with manufacturer's touch up paint and application procedures to match original factory finish.

F. Roof Pipe, Duct and Equipment Support

1. Work by Division 07 will install all roof pipe, duct and equipment support curbs furnished by Division 23. Coordinate delivery of curbs as to not delay the work.
2. Roof pipe, duct and equipment supports specified in various sections of Division 23 shall be coordinated for exact location and type suitable for roof construction.

G. Wall and Ceiling Access Doors

1. Access Doors shown on Architectural Drawings will be provided under Division 08.
2. Furnish access doors required for access to concealed dampers, valves, air vents, traps, cleanouts, unions, expansion joints, and other equipment where no other means of access is available. Access doors shall be of adequate size for the service requirements, minimum clear opening of 14 inches by 16 inches.
3. Access doors shall be as specified in Division 08. Coordinate locations of access doors with all trades.

3.2 PENETRATIONS

A. General

1. Coordinate with other trades as to the size and location of openings to be provided in new floors, walls, roofs and ceilings as construction progresses.
2. Do not cut openings in new or existing floors and walls without proper structural reinforcement.
3. Install both piping and seals so as to maintain integrity of seals with expansion and contraction of piping.
4. Clean Room Sealing Requirements:

    a. Seal completely all penetrations of piping, ductwork and conduit through any surface.
    b. Seal completely all penetrations of piping, ductwork and conduit through above ceiling full height partitions.
    c. Seal completely the perimeter of all Mechanical fixtures and devices, including diffusers and grilles, applied to any surface.
    d. Seal completely the perimeter of all access doors or panels in any surface.

B. Sleeves

1. Provide each pipe, duct or conduit passing through a masonry or concrete wall, floor or partition, and elsewhere as indicated, with a sleeve made from standard weight galvanized steel pipe for pipe or conduit and 12 gauge galvanized sheet steel for ducts, with smooth edges, securely and neatly set in place.
2. Select sleeves two pipe sizes larger than any pipe or conduit to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide minimum of 3/8 inch clearance.
3. Be responsible for the proper location and alignment of all sleeves.
4. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.
5. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral water stop flanges, where they are to receive either watertight or hydrostatic seals.

C. Fire Rated Penetrations

1. Provide through-penetration fire-stop sealing system for pipe, duct and conduit penetrations through fire or smoke rated construction. Refer to Division 07 for through- penetration fire stop sealing system.
2. Coordinate with Division 07 to determine requirements for sleeves and clearances.
3. Select duct sleeve sizes to suit requirements of manufacturer of fire and/or smoke dampers.

D. Interior Non-Rated Wall Pipe Penetrations

1. For acoustically treated partitions, and walls between mechanical equipment rooms and occupied spaces, fill annular void at penetration with acoustical sealant.

E. Resilient Penetration Sleeve/Seal

1. Provide resilient penetration sleeve seal for piping and ductwork subject to vibration to prevent transmission to the building structure.
2. Maintain an airtight seal around the penetrating element and prevent rigid contact of the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

F. Floor Pipe Penetrations

1. Provide water stops for new cored openings for piping where such openings are above grade in mechanical rooms, penthouses, and pipe chases.
2. Provide water stops for existing pipe floor openings that do not have sleeves extended above the floor.
3. Provide either a sleeve or angle water stop. Sleeve may be used if the fire-stop sealing method selected by Division 07 allows the use of a sleeve, otherwise provide angle water stop.
4. Sleeve Water Stop: Construct of Schedule 40 galvanized steel pipe, length as required for 1 inch above floor and 1 inch below underside of floor. Provide 1 inch by 1 inch by 1/8 inch galvanized angle clips welded to sleeve at 90 degree intervals and securely fastened to underside of floor. Caulk space between floor opening and sleeve watertight with soft setting waterproof silicone sealant.
5. Angle Water Stop: Construct of standard weight pipe 1 inch long welded to a ¼ inch circular steel base plate ring fastened to floor with expansion anchors. Base plate ring width as required for anchor clearance from edge of cored opening. Seal between base ring and floor and caulk all edges of base ring with waterproof silicone sealant.

G. Pipe Penetrations Through Roof

1. Work by Division 07 will provide flashing for piping not subject to vibration and/or thermal movement. Provide counterflashing of 16 ounce copper for sleeves through roof and curbed roof openings provided under Division 23 to provide a completely weather tight installation.
2. For piping subject to vibration and/or thermal movement, provide pipe sleeve as detailed on the drawings, or use pipe curb where curb is sized to accommodate both required overall pipe and insulation diameter and thermal movement.

3.3 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Make all necessary alterations to existing Division 23 systems as required for removing or for connecting or extending these systems to new work and for revisions in existing work as indicated and as required, whether indicated or not. Match new materials in altered systems with existing materials unless otherwise indicated.

C. Continuity of Existing Services

1. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for shutdown activities, coordinate with Architect, Owner and other trades, and obtain written approval from Owner prior to proceeding with the work. Include work scheduled for off hours, when Owner requires that shutdown and interruption of facilities occur during unoccupied times.
2. Prepare and set notices on services and equipment that are temporarily shut off or disconnected.

D. Provide shutoff valves to isolate new work from existing and temporary or permanent connections to new work as required for proper testing and cleaning of new work.

E. All relocations of existing work shall be accomplished using new materials and accessories unless specifically noted otherwise.

F. Where equipment, ductwork and piping is removed or disconnected under Division 23, perform the work in such a manner that no damage is done to the structure or remaining portions of the existing systems. Do not under any circumstance place stress on existing pipe and fittings that are to be reused. Be fully responsible for and repair, at no additional expense to the Owner, any leaks developing in existing piping due to failure to take proper precautions when making alterations.

G. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Do not abandon any piping in place unless specifically noted to do so. Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Do not abandon any ductwork in place unless specifically noted to do so. Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
8. All materials and equipment removed or disconnected by Division 23, which is not to be reused or delivered to Owner, shall be removed from the premises. Provide owner first right of refusal of equipment prior to removal from site.

H. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

I. Remove all piping, ductwork and equipment hangers and supports.

J. Cap tight unused connection at mains and risers behind finished surfaces.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install all piping in accordance with best practices of trade and latest code requirements. Locate groups of pipes parallel to each other, spaced to permit valve servicing. Use uniform system materials throughout building.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum head room. Cut piping accurately to measurements established at building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible without sags between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.

F. Pitch all systems for proper venting at high points and to drain at low points where the systems can be completely emptied. Install vents at all high points and drains at all low points, including where offsets and bends in horizontal pipe runs create a low point. Provide drain points with bronze hose end drain valves.

G. Do not install piping above or through electrical rooms, telecommunication rooms, or similar room having a large collection of electrical equipment.

H. Keep pipe and fittings clean from cutting burrs, foreign matter and defects in structure and threading. Make all cuts square. Ream after cutting. Bevel plain ends of steel pipe. Clean off scale and dirt inside and outside before assembly. Remove welding slag or other foreign matter inside and outside.

I. Install piping within building concealed in walls, furred spaces, pipe spaces or above suspended ceilings. Do not build in or bury horizontal piping within partitions. Install exposed piping as closely as possible to walls, ceilings and columns, allowing space for installation of insulation and access for valve operation.

J. Install piping sections using greatest length possible in all cases. The use of short lengths socketed together will not be allowed.

K. The use of lampwick or other material for packing threads, caulking or wrapping of joints to stop or prevent leaks or correct faults is not permitted. The use of long screws having right and left hand threads or couplings is not permitted.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. Install piping to permit valve servicing and application of insulation.

N. Provide offsets and loops as required for piping crossing a building expansion joint to accommodate building movement, whether or not shown on the drawings.

O. Changes in Pipe Size and Direction

1. Make reduction or increase in pipe size with fittings. Use eccentric reducing fittings in horizontal piping. Use reducing tees in pressure piping for side outlet reduction only, not on run. Bushed fittings, notched or straight runs to form tees, or any similar fabrication method will not permitted.
2. Make changes in direction with standard fittings. Mitering of pipe to form elbows or similar fabrication method will not be allowed. Bending of piping will not be permitted.

P. Electrolysis Control

1. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.
2. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric union to prevent electrolytic action between the ferrous and

nonferrous metals. At branch connections off mains, provide shut off valve upstream of dielectric union in order to isolate downstream union.

3. Where copper or brass piping, tubing or fittings are anchored to, supported by, or come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, plastic or equivalent material to assure prevention of electrolysis.

Q. Equipment Piping

1. Verify final locations of equipment for rough in of piping connections.
2. Provide shut off valves in the supply and return to each item of equipment. Suitably locate equipment isolation valves to facilitate removal of equipment.
3. Provide piping from pump glands, cooling coil drain pans, relief valves or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge, terminating with plain end cut at a 45 degree angle.

R. Expansion and Contraction of Piping

1. The piping installation shall be free of stress. Run all piping with full allowance for expansion or contraction. Base expansion calculations on 50 degree F installation temperature to 200 degree F for hot water systems and temperature of steam pressure for steam systems, plus 30% safety factor.
2. Evaluate the complete piping layout and notify Architect of additional anchors or expansion joints and any deviations required to compensate for expansion.
3. Make connections to equipment in such a manner as to eliminate undue strains in piping and equipment. Install sufficient number of elbow swings to allow for proper expansion and contraction of piping at the point of connection to mains and equipment.
4. Fabricate expansion loops with long radius welded fittings in steel piping and with long radius copper sweat fittings in copper piping.
5. Provide adequate pipe guides on each end of the expansion device to preserve alignment and pitch.
6. Install pipe hangers and supports in such a manner as to not cause an anchor condition in any direction.

S. Pipe Anchors

1. Install anchors where required to direct pipe expansion properly into expansion joints, loops or offsets and to prevent transfer of loading and stresses to connected equipment.
2. Pipe anchors may consist of heavy steel clamps bolted or welded to piping and provided with lugs and bolts for clamping and attaching anchor braces. Design anchors to restrict pipe movement and fasten to main members of building structure in most effective manner to secure desired results.
3. Do not attach supports, anchors or stays in places or in such a manner that will damage construction or integrity of the structure, either during installation, by weight of the pipe, or by expansion and contraction of the pipe.

T. Pipe Insulation Inserts and Shields

1. Refer to Section of Division 23, “HVAC Insulation” to coordinate specific insulation thicknesses and requirements. At hanger locations for insulated piping 1 ½ inches and larger where hanger support is outside the insulation, provide inserts of exploded silica pipe insulation between pipe and hanger. Density and compression strength suitable for pipe size and support

spacing as required by MSS SP-58, Paragraph 9 and MSS SP- 69, Table 3. Provide inserts as required for smaller piping to prevent deformation of insulation. Inserts of equal thickness to adjoining insulation, provided with vapor retardant seals, and of proper length to fully support pipe at each hanger location. Manufactured by Value Engineered Products Max Span; or equivalent.

2. At all hanger locations for insulated piping where hanger is outside of insulation, provide galvanized sheet steel shield formed to fit insert/insulation, extending up to pipe centerline. Length 12 inch minimum when insert is not required. Where inserts are provided, length of shield 4 inches less than insert length. Provide shields 16 gauge for piping up to 4 inches, 12 gauge for piping 6 inches and larger. Shields shall have preformed ridges on each side of hanger to prevent hanger from slipping along shield.
3. Preformed insulated pipe saddles may be used in lieu of insert and shield where appropriate. Thickness of insert or pipe saddle same thickness as pipe insulation.

3.5 WELDING, SOLDERING AND BRAZING

A. Do not employ workers who have not been fully qualified and certified for the specified procedures.

B. Pipe Welding, Black or Galvanized Steel Pipe: Perform all welding of black or galvanized steel pipe by shielded metallic arc method of fusion welding, in accordance with welding procedures of AWS (American Welding Society) D10.12 recommended procedures for welding low carbon steel pipe, or other approved procedure, conforming to requirements of ASME/ANSI B31.1 for high pressure steam boiler piping and B31.9 elsewhere.

C. Pipe Welding Stainless Steel Pipe: Refer to other Sections of Division 23 for welding requirements.

D. Structural Steel Field Welding: Comply with AWS D1.1 procedures for manual shielded metal- arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

E. Soldering: Comply with the requirements of the AWS Soldering Manual.

F. Brazing: Comply with the requirements of the AWS Brazing Manual and AWS A5.8 specification for filler materials for brazing.

3.6 UNIONS

A. In Screwed Steel Pipe, 2 inches and smaller: Screwed, Class 250 malleable iron, brass to iron seat, ground joint union with brass seat ring pressed into head piece. Provide galvanized unions in galvanized pipe.

B. In Welded Steel Pipe, 2 inches and smaller: Class 3000 carbon steel socket welded union, steel to steel seat and ground joint. Provide stainless steel in stainless steel piping.

C. In Copper tubing, 2 inches and smaller: Class 200 wrought copper, solder type, brass ground joint union.

D. In Brass Piping, 2 inches and smaller: Class 250 cast bronze, screwed ends, brass ground joint unions. Provide chromium plated unions in chromium plated piping.

E. Provide companion flanges in piping 2 ½ inches and larger.

3.7 PIPING CONNECTIONS

A. Refer to other Sections of Division 23 for additional requirements.

B. Flanged Connections: Make with nonasbestos gaskets of 1/8 inch thick best quality material as recommended by manufacturer for the service application. For steam piping, factory manufactured for flange/connection size/type as manufactured by Flexitallic. For other piping services either Flexitallic or gaskets factory cut for flange size as manufactured by Garlock Packing Division, Colt Industries, or equal. Align flange surfaces parallel. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

C. Mechanical Couplings: Prepare pipe and install in accordance with manufacturer's instructions. Standard wall steel pipe either roll or cut grooved at Contractor's option, all sizes, except provide cut grooved as required to accommodate thermal expansion and contraction. Heavy wall steel pipe cut grooved all sizes. Light wall steel pipe roll grooved all sizes. Copper tubing roll grooved.

D. Soldered Joints: Unless noted otherwise, make with appropriate flux and solder. Clean tubing ends and fittings before assembly. For piping 2 inch and larger tin tubing and fittings before assembly. For tubing 2-1/2 inch and larger use circular flame torch for soldering. The use of lead flux or solder and finishing with 50-50 solder is prohibited.

E. Threaded Pipe: Make full, clean-cut standard ANSI/ASME B1.20.1 taper pipe threads using sharp dies. Carefully cut, ream or file out to size or bore, removing all chips. Use Schedule 80 pipe for all screwed close and shoulder nipples. Do not use all thread nipples. Provide teflon tape or other approved nontoxic joint compound, applied to male thread only.

F. Welding Connections: Use only factory-made welding fittings, same weight as piping, on welded pipe, except that Bonney Forge WELDOLET or THREADOLET, or Allied Type 1 Branchlet fittings, of same weight as connecting piping, may be used for branch takeoffs two or more commercial pipe sizes smaller than main. All elbows long radius.

G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
4. PVC Nonpressure Piping: Join according to ASTM D2855.

H. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.9 PROTECTION OF WORK

A. Clean pipe, tubing, fittings, valves, piping specialties, ductwork and equipment before installation and keep clean while the work is in progress.

B. Securely close open ends of pipe and tubing and openings in other material and equipment until installed, during installation, and until finally connected or otherwise finished, with caps, plugs or other approved closure devices designed for such service.

C. Protect factory finished equipment, fixtures and devices with approved temporary covering material where those items are installed so as to be subject to accidental damage or abuse. Contractor shall remove all temporary covering material at the conclusion of the work or as directed.

D. Protect the work of other trades and property of Owner from damage and assume full responsibility for the cost of repairing or replacing any damage to such work or property caused by the performance of the work under Division 23.

3.10 CLEANING OF SYSTEMS

A. Refer to Division 23 “HVAC Water Treatment” for additional cleaning and system flushing requirements.

B. Following completion of system testing, thoroughly clean all piping systems by flushing with water or other approved method, or as otherwise specified. Completely remove all dirt, scale, oil, grease and other foreign substances that may have accumulated in systems during installation.

C. Carefully wipe out, wire brush, or if necessary, sand blast sections of pipelines between temporary or permanent strainers and equipment they are to protect. Replace all permanent strainer screens with

temporary screens during cleaning process. Remove temporary screens and reinstall permanent screens after cleaning is completed.

D. Disconnect automatic devices that can become clogged during cleaning process and do not connect permanently until cleaning process is complete.

E. Clean all ductwork, piping and equipment of dirt, scale, plaster, concrete, splattered paint and other foreign matter.

F. Clean all grease and cuttings from stainless steel piping and trim.

G. Clean all strainers, dirt pockets, drip legs, traps and other accessories that may collect foreign matter.

3.11 EQUIPMENT PADS

A. Provide reinforced concrete equipment pads for the work specified under Division 23. Be responsible for preparing equipment pad drawings and setting foundation anchor bolts in time so as not to delay the work. Equipment pads shall be of the types detailed on the drawings.

B. Reinforce concrete to suit the loads placed on them. Materials and methods shall be as specified in Division 03.

C. Unless otherwise indicated, extend equipment pads minimum 4 inches above the finished floor and minimum 4 inches beyond the equipment base in all directions. Have the top edges and vertical corners chamfered along the full perimeter. Equipment pads shall have the same surface finish as the adjacent and surrounding floor.

D. Set with proper templates, epoxy coated anchor bolts and inserts required for proper attachment of the equipment to the concrete foundations. Provide anchor bolts of the same size and number required by the equipment or as recommended by the equipment manufacturer and in accordance with the requirements detailed. Anchor bolts shall be compatible with vibration isolation requirements specified for the equipment.

E. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, fill the annular space between the anchor bolt and the inside of the pipe sleeve completely for the full length of the pipe sleeve with nonshrink cement grout.

F. Grout any openings between the top of the concrete foundation and the base of the equipment.

3.12 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.13 GROUTING

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

B. Packaging: Premixed and factory packaged. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

C. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout.

D. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout according to manufacturer's written instructions.

3.14 HANGERS AND SUPPORTS

A. General

1. Support major piping 3 inch and above, ductwork, tanks and other equipment to the structure above (beams and girders) or by means of struts or brackets to columns. Do not support from floor or roof decks. Do not overload structural members to which supports are attached. Hanger spacing not to exceed MSS SP69.

    a. Provide hangers, rollers, threaded rods, turnbuckles, deflection guides, deflection provisions, inserts, beam clamps and all miscellaneous specialties for attachment of hangers and supports to structure.
    b. Provide all rods, angles, rails, struts, brace plates, structural steel, platforms and other items required for suspension or support of piping, ductwork, tanks and equipment.
    c. Provide supplemental angles, channels, plates or other reinforcement where supports are required between building structural members. Size supports for weight of duct, pipe, pipe contents, equipment fittings and other items, plus a 200 pound live load. Attach supplemental supports in a manner that will not weaken or overload structural members. Weld steel according to AWS D-1.1.
    d. Attach by welding, clamping, concrete inserts, drilled in mechanical type anchors (Hilti or equal) and other approved means. Adhesive type anchors are not approved.
    e. Place grout under supports for equipment, and make a smooth bearing surface.
    f. For seismic restraint, provide double-sided beam clamp loaded perpendicularly to beam for seismic anchor point.

2. No lead shield anchors, powder or power fasteners permitted for attachments.
3. Do not use perforated strap hangers. Do not use steel strap hangers on piping.
4. Wherever possible, support shall be provided directly to main steel or concrete framing beams. If spacing of structure exceeds spacing required to support the mechanical work, supplemental channel or unistrut framing shall be designed and provided by the Contractor.
5. Support all mechanical work independently of other trades. Under no circumstances shall work be supported or suspended from ceiling grids, piping or other supports by other trades.

6. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
7. Inserts in precast concrete to support Work of Division 23 will be furnished and installed
8. by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.

B. Inserts

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in form work in advance of concrete work. Provide reinforcement rod placed through opening on top and bent over adjacent concrete reinforcement rods.
3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
4. Where inserts are omitted, if approved by Architect, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab or provide drilled in mechanical type anchors, Hilti or equal, after concrete is completely cured.

C. Pipe Hangers and Supports

1. Unless otherwise required to avoid overloading of structural members or for seismic restraint, support horizontal steel and copper piping as follows:

Nominal Pipe Size (inch)	(a)Maximum Distance Between Support (feet)		Hanger Rod Diameter (inch)
	Steel Pipe	Copper Tubing	

up to 3/4	6	5	3/8
1 to 2	6	6	3/8
2-1/2 to 3-1/2	10	8	1/2
4 & 5	12	10	5/8
6 to 8	12	10	3/4

a. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
b. As required to carry weight of trapeze channel, span of piping with contents, insulation and supports, plus a 200 pound live load.
c. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.

3. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers and expansion joints/loops.
4. Place a hanger within one foot of each horizontal elbow.
5. Use hangers that are vertically adjustable 1-1/2 inch minimum after piping is erected.
6. Vertical Piping Support:

a. Unless otherwise required to avoid overloading, of structural members or for seismic restraint, support vertical piping with clamps spaced appropriately as to type and weight of piping, minimum spacing at every other floor and below roof. Support vertical soil pipe at each floor at hub. For exposed piping in stairs and finished areas, locate clamps below floor and secure to structure below floor as required.
b. Support vertical steel pipe at a maximum of 15 feet spacing.
c. Support vertical copper pipe and tubing at a maximum of 10 feet spacing.

7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers. Space hangers for smallest pipe size or provide intermediate supports for smaller pipe as specified above for individual pipes.
8. Where practical, support riser piping independently of connected horizontal piping.
9. Support pipe runs in a manner to minimize stress in the pipe or tubing and on bodies of valves and fittings.
10. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
11. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
12. For piping subject to sweating (e.g.: domestic cold water, chilled water, refrigerant suction, drain piping for air conditioning equipment, heat recovery piping, etc.) and for insulated piping requiring roller supports, install hangers outside insulation and provide pipe insulation protection shields as specified in this section. For all other piping, hanger may be attached to the piping before insulation is applied or may be installed outside the insulation with insulation protection shields.
13. Do not support nonferrous piping with ferrous materials even on a temporary basis.

14. Do not support piping or ductwork from other piping or ductwork.
15. Install hanger rods subjected to tension only. Accomplish lateral and axial movements by proper linkage in rod assembly. Secure hanger to hanger rod with two bottom lock nuts.

B. Duct Hanger and Supports: Refer to Section 23 30 00 “Ductwork and Ductwork Accessories”.

3.2 IDENTIFICATION

A. Identify all new and altered equipment, new and altered exposed and concealed ducts and new and altered exposed and concealed pipe with legible lettering, applied after finish painting, in a color to contrast with basic color in accordance with ANSI A13.1 and OSHA.

B. Identify piping by name of pipe content and direction of flow near major equipment items, adjacent to valves or flanges, adjacent to gauges or thermometers, at each tee, at changes in direction, on each side of a penetration of a wall or floor, at each access door or panel and then at maximum 20 foot centers in congested areas and 50 foot intervals elsewhere; indicate flow direction with arrows. Identification shall be by means of plastic markers or tape or painted on the finished pipe surface by using stencils. Lettering shall not be smaller than one third of the pipe diameter and directional arrows not less than 1/2 inch wide and 12 inches long.

C. Identify equipment and operating devices such as switches, starters and similar equipment, by the equipment numbers shown on Drawings or by the Owner's numbering system, if so directed.

1. Include the type of service or the name of areas served.
2. Lettering minimum 1 inch high.
3. Nameplates shall be two tone plastic, or printed white paper enclosed in a transparent, laminated plastic case with permanently sealed edges.
4. Attach securely to equipment, or where this is not practicable attach by brass link chains.
5. Do not stencil surfaces exposed in public areas.

D. Furnish for each valve, except those immediately adjacent to apparatus, a 2-inch diameter nonferrous metal tag with figures stamped on the tag.

1. Number tags for HVAC H-1, H-2, etc.; Use Owner's numbering system if so directed.
2. Fasten tags to valves with nonferrous S hooks and nonferrous chains.
3. Where valves are located above removable acoustical tile ceilings, identify the tile section below the valves by an approved color pin system.
4. Furnish duplicate framed schedules showing the location of each valve, system or equipment it serves, manufacturer, and figure number.

E. Identify exposed ductwork similar to piping.

F. Identify access doors to fire dampers with access panel markers or by stencils with the words "Fire Damper Access" except for dynamic fire dampers, use the words "CAUTION Dynamic Fire Damper Access". Provide approved markers to locate fire dampers concealed above ceilings.

3.3 TESTING OF PIPING SYSTEMS – COMMON REQUIREMENTS

A. Refer to individual piping system specifications elsewhere in Division 23 for additional piping system testing requirements.

B. Provide materials and equipment required for testing. Test and make tight all new piping systems and alterations and connections to existing piping system.

C. Take precautions during testing to ensure safety of personnel and equipment. Provide systems to be pressurized with appropriate gauges and blowouts or relief valve set at a pressure no more than one third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Make good at no increase in Contract sum damage to work or work of other trades caused by failure to observe proper precautions.

D. Test piping systems prior to application of insulation. Testing as stipulated herein shall be considered minimum, and where tests stipulated by lawful jurisdictional authorities exceed these requirements, such more stringent tests shall be performed. Tests shall be witnessed and approved by the authorities having jurisdiction over the work.

E. Concealed work shall remain uncovered until required tests have been completed. Provide proper sectionalizing devices so that portions of a system may be tested as appropriate.

F. Isolate and exclude from tests all in line equipment, instruments, gauge glasses, flow meters and all other devices not capable of withstanding test pressure.

G. Use ambient temperature water as testing medium, except where otherwise specified and except where there is a risk of damage due to freezing.

H. Apply soap solution to all joints of pneumatically tested systems while system is being subjected to test pressure.

I. Maintain test pressures sufficient length of time to permit thorough inspection of all joints. Where leaks are observed, replace defective work or material. Caulking of screw joints or holes is not acceptable. Repeat entire test as many times as necessary, until successful completion of test with no leaks.

J. Prepare written report of testing.

3.4 BALANCING, ADJUSTING AND PERFORMANCE TESTING

A. Testing, adjusting and balancing of air and water systems will be provided under Division 01 “Testing, Adjusting and Balancing of HVAC Systems”.

B. Installing Contractor(s) responsible for the work specified in Division 23 shall perform all work necessary to place systems in full operation prior to start of testing, adjusting and balancing work. In addition, Installing Contractor shall perform certain additional preparatory work required for testing, adjusting and balancing as specified in various Sections of Division 23.

Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as

directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.

C. Cooperate with testing, adjusting and balancing Contractor in coordination and scheduling of testing, balancing and adjusting work. Furnish approved manufacturer's technical data and shop drawings for equipment, including fan and pump performance curves.

3.5 INSTRUCTION AND DEMONSTRATION

A. Upon completion of all work and all tests, and at a time mutually agreed on by Contractor, Architect and Owner, Installing Contractor shall operate systems in all parts and at their expense for sufficient length of time to demonstrate the mode of operation and definitively determine whether the systems as a whole are in first class working condition. Immediately correct, at no cost to Owner, any defects that may develop during this period of operation and place systems in first class working condition before being finally turned over to Owner.

B. Provide experienced operating personnel to instruct Owner's authorized employees in the operation, adjustment and maintenance of systems and equipment installed under this Contract. Provide instructions for the period of time appropriate for the size and complexity of the system, or as requested by Owner.

3.6 MANUFACTURER'S SUPERVISIONS AND STARTUP SERVICE

A. Include manufacturer's supervision/startup/certification and special instruction service for equipment as specified in various Sections of Division 23. Be responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified work. Make any corrections/modifications to the installation as required by the manufacturer at no additional cost to Owner.

B. The manufacturer's engineer or authorized service personnel shall check the equipment for its conformance to the Specifications, for proper installation and run the system in all modes of operation to ascertain that the unit will function properly. Make necessary adjustments to insure optimum efficiency and trouble-free service.

C. After completion of the startup procedures, the manufacturer shall certify, in writing, that the equipment is installed in accordance with their requirements and is operating in accordance with the intent of the Specifications.

END OF SECTION 23 05 00

SECTION 23 05 13 – ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes extent of electrical equipment and electrical wiring that is responsibility of Division 23.

B. Section includes general requirements for motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

C. Related Sections:

1. Variable Frequency Motor Speed Controllers furnished by Division 23 are specified in Division 26.

1.3 REFERENCE STANDARDS

A. ANSI/IEEE 112 (C50.20): Test Procedure for Single Phase Induction Motors.

B. ANSI/IEEE 114 (C50.21): Test Procedure for Polyphase Induction Motors and Generators.

C. NFPA 70: National Electric Code (NEC)

D. UL: Underwriters Laboratories

1.4 SUBMITTALS

A. Product Data: Include with equipment submittals, data pertinent to electrical characteristics; motor size, type, power requirements, wiring requirements.

1.5 QUALITY ASSURANCE

A. Provide electrical products, including those factory mounted or factory furnished, which have been tested, listed and labeled with Underwriters' Laboratory (UL) or Electrical Testing Laboratory (ETL).

B. There shall be no field modifications made to any materials, equipment and systems that would violate the listing and labeling.

C. Comply with Division 26, NEC and NEMA as applicable to wiring methods, materials and equipment and equipment, construction and installation.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

B. Duct Smoke Detectors: Duct mounted smoke detectors will be furnished by Division 28 and installed by Division 23. Detectors will be wired to Fire Alarm system by Division 28.

C. Smoke Dampers: Smoke dampers will be provided by Division 23. Smoke damper will be wired to the Fire Alarm system by Division 28. Wiring and addressable interface module will be provided by Division 28.

D. Air Volume Control Boxes: Air volume control boxes with integral 120/24 volt transformer will be provided by Division 23. Control wiring to and from air volume control boxes will be provided by Division 25.

E. Wiring Under Division 26 “Electrical”

1. Power wiring under Division 26 will include power feeders from source of building power to wiring terminals on the equipment, unit mounted disconnects, or control panels.
2. Where disconnect switches for equipment are provided by Division 26, power wiring under Division 26 will include wiring from disconnect to wiring terminals on the equipment.

F. Wiring Under Division 25 “Instrumentation and Control For HVAC”

1. Wiring under Division 25 shall include all connections to control devices, wiring of pressure and flow control switches, flow meters and similar mechanical-electrical devices for mechanical systems to control panels, interlock wiring, control relays, and minor power wiring to auxiliary components for major pieces of apparatus such as damper motors, solenoid valves and control valve motors.

G. Provide all other power and control wiring for Division 23 systems and equipment in accordance with the requirements of Division 26, required for complete operation, including wiring that is specified for factory prewired equipment, but not so provided.

H. Short Circuit Current Ratings (SCCR) for HVAC Equipment

1. Unless otherwise noted, the listed short circuit current rating (SCCR) of all motor controllers, disconnects, contactors, protective devices and associated assemblies that are integral or external to electrically powered mechanical equipment (except for controllers rated less than 2HP at 300V or less and listed exclusively for general purpose branch circuits), shall be equal to or greater than the electrical distribution equipment feeding it. The SCCR value shall be

clearly labeled on the equipment. Refer to the electrical drawings, specifically the single line diagrams, panelboard schedules and HPE schedules to obtain this information. Where the minimum SCCR rating is not specifically identified on the documents at the referenced equipment, the SCCR rating of the HVAC equipment shall be equal to or greater than the kAIC rating of the electrical distribution equipment feeding the electrically powered mechanical equipment.

HVAC equipment submittals shall include the SCCR rating meeting the above requirements. The contractor may elect to perform short circuit calculations to determine the available short circuit rating at the connection point of the applicable equipment. If the SCCR rating is determined to be less than the values indicated on the contract documents, the submittal shall include the calculations (inclusive of all input and output data), in particular the short circuit reduction on the feeder for each specific piece of equipment, and should show that the equipment rating meets or exceeds this calculated value. The calculations must be signed and sealed by a professional engineer (PE) registered in the project state.

All information required to show overall compliance with the above short circuit rating requirements shall be submitted as part of the product submittal. Submittals omitting this required information will be returned 'Resubmit' or 'Rejected'.

No change orders or additional costs will be accepted by Owner or Architect to provide upgraded equipment in order to meet the above requirements or to perform any of the calculations described above.

I. Electrical Ratings

1. The motor horsepower and apparatus full load amperage ratings shown or specified are Basis of Design values and the corresponding sizes of feeders and other electrical equipment indicated to serve them are minimum sizes required to meet the Basis of Design requirements. When motors of greater horsepower and apparatus with larger full load amperage ratings are furnished as necessary to meet the design intent of the various sections within the specification, the associated changes to the electrical system (i.e. increase in capacity of the feeders and other electrical equipment serving them) shall be submitted for approval and be completed by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 ELECTRICAL WIRING

A. Electrical wiring provided by Division 23 shall be in accordance with the requirements of Division 26.

2.2 MOTORS

A. Acceptable Manufacturers:
1. Toshiba
2. General Electric
3. Lincoln
4. Reliance

5. U.S. Electric
6. Marathon
7. Baldor

B. General Motor Requirements

1. Construct in accordance with the latest NEMA MG 1 standards and UL 1004, test in accordance with NEMA MG 1, ANSI/IEEE 112 and ANSI/IEEE 114. Except where more stringent requirements are indicated, comply with the following.
2. Single phase/3 phase (polyphase) and voltage characteristics as scheduled on drawings, 60 Hz.
3. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors that will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
4. Class B insulation unless otherwise specified.
5. Provide each motor with a conduit terminal box or factory installed cord set with molded plug as applicable.
6. Provide motors with grease or lubrication fittings. For specific applications, and at the approval of the Architect, the use of permanently lubricated or lifetime bearings will be permitted.
7. Open dripproof (ODP) or totally enclosed fan cooled (TEFC) type with a minimum service factor of 1.15 unless otherwise specified herein or in other section of the specifications.

C. Motor Characteristics

1. Duty: Continuous duty at 100 percent of rated capacity at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

D. Polyphase Motors

1. Squirrel cage induction type conforming to the following requirements unless noted otherwise:
2. Description: NEMA MG 1, Design B, medium induction motor, unless otherwise required by starting torque.
3. Separate winding for each speed for multispeed motors.
4. Efficiency:

    a. Single speed motors larger than 100 Hp shall be of “Energy efficient” design as defined in NEMA MG-1.
    b. Single speed motors 75 Hp shall be of “Premium efficiency” design, as defined in NEMA MG-1. Class F insulation.
    c. Motors driven by variable frequency motor speed controller (VFD) shall be “Premium” efficiency, as defined in NEMA MG-1. NEMA Design B, Class H insulation.
5. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading. For motors 1.0 Hp and smaller, prelubricated, antifriction sleeve bearings.
6. Motors drawing 1000 watts or more at full load shall have a power factor rating of at least 85% without external capacitor correction. Verify efficiency in accordance with NEMA MG-1. Test per NEMA MG-1, ANSI/IEEE 112. Display efficiency on nameplate in accordance with NEMA MG-1.
7. Special Requirements:

a. Motors installed in air handling unit directly downstream of cooling coils or humidifiers shall be totally enclosed fan cooled (TEFC) type.
b. Motors driven by variable frequency motor speed controller (VFD) shall be inverter duty rated, thermally protected, in full compliance with NEMA MG-1 Part 31.
c. For motors driven by VFD, provide motor shaft grounding ring (SGR) to protect against electrical discharge machining (EDM) motor bearing damage.
d. Provide next size larger motor and drive, where fan motor brake horsepower, including all drive and belt losses, exceeds the following limits:

1) 85% of nameplate horsepower for motor 40 Hp and smaller in size.
2) 90% of nameplate horsepower for motor 50 Hp through 100 Hp in size.
3) 95% of nameplate horsepower for motor larger than 100 Hp.

E. Single Phase Motors

1. Motors larger than 1/20 hp shall be energy efficient capacitor start type to suit starting torque and requirements of specific motor application:
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

A. Variable frequency motor speed controllers (VFD), including line reactor and/or harmonic filter as required, shall be furnished by Division 23 in accordance with Division 26 Section “Variable Frequency Motor Speed Controller (VFD)”.

B. It shall be the responsibility of Division 23 Sections to properly match the motor and drive.

C. All variable frequency motor speed controllers furnished by Division 23 shall be of the same manufacturer.

2.4 MOTOR STARTERS

A. Motor starters for chillers and certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 23. All other motor starters, except variable frequency drives, shall be provided by Division 26.

2.5 POWER FACTOR CORRECTION

A. Power factor correction for certain packaged equipment will be furnished by equipment manufacturer(s) as specified in their respective sections of Division 23.

B. For each motor 25 hp and larger, except those driven by a VFD, furnish 3 phase, 60 hertz, biodegradable, low toxicity type capacitor for power factor correction with maximum rating allowed by motor manufacturer sufficient to raise overall motor power factor to 95%.

C. Provide NEMA enclosure with gray enamel finish, porcelain bushings, non-PCB impregnated dielectric resistors, current limiting fuses, mounting brackets, internal connections and appurtenances, including blown fuse external indicator.

D. Factory test capacitors for compliance with referenced NEMA and ANSI/IEEE Specifications. Submit certified test reports with equipment shop drawings.

2.6 CONTROL PANELS

A. Include in control panels provided as a part of apparatus specified in Division 23, fused disconnect, circuit breaker or motor circuit protector combination starter with overload protection for each motor, contactors, and electric heaters, if required. Provide 120 volt control circuit and other required circuit protection. Where remote controls are required, they shall operate at 120 volt maximum, with properly fused control transformer provided for that purpose.

PART 3 - EXECUTION

3.1 ELECTRICAL WIRING

A. Power wiring will be provided under Division 26 and control wiring will be provided under Division 23. Provide power and control wiring for Division 23 systems and equipment for interconnecting wiring on apparatus that has not been factory installed.

3.2 MOTORS

A. Provide electric motors required for equipment specified in the various sections of Division 23, designed and wound for electrical characteristics shown on the Drawings.

B. Select motors for quiet operation and for sufficient capacity to operate driven devices under all conditions of operation without overloading.

C. Install motors in accordance with manufacturer’s published instructions. Mount direct drive connected motors securely in accurate alignment. For belt drive motors, use adjustable mounting bases, align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

D. Extend lubrication lines to accessible locations.

E. Startup

1. Check operating motors, both factory and field installed, for unusual conditions during normal operation. Coordinate with the balancing and commissioning of the equipment for which the motor is a part.
2. Report unusual conditions and correct deficiencies.

3.3 VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

A. Deliver variable frequency motor speed controllers not factory mounted on equipment to Division 26 for field installation and wiring.

3.4 MOTOR STARTERS

A. Deliver motor starting equipment not factory mounted on equipment to Division 26 for field installation and wiring.

3.5 POWER FACTOR CORRECTION

A. Deliver capacitors not factory mounted on equipment to Division 26 for field installation and wiring.

END OF SECTION 23 05 13

SECTION 23 05 33 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes heat tracing with self-regulating, parallel resistance electric heating cables and digital controls for freeze protection

1.3 SUBMITTALS

A. Product Data: Include product cut sheets indicating rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings

1. Wiring Diagrams: Provide wiring diagrams indicating power, signal, and control wiring.
2. Plans: Provide plans indicating quantities, and locations of heating cables and controllers with power connection points shown.
3. Schedules: Indicate heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period. Contractor shall coordinate with owner and manufacturer to submit all necessary warranty

registration forms to the manufacturer within the manufacturer's required maximum number of days after installation.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Raychem; a division of Tyco Thermal Controls
2. Chromalox, Inc.
3. Delta-Therm Corp.

B. Provide a complete system of heating-cables, components and controls, which shall be UL listed, FM Approved or CSA certified for the specific application and specific system for which they are used.

C. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-plated copper bus wires embedded in parallel in a self-regulating, cross-linked polymer core that varies its heat output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric inner jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of modified polyolefin or fluoropolymer, as required per section 427-23 of the NEC, latest edition.

1. For installation on plastic piping, the heating cable shall be applied using aluminum tape (Raychem AT-180 or approved equal).

D. Power connection, end seal, splice, and tee kit components shall be applied in the field.

E. Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC, latest edition.

F. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion.

G. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable.

H. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES FOR FREEZE PROTECTION

A. Electrical Characteristics:

1. Volts: 277
2. Phase: Single
3. Hertz: 60

B. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.

C. Maximum Operating Temperature Rating (Power On): 150°F.

D. Maximum Exposure Temperature (Power Off): 150°F.

E. Heat tracing for freeze protection of water piping shall be capable of maintaining a minimum water temperature of 40°F at an ambient air temperature of 0°F.

F. The heating cable for metal-pipe freeze protection shall be sized according to the table below. The heating cable output ratings selected in this table are based on 1-inch fiberglass insulation. The given wattages refer to the nominal watts per foot rating, which corresponds to the standard heat output provided by the cable at a surrounding temperature of 50°F.

	Minimum Ambient Temperature	
Pipe Size (inches)	0°F	-20°F
3 or less	5 watts	5 watts
4	5 watts	8 watts
6	8 watts	12 watts
8	8 watts	12 watts
10	12 watts	2 strips - 8 watts
12	12 watts	2 strips - 8 watts
14	12 watts	2 strips - 12 watts
16	2 strips - 8 watts	2 strips - 12 watts
18	2 strips - 8 watts	2 strips - 12 watts
20	2 strips - 12 watts	2 strips - 12 watts
24	2 strips - 12 watts	3 strips - 12 watts

2.3 SINGLE CIRCUIT LOCAL DIGITAL CONTROLLER

A. Local digital controller shall be DigiTrace C910-485 as manufactured by Raychem or approved equal.

1. Heating cable manufacturer shall provide a local digital controller with built-in GFPD compatible with selected heating cable.
2. Digital controller shall be capable of supporting up to two (2) RTD temperature sensors per control point. Leads can be extended using 18 AWG, 3-wire, shielded cable.

B. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP).

C. Digital controller shall be capable of operating with supply voltages from 100 V to 277 V.

D. Digital controller shall have an integrated adjustable Ground Fault Protection Device (10 – 200 mA).

E. Digital controller shall have a built-in self-test feature to verify proper functionality of heating cable system.

F. Digital controller shall be able to communicate with BMS via BACnet® protocol. Provide the controller manufacturer's recommended multi-protocol gateway (translator device) with controller as required.

G. Digital controller will also supply an isolated triac alarm relay and a dry contact relay for alarm annunciation back to the BMS.

H. The following variables shall be monitored by the digital controller and reported back to the BMS.

1. Temperature
2. Ground-fault
3. Current draw
4. Power consumption
5. Associated alarms

I. Digital controller shall have c-CSA-us approvals.

J. Digital controllers serving freeze protection cables shall be configured for line sensing mode.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, aluminum tape for plastic piping, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer. Connection systems that require cutting or stripping to expose buswire, or that use crimps or terminal blocks will not be accepted.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install heat trace on all exposed outdoor chilled water and hot water, makeup water piping.

C. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.

D. Install electric heating cables according to IEEE 515.1.

E. Install electric heating cables after piping has been tested and before insulation is installed.

F. For installation on plastic piping, the heating cable shall be applied using aluminum tape.

G. Install insulation over piping with electric cables according to the insulation specification section. Coordinate diameter of insulation to include thickness of cable as per manufacturer’s recommendations.

H. Install warning tape on 10 foot centers on piping insulation where piping is equipped with electric heating cables.

I. Set field-adjustable switches and circuit-breaker trip ranges.

J. Protect installed heating cables, including nonheating leads, from damage.

K. For heat tracing using line sensing, install temperature sensor in an area that is representative of conditions along entire length of pipe.

L. Terminate cables with water-proof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end water-tight.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. A factory-certified technician or manufacturer's representative shall perform startup and commissioning of the heat trace system and controls. Provide commissioning report to owner.

B. Coordinate all controller settings with specifying engineer prior to programming.

C. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 05 33

SECTION 23 05 48 - VIBRATION ISOLATION AND SEISMIC RESTRAINTS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Vibration isolation devices, accessories, materials, and related items for new equipment, piping and ductwork as may be required to prevent the transmission of vibration to the building structure.
2. Seismic and wind restraint devices, accessories, materials, and related items for new equipment, piping and ductwork as may be required to keep all components in place during a seismic or wind event and operational where this specification so requires.
3. Requirements for Certification of seismic and wind analysis, design, and installation.

B. Refer to Division 01 “Summary of Work” for seismic criteria and site specific seismic restraint design parameters to be used for this project.

1.3 REFERENCES

A. ASCE: American Society of Civil Engineers, ASCE 7, latest edition.

B. ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., Applications Handbook, latest edition.

C. ASTM: American Society for Testing and Materials.

D. AWS: American Welding Society.

E. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association, Duct Construction Standards – Metal and Flexible, latest version.

F. SMACNA: Seismic Restraint Manual Guidelines for Mechanical Systems, latest version.

G. MSS: Manufacturer’s Standardization Society.

H. IBC: International Building Code

1.4 DEFINITIONS

A. Failure: For the purpose of this project, is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch.

B. Isolation Manufacturer: For the purpose of this project, manufacturer of vibration isolation and seismic and wind restraint equipment.

C. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

D. Positive Attachment: A cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps and power shots for support rods of piping, ductwork, or any other equipment are not acceptable on this project as positive attachment.

E. Restraint: Device(s) intended to keep component in place during a seismic and wind event.

F. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

G. High Hazard Systems

1. Systems conveying material that is either toxic or potentially explosive and in significant quantity could pose a threat to the general public.
2. Fuel oil, natural gas, propane, compressed air, high pressure steam or any piping containing flammable, combustible, toxic or corrosive material.

H. Life Safety Systems:

1. Supply, fresh air, exhaust, and relief air systems on automated emergency smoke control sequence, or manually controlled smoke evacuation and purge systems.
2. Hospital heating and air-conditioning systems required to maintain normal ambient temperature.
3. Mechanical systems that support the operation of or are connected to emergency power generation equipment.

I. Refer to ASCE 7 for additional definitions of items related to seismic and wind restraints.

1.5 SUBMITTALS

A. Product Data: Annotate to indicate application of each product submitted and compliance with the specifications.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style material, strength, fastening provision, and finish for each type and size of seismic and wind restraint component used.
3. Installation instructions and requirements, including all anchoring and fastener torque requirements.

B. Product Schedule or List: Provide schedule of all vibration isolated and restrained equipment and all restrained but not vibration isolated equipment, all vibration isolated and restrained piping and ductwork systems and all restrained, but not vibration isolated piping and ductwork systems. Submit separate schedules for "Vibration Isolated and Restrained" and for "Restrained but Not Vibration Isolated". Include the following for each piece of equipment and, as applicable, for each piping and ductwork system:

1. Identification. Include equipment ID where applicable.
2. Isolator type(s) with identification reference numbers of applicable product data and shop drawings.
3. Actual load for each isolator type.
4. Actual static deflection expected under actual load for each isolator type.
5. Specified minimum static deflection under actual load for each isolator type.
6. Seismic and wind restraint(s) with identification number(s) of applicable product data and shop drawings. Include overstressed condition information, if any, as required by the Article titled "Seismic and Wind Restraint Design Engineer's Responsibilities" in Part 1 of this section. Do not include calculations with submittal. Calculations will not be reviewed.

C. Shop Drawings:

1. Fabrication details of roof curbs, steel rails, steel base frames and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method and location of equipment bolts.
2. Drawings showing methods of suspension, support guides for piping and ductwork.
3. Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
4. Drawings showing number and location of seismic restraints and anchors for each piece of equipment and each piping and ductwork system.
5. Specific details of restraints including anchor bolts for mounting at each location, for each piece of equipment and for pipe, conduit and duct locations.
6. Methods and details for vertical restraints.
7. Details and sizing of housekeeping pad(s) showing reinforcement, method of attachment to structure and method of attachment of equipment restraint(s).
8. All other special details necessary to convey complete understanding of work to be performed.
9. Provide the number, size and location of braces and anchors for suspended piping and ductwork on shop drawings.

D. Certification of Seismic and Wind Analysis and Design: Statement on seismic and wind design engineer's letterhead stationery with original signature of an authorized representative of the manufacturer certifying that, as required by the Article "Seismic and Wind Restraint Design Engineer Responsibilities" in Part 1 of this section:

1. Seismic and wind restraint design calculations have been completed and stamped by a registered engineer in the same state as the project, including name, license number and state of registration of responsible engineer. Do not include calculations with submittal.
2. All overstressed conditions have been included in the submittal.
3. Seismic and wind restraints and attachments are capable of safely accepting loads resulting from the site specific seismic and wind forces when installed in accordance with manufacturer's instructions.

E. Certification of Component Manufacturer Seismic and Wind Compliance:

1. For life safety and high hazard components and systems, provide component manufacturer's Approved Agency Certificate of Compliance for their equipment when used on project with Seismic Design Category C through F, including testing certification.
2. All other components, equipment manufacturer must provide certification product has been tested or analyzed to withstand the site-specific restraining loads. Seismic and wind restraint design engineer shall review products for capability to withstand project design anchoring loads.
3. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the site specific seismic and wind forces specified.”

4. Dimensioned Outline Drawings of Unit Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
5. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. It is the objective of this specification to provide the design and installation requirements for vibration isolation equipment and devices for the avoidance of excessive noise and vibration in the building(s) due to the operation of machinery or equipment and/or due to interconnected piping, ductwork or conduit, and to provide the design and installation of restraint equipment and devices for seismic and wind restraint for the mechanical systems.

B. All vibration isolation equipment and devices, including auxiliary steel bases and pouring forms, and all seismic and wind restraint equipment and devices shall be the products of a single manufacturer, hereinafter called the isolation manufacturer, unless otherwise allowed in writing by the Architect, shall be certified by the isolation manufacturer and shall be furnished by the isolation manufacturer or his authorized representative, who shall be responsible for performing all work specified in this section to be performed by the isolation manufacturer or his representative and for coordination of all phases of the work.

C. This specification represents the minimum requirements for seismic and wind consideration. All systems must be installed in strict accordance with seismic and wind restraining forces and in compliance with site specific design parameters. Applicable codes and component manufacturer’s standards and written instructions shall be complied with. Whenever a conflict occurs between codes, manufacturer’s standards, and requirements in this Section, the most stringent shall apply.

D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel.

E. Quality Assurance Program: The quality assurance plan shall be included when required by the applicable building codes. The design of each seismic and wind restraining system shall include a written quality assurance plan prepared by a professional engineer registered in the same state as the project. The quality assurance plan shall identify the following:

1. Seismic and wind restraining systems that are subject to quality assurance:
    a. Air Handling Systems (AHU-2, AHU-2, AHU-3)
    b. Exhaust Fans (EF- 1 through EF-6)

c. Boilers (B-1, B-2)
d. Chiller (CH-1)
e. Pumps (CHWP-1, CHWP-2, HWP-1, HWP-2)

2. Special inspections and testing to be provided as per applicable code requirements.
3. The type and frequency of testing and special inspections.
4. The frequency and distribution of testing and special inspection reports.
5. The structural observations to be performed.
6. The required frequency and distribution of structural observation reports.

F. Contractor Responsibility Statement: When a quality assurance plan is required by the applicable building code, the Contractor responsibility statement is required. Contractor shall submit a written statement with copies to the building official and Owner indicating acknowledgement of the requirements of the quality assurance plan and identification qualifications and position of individual(s) responsible for maintaining conformance to quality assurance plan within the Contractor's organization.

G. Owner will retain and pay for services of a qualified seismic and wind restraint design engineering consultant to inspect and certify seismic and wind restraint installation where special inspections are required by the applicable codes. The Contractor shall notify the Owner of all special inspection requirements included in the quality assurance plan. Special inspection reports shall be submitted to the Architect, seismic and wind restraint design engineer, Owner and Contractor for record purposes.

H. Contractor must select a single seismic restraint system pre-designed to meet the requirements of the applicable building code.

1.7 DESIGN REQUIREMENTS

A. Refer to Section 23 05 00 Article titled “Seismic Requirements.”

B. Design isolators and restraints for equipment installed outdoors to provide site specific restraint to withstand wind loads as calculated in accordance with ASCE 7, applied to any exposed surface of the isolated and/or restrained equipment. Isolators and restraints for outdoor equipment shall have bolt holes for attachment to the equipment and to the supports. Equipment shall be anchored to roof curb or rail, and roof curb or rail shall be anchored to the building structure.

C. Design seismic and wind restraints to safely anchor and resist earthquake and wind generated external horizontal forces of not less than those values required by ASCE 7-10 as modified by the 2015 International Building Code in any direction at the center of mass without failure or permanent displacement.

D. Non-simultaneous vertical force shall be 66% of the horizontal force.

E. Internally isolated and restrained equipment may be used in lieu of specified external isolation and restraint provided all site specific seismic and wind design parameters are met.

F. Exclusions for seismic restraint of ductwork and piping shall be according to referenced code.

G. Expected noise levels in various parts of the building shall conform to room criteria (RC) recommendations as set forth in the latest edition of the ASHRAE HVAC Applications Handbook. The midpoint range of the NC criteria curves shall apply.

H. Isolation manufacturer shall have the responsibility to determine the base type, if any, and the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration, and meet the noise criteria referenced herein. Select isolation in accordance with the requirements of the latest edition of the ASHRAE HVAC Applications Handbook. The following shall apply:

1. 30 to 40 Foot Floor Span: Use for locations above grade which are adjacent to sensitive occupied spaces or on lightweight or flexible construction. The span is included for reference only and shall not be the primary consideration in design.
2. 20 to 30 Foot Floor Spans: Use for locations above grade as appropriate for construction.
3. Up to 20 Foot Floor Span: Use for equipment on ground supported slabs adjacent to or below noise-sensitive areas.
4. Grade Supported Slab: Use for equipment on ground supported slabs which are remote or are not adjacent to or below noise- sensitive areas.

1.8 COMPONENT MANUFACTURER'S RESPONSIBILITIES

A. Seismic and wind restraint and vibration isolation component manufacturer shall have the following responsibilities:

1. Select vibration isolators, which will enable the noise criteria standards to be met, to the extent that the vibration isolators can control the noise. Determine vibration isolation and seismic and wind restraint sizes and locations.
2. Furnish vibration isolation systems and seismic and wind restraints as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide design and application of seismic and wind restraints in accordance with the more stringent of the requirements of the referenced building code, SMACNA standards and the requirements of latest version ASHRAE Applications Handbook.
5. Provide installation instructions, drawings, and field supervision to assure code compliant installation and performance. The installation of all vibration isolation units and seismic and wind restraints, and associated hangers and bases, shall be under the direct supervision of the manufacturer's component application Engineer or their chosen representative. Upon completion of installation and after system is put into operation, representative shall make a final inspection and submit report to Architect in writing certifying that the installation is in compliance with site specific code and specification requirements. The completed Certification shall be submitted within 30 days of project completion.
6. Provide component certification of seismic and wind restraints and attachments anchored to building structure resulting from seismic and wind restraint forces determined by Engineering calculations using site specific design parameters. Certification must be verified by a licensed engineer.
7. Design restraining devices to comply with thermally active components in such a manner that does not impose load due to thermally generated movement to building structure.
8. Advise Contractor of special size and anchor bolt requirements for foundations and housekeeping pads to develop strength equal to that for which the seismic and wind restraints are designed to anchor and certify same.

1.9 SEISMIC AND WIND RESTRAINT DESIGN ENGINEER'S RESPONSIBILITIES

A. Seismic and Wind Restraint Design Engineer retained by the Mechanical Contractor as required shall have the following responsibilities:

1. Seismic and wind restraint application calculations, seismic and wind restraint analysis and design certification.
2. Provide a written seismic and wind restraint quality assurance document.
3. Registered Professional Engineer in the state where the project is located.
4. Identification of any overstressed conditions and notification to Architect of overstressed conditions.
5. Review of seismic and wind restraint manufacturer's component certifications.
6. Provide special inspections for this project as required by applicable codes and standards.
7. Shop drawing review, design and certification of compliance with site specific seismic and wind restraint design.
8. Provide calculations to determine restraint loads resulting from site specific seismic and wind forces and in governing codes and project seismic and wind restraint requirements; with a minimum seismic acceleration applied at the equipment center of mass as specified in the "Design Requirements" Article in Part 1 of this section. Seismic and wind calculations shall be certified by a licensed engineer, experienced in the design of seismic and wind restraints. Submit calculations with professional engineer's stamp and signature to Owner for record purposes. Calculations included in submittal will not be reviewed.
9. Check the structural members of the building for localized stress at points of attachment for seismic and wind restraint. The Engineer shall provide to the Architect the magnitude of seismic and wind restraint force and include direction on shop drawings, together with computation of stress conditions at localized attachments only in the event that an overstressed condition is determined by the Engineer. The Engineer shall certify that the Architect has been advised of all overstressed condition information. The Architect will review only such identified locations for additional bracing or reinforcing at these localized conditions.

1.10 COORDINATION

A. Coordinate work with other trades to avoid having isolated systems coming in contact with the building. Inform other trades following this work to avoid causing any contact which would reduce the vibration isolation.

B. Coordinate size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pad.

C. Bring to the Architect's attention in writing prior to installation any conflicts with other trades which will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.

D. Bring to the Architect's attention in writing any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.11 INSPECTION AND INSTRUCTION

A. Notify the isolation manufacturer's representative prior to the general installation of vibration isolation devices and seismic and wind restraints so that the isolation manufacturer's representative can instruct and demonstrate the proper installation procedures with the Contractor's foremen.

B. Comply with written instructions from the isolation manufacturer's representative as to the proper installation and adjustment of vibration isolation devices and seismic and wind restraints.

C. Obtain inspection and approval from the isolation manufacturer's representative of the completed installation. Perform all work and make all adjustments as stated in the quality assurance document as provided by the isolation manufacturer.

D. Obtain inspection and approval from the isolation manufacturer's representative, and perform all directed work and adjustments, of any installation to be covered or enclosed prior to such closure.

E. Where special inspection and periodic special inspection of seismic and wind restraints is required by the referenced building code, Contractor must submit a written statement of responsibility as part of the Quality Assurance Program including, identification of components, control procedures for all inspection and testing including frequency and method of reporting, and list of qualified personnel responsible for certifying seismic and wind restraints.

F. The following systems require special inspection and periodic special inspection for anchorage to the building structure during the course of construction:

1. Smoke Control Systems: Periodic during erection and prior to concealment, during leakage testing and additionally during pressure differential testing.
2. Electrical Components of Standby or Emergency Generator: Periodic.
3. All flammable combustible and highly toxic and associated systems: Periodic.
4. Ductwork Containing Hazardous Material: Periodic.
5. Equipment Using Toxic or Combustible Energy Sources: Special.
6. Reciprocating and Rotary Machinery: Special.
7. Pipe Larger Than 3 Inches: Special.
8. Tanks, Heat Exchangers, Pressure Vessels: Special.
9. Isolator Units for Seismic Isolation System: Periodic.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries

B. General:

1. Clean and paint steel components, and zinc-electroplate all nuts, bolts, and washers. Clean structural steel bases of welding slag and prime with zinc-chromate or metal etching primer.

2. All springs installed out-of-doors shall be cadmium plated, zinc electroplated or powder- coated, hardware and other metal parts installed out-of-doors shall be galvanized, zinc electroplated, or cadmium plated. Non-Electro-Plated zinc coating shall be by hot dipped galvanizing and shall comply with ASTM-B 17 salt spray test standards and Federal Test Standard No. 14.
3. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
4. Isolator types are scheduled to establish minimum standards. At Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic and wind restraint features must not degrade the isolation performance of the isolators.
5. All static deflections stated are not "minimal" or "rated" deflections but are the minimum acceptable deflection for the mounts under actual load as certified by the manufacturer. Isolators selected solely on the basis of rated deflections are not acceptable and will be rejected.
6. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of compressed height of spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1/1. All mounts shall have leveling bolts.
7. All elastomeric isolation elements shall be fabricated of neoprene or high-quality synthetic rubber with anti-ozone and antioxidant additives and shall be cured to eliminate curing outgassing. The formulation shall have a shore hardness of 30 to 60 $\pm$5, after minimum aging of 20 days or corresponding oven-aging. Elements used in restraints shall be bridge-bearing quality.

C. Pads:

1. Type NP (Neoprene Pad – ASHRAE Type 1):

    a. One layer of ¼-inch- to 3/8-inch- thick ribbed or waffle-pattern neoprene. Pads sized so that they will be applied within manufacturer's supplied application Engineering data.

D. Spring Isolators, Type FSN (Floor-Spring-Neoprene): Freestanding, laterally stable, combination coil-spring and elastomeric isolator with spring and insert in compression (ASHRAE Type 3).

1. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
2. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not mounted on a housekeeping pad and may be zinc- grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
3. If isolator is to be fastened to the building structure and a Type NP isolator is used under the bearing plate, provide grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
9. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators, Type FSNTL (Floor-Spring-Neoprene, Travel Limited): Freestanding, laterally stable, combination coil-spring and elastomeric-insert isolator with seismic or limit-stop restraint (ASHRAE Type 4).

1. All mounts shall have leveling bolts and vertical travel limit stops to control extension when weight is removed. Travel limit stops shall be capable of serving as blocking during erection of equipment. Maintain a maximum clearance of 1/4 inch around restraining bolts and between limit stops and spring to avoid interference with spring action.
2. Either set spring element in isolator in a neoprene cup with a steel washer to distribute load evenly over the neoprene or mount each isolator on a Type NP isolator. If the NP isolator is used, provide a rectangular bearing plate of appropriate size to load pad uniformly within the manufacturer's recommended range.
3. If basic spring isolator has a neoprene friction pad on its base and an NP isolator is to be added to the base, a separator plate shall be used between the friction pad and the NP isolator. Separator plate shall be stainless steel or aluminum for isolator installed outdoors and for indoor isolator not mounted on a housekeeping pad and may be zinc- grip galvanized steel for indoor isolator mounted on a housekeeping pad. The NP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
4. If isolator is to be fastened to building structure and a Type NP isolator is used under the bearing plate, provide neoprene grommets for each bolt hole in base plate. Bolts and washers are to be galvanized for galvanized plate, stainless steel elsewhere.
5. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
6. Restraint: Seismic and wind or limit stop shall comply with site specific design parameters as defined by applicable code.
7. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
8. Minimum Additional Travel: 50 percent of the required deflection at rated load.
9. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
10. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Housed Spring Mounts Type FSNTL-SR (Combination Floor Spring and Neoprene Travel Limited Isolation and Seismic and Wind Restraint): Housed spring isolator with integral seismic and wind snubbers.

1. Same as Type FSNTL. In addition, unit tested and rated as a seismic and wind
2. restraint and shall incorporate snubbing restraint in all directions.
3. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
4. Base: Factory drilled for bolting to structure.
5. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

G. Elastomeric Hangers Type HN (Hanger-Neoprene): Single or double-deflection type compression hanger (ASHRAE Type 2).

1. General: Fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Provide neoprene neck bushing where hanger rod passes through the hanger housing to prevent rod from contacting hanger housing. Make diameter of hole in housing sufficient to permit hanger rod to swing through a 30° arc before contacting hanger housing.

H. Spring Hangers Type HSN (Hanger Spring Neoprene): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression (ASHRAE Type 3).

1. General: Vibration isolation hangers consist of a freestanding, laterally stable steel spring and a neoprene element in series, contained within a steel housing. Make spring diameters and hanger housing lower hole sized large enough to permit hanger rod to swing through a 30° arc before contacting housing or make equivalent alternative provisions to allow specified movement.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene with a 0.3 inch minimum static deflection. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

I. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

K. Resilient Penetration Sleeve/Seal: Field fabricate from pipe or sheet metal section 1/2 inch to 3/4 inch larger in each dimension than penetrating element in all directions around the element. Use to provide a sleeve through construction penetrated. Extend sleeve 1 inch beyond penetrated construction on each side. Pack annular space between sleeve and the penetrating element tightly with glass fiber or mineral wool to within 1/4 inch of ends of sleeve. Fill remaining 1/4 inch space on each side with acoustical sealant to form an airtight seal. Penetrating element shall be able to pass through sleeve without contacting sleeve. Alternatively, prefabricated sleeves accomplishing same result are acceptable.

L. Grommets: Apply a formed grommet to prevent bolts from directly contacting the isolator base plate and sized so that they will be loaded within the manufacturer's recommended load range.

2.2 VIBRATION ISOLATION ROOF CURB (Type BC-1)

A. Acceptable Manufacturers:

1. Kinetics Noise Control
2. Mason Industries

B. General Requirements for Vibration Isolation Roof Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support equipment and withstand site specific wind forces. Prefabricated assembly consisting of steel frame and steel spring isolation system that forms the roof curb under isolated equipment.

C. Spring Isolators: Adjustable, restrained spring isolators (Type FSNTL) shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof. Select and position spring isolators along curb to achieve the required minimum constant static deflection around entire periphery of the base. Adjust springs and limit stops to limit movement of equipment under wind load to 1/4-inch.

D. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building structure. Details of anchoring requirements shall be provided by the Curb supplier.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials. Weather protect each spring isolator.

F. Pitched Roof: Fabricate roof curb with tapered bottom designed to match roof slope where required whether or not indicated on drawings.

G. Connections: All wiring and duct connections made within perimeter of roof curb.

2.3 NON-RESTRAINED, NON-ISOLATED ROOF CURB (Type BC-4)

A. Acceptable Manufacturers:

1. Roof curb manufacturer shall be the responsibility of the roof-mounted equipment manufacturer.

B. General: Requirements for Non-Restrained Non- Isolated Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to support equipment and to withstand wind forces.

C. Lower Support Assembly: Formed sheet-metal section that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building structure. Details of anchoring requirements shall be provided by the Curb supplier.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials. Weather protect each spring isolator.

F. Pitched Roof: Fabricate roof curb with tapered bottom designed to match roof slope where required whether or not indicated on drawings.

G. Connections: All wiring and duct connections made within perimeter of roof curb.

2.4 VIBRATION ISOLATION ROOF RAIL (Type RIRS)

A. Acceptable Manufacturers:

1. Mason Industries
2. Kinetics Noise Control

B. General: Prefabricated assembly consisting of continuous equipment support piers and steel spring isolation system that forms the support under isolated equipment.

C. Spring Isolators: Adjustable, restrained spring isolators (Type FSNTL-SR) shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

D. Support Piers: Construct equipment support pier of galvanized steel or plaster coated steel, straight base section without cant strip and with integral base place, all welded construction, internal reinforcement, treated wood nailer. Provide clearance above roof surface as per requirements by the National Association of Roofers recommendation for maintenance and re- roofing.

2.5 VIBRATION ISOLATION EQUIPMENT BASES

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries

B. Inertia Base, Type BIB (Base Inertia Base): Factory-fabricated, welded, structural steel bases and rails ready for placement of cast-in-place concrete (ASHRAE Type C).

1. General: Form base of stone-aggregate concrete cast into steel pouring form with appropriate reinforcement. Build inertia base to form a rigid base which will not twist, rack, deform, deflect or crack in any manner which will adversely affect operation of supported equipment or vibration isolation mounts. Size inertia base adequately to support basic equipment unit and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements or other

components closely related and requiring resilient support in order to prevent vibration transfer to building structure. Base depth at least 1/12 the longest dimension of inertia base, and not less than 6 inches or more than 12 inches. Base footprint shall be large enough to provide stability for supported equipment. Steel frame and reinforcement pouring form with full bottom pan to be supplied by vibration isolator manufacturer. Concrete to be placed in the field and appropriately cured before installation of equipment.

2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support. Include side mounting brackets for attachment to vibration isolators. Locate mounting brackets on the sides of the base that are parallel to the axis of rotation of the supported requirement.
5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
6. Inertia base equipment mass to inertia mass ratio shall be a minimum of 1/1.

2.6 SEISMIC AND WIND RESTRAINT DEVICES

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries
4. TOLCO Incorporated; a brand of NIBCO, INC.

B. General Requirements for Restraint Components:

1. Restraints shall be capable of safely accepting external forces specified in the DESIGN REQUIREMENTS article in Part I of this section, without failure, shall maintain mechanical systems, and accessories in a captive position, and shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.
2. EXCEPT FOR TYPE I RESTRAINT, systems that incorporate vibration isolation support within seismic and wind restraint housing are not permitted – seismic and wind restraints must be separate from isolation mounts.
3. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic and wind forces to which they will be subjected.

C. Type I Restraint: Type FSNTL-SR, Type FN-SR.

D. Type II Restraint

1. All directional, double acting seismic and wind restraint snubber consisting of interlocking steel members restrained by shock absorbent elastomeric material compounded to bridge bearing

specifications as indicated elsewhere in this section. Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

2. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Elastomeric bushing shall be replaceable and a minimum of 1/4-inch- thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8-inch or more than 1/4-inch.
5. The snubber shall be constructed to allow easy inspection of snubber internal clearances.

E. Type III Restraint

1. Cable type system consisting of ASTM A603 galvanized pre-stretched aircraft type steel cable designed for a minimum safety factor of 2, and end fastening devices, arranged to provide all-directional restraint. End fastening devices, steel assemblies with thimbles, brackets, swivel and bolts designed to swivel and clamp cable with 2 clamping bolts. All parts of system including cables and clamps, but excluding fastenings, to be furnished by a single vendor to assure seismic compliance.
2. The cable size and attachment to the restrained item and structure shall be designed and signed by a licensed engineer.
3. Submittal drawing shall indicate method of vertical restraint.

F. Type IV Restraint: Non-isolated equipment to be positively attached to structure (powder shots not acceptable) to resist seismic and wind forces.

G. Type V Restraint: Seismic and wind solid brace consisting of steel angles or channels to restrain seismic and wind loads with a minimum safety factor of 2 and arranged to provide all direction (compression, tension and torsion) restraint. Solid brace end connectors shall be assemblies that swivel to the final installation and utilize minimum 2 bolts to provide proper attachment to structure. Provide corrosion resistant coating on all applied hardware.

H. Hanger Rod Stiffener: Hanger rods shall be reinforced to restrain site specific uplift seismic forces.

I. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

J. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

L. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Anchor bolts shall be seismic and wind rated and selected to anchor equipment to building structure. Minimum length of eight times diameter.

M. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior

applications. Anchor bolts shall be seismic and wind rated and selected to anchor equipment to building structure. Minimum length of eight times diameter.

2.7 VIBRATION ISOLATION THRUST RESTRAINTS (ASHRAE Type 5)

A. Acceptable Manufacturers:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Mason Industries

B. Consists of a spring element in series with a neoprene pad. Design unit to have the same deflection due to thrust-generated loads as specified for isolators supporting equipment. Contain and design the spring element within a steel frame so it can be pre-compressed at the factory to allow for a maximum of 1/4-inch movement during starting or stopping of equipment. Allowable movement shall be field adjustable.

C. Furnish assembly complete with rods and angle brackets for attachment to both equipment and adjacent fixed structural anchor. Oversize holes in the spring restraint brackets through which the restraint rods pass to prevent contact between the brackets and rods.

D. Impact bumper type thrust restraint is not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after non-conforming code compliance conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Provide vibration isolators of appropriate sizes and proper loading to meet specified deflection requirements. Select in accordance with the weight distribution to provide uniform isolator load distribution.

B. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet requirements stated herein, even if not expressly specified or shown on Drawings, without claim for additional payment.

C. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

D. Should any rotating equipment cause excessive noise or vibration when properly installed on the vibration isolators, and if it is caused by isolator, then the isolation manufacturer shall be responsible for rebalancing, realignment or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for unit in question.

E. Make certain that seismic and wind restraints do not short circuit the isolation system and that isolation system is unrestrained. Special attention shall be applied in the installation of restraints on thermally active piping systems as this condition can shorten out vibration isolation devices and impose excessive stress on the structural components.

F. Adjust isolators after piping system is at operating weight.

G. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

H. Adjust active height of spring isolators.

I. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.3 SEISMIC AND WIND RESTRAINT, APPLICATION

A. General

1. Seismically restrain all specified work in all directions.
2. Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

B. Equipment

1. Isolated Equipment

a. Suspended Isolated Equipment: Provide four-point Type III restraints, up-stop snubbers for vibration isolators and suspension rod stiffener angles or pipe sleeves as required for the following equipment:

1) Fans
2) Air Handling Units
3) Tanks
4) Unit Heaters
5) Fan Coil Units
6) Heat Exchangers

b. Curb-Mounted Rooftop Air Handling Unit: Provide base curb Type BC-2 for all curb-mounted rooftop air handling units not internally isolated.

c. Other Isolated Equipment: Mount equipment on rigid steel frame unless the equipment manufacturer certifies direct attachment capability. Provide a minimum of four Type I or Type II Restraints. Locate Type II restraints as close to the vibration isolator as possible to facilitate attachment to the base and the structure. At option of Contractor, provide Unit RIRS where applicable.

2. Rigidly Mounted Non-Isolated Equipment

a. Provide four-point Type III or Type V restraints for overhead suspended equipment. For other equipment, provide Type IV restraints using properly sized anchor bolts.

3. Internally Isolated Equipment

a. Manufacturer and supplier of seismic and wind restraints assumes responsibility of meeting seismic requirements and must submit in writing, certification that equipment meets all applicable codes and site specific seismic and wind restraint design requirements, signed and stamped by a registered engineer in the state where the project is located.

4. Supplementary Restraints, Isolated and Non-isolated Equipment

a. Where base anchoring for heavy equipment and for high center of gravity equipment is insufficient to resist seismic anchoring forces, provide four-point Type III restraints, connected above center of gravity, as required to suitably restrain the seismic overturn anchoring forces. The need for such additional restraints shall be determined by the isolation manufacturer.

5. Diffusers, registers and grilles installed in ceilings must meet seismic requirements of ceiling by using earthquake clips secured to T-bar structure or 4-point Type III restraint.
6. Air volume control boxes rigidly connected to ductwork and with a Seismic Design Category Component Importance Factor of Ip=1.0 is exempt from seismic restraint. Air volume control boxes with an Ip=1.5 and weighing more than 26 pounds shall be provided with 4-point Type III restraints.
7. Fans, heat exchangers, humidifiers, and other suspended equipment in ductwork greater than 75 pounds must be independently restrained.

C. Unrestrained Ceiling Systems

1. Connections to all equipment, devices, fixtures, grilles, registers, diffusers, and other appurtenances mounted in the ceilings shall be flexible so that they do not restrict the movement of the unrestrained ceilings. The ceilings must be “free-floating”, and the flexible connections must allow for a minimum free movement of the ceiling system of 3/8 inch in all directions.
2. Allow for ceiling movement at rigid penetrations through ceiling tiles such as ductwork and piping by providing an oversized opening in the ceiling tile. Provide suitable escutcheons or closure details to cover gaps from view.
3. Each individual device shall be independently supported from building structure in accordance with the applicable code.

D. Piping and Ductwork

1. Piping restraints shall comply with requirements in MSS SP-127.
2. Provide Type III restraints for isolated piping in mechanical rooms. Type III or Type V seismic restraints for non-isolated piping. All other piping 2-1/2 inch diameter and larger, provide Type III restraints for isolated piping and Type III or Type V restraints for non-isolated piping. Provide up-stop snubbers for vibration isolators and suspension rod stiffeners as required.
3. Transverse bracing on runs of piping not to exceed a spacing of 10 feet on no-hub piping; transverse bracing on runs of other piping up to size 16 inches not to exceed 40 feet; piping 18 inch to 28 inch not to exceed 30 feet, piping 30 inch to 40 inch not to exceed 20 feet; at all changes in direction of more than 4 feet.

4. Longitudinal bracing at 20 feet intervals on no-hub piping; longitudinal bracing of other piping at intervals of 80 feet on piping size up to 16 inches, 60 feet on piping size 18 inch to 40 inch.
5. Bracing distances for multiple pipe runs on the same support must be calculated by isolation manufacturer.
6. Hold-down clamps must be used to attach pipe to all trapeze hangers prior to installing restraint. Clamps or restraints must not impede thermal expansion or contraction of piping system.
7. Branch piping is not an acceptable means for restraining main piping.
8. Provide Type III or Type V seismic restraints for rectangular ductwork with cross sectional area of 6 square feet or larger, and for round ductwork 28 inches and larger.
9. Transverse bracing on runs of ductwork not to exceed 30 feet; longitudinal bracing at 60-foot intervals; provide bracing at all changes in direction of more than 4 feet.
10. Provide additional duct reinforcement consisting of steel angle on top of ductwork attached to hanger at restraint locations. Ductwork is to be attached to both upper angle and lower trapeze.
11. All high hazard and life safety systems regardless of size such as fuel oil or gas shall be seismically restrained. Provide Type III restraints for isolated piping and Type III or Type V restraints for non-isolated piping.

E. Electrical Equipment and Conduit: Restrain electrical equipment and conduit provided under Division 23 as specified for mechanical equipment and piping.

F. Chimney, Chimney Connector, Stack, Smoke Vent, Breeching, Emergency Generator Engine Exhaust

1. Restrain horizontal runs as specified above for ductwork and piping.
2. Restrain vertical risers by bolting at base and, if required, by bolting at each floor level or by riser clamps above and below each floor level. Riser restraint shall not limit thermal piping activity.

G. Tanks and Vessels: Seismic restraints for tanks and vessels storing liquids, gases and granular solids shall be designed in accordance with referenced codes within this section.

H. Exclusions to Seismic Restraints

1. Only systems or components specifically indicated herein are not required to be seismically restrained. High hazard systems and life safety support systems cannot be excluded in any circumstance.

    a. Air handling ductwork less than 6 square feet cross sectional area with $I_p = 1.0$.
    b. Ductwork with $I_p = 1.0$ suspended by hangers 12 inches or less in length from the top of the duct to the supporting structure. Entire duct run must meet length requirement, any portion of duct suspended greater than 12 inches will require the entire duct run to be seismically restrained.
    c. Clevis supported piping or conduit suspended 12 inches or less in length from the top of pipe to the supporting structure. All hangers must meet length requirement, any portion of pipe run suspended greater than 12 inches will require the entire pipe run to be seismically restrained.
    d. Ductile piping in seismic design categories D, E and F designated as having an $I_p = 1.5$ and a nominal pipe size of 1 inch or smaller when protected from impact of larger piping or mechanical equipment.
    e. Ductile piping in seismic design category C designated as having an $I_p = 1.5$ and a nominal pipe size of 2 inches or smaller when protected from impact of larger piping or mechanical equipment.

f. Ductile piping in seismic design categories D, E and F designated as having an $I_p = 1.0$ and a nominal pipe size of 3 inches or less.
g. Ductile piping in seismic design categories A, B or C designated as having an $I_p = 1.0$ and a nominal pipe size of 6 inches or less.
h. Curb mounted exhaust fans and hoods with curb area less than 9 square feet.

3.4 SEISMIC RESTRAINTS, INSTALLATION

A. General

1. Install restraints in strict accordance with applicable site specific seismic and wind codes and design parameters and the isolation manufacturer's written instructions. Whenever a conflict occurs, the most stringent shall apply.
2. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.
3. Positively attach restraints to the building structure and to the equipment, piping, and ductwork in accordance with the reviewed submittal data.
4. Install seismic and wind snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and anchor equipment to base and building structure.
5. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

B. Equipment Restraints

1. Construct housekeeping pads in accordance with site specific design parameters for anchoring the equipment to the concrete pad with proper edge distances.
2. Restraints shall not interfere with the performance of the vibration isolation system and shall not restrict normal vibratory movement of equipment, piping or ductwork during normal operation, startup or stopping. Install carefully and adjust carefully after system startup and with equipment in operation to ensure that proper clearances are maintained.

C. Where restraints are attached to clevis hangers, provide cross bolt reinforcement.

D. Shim or grout snubbers as required to achieve and maintain clearance.

E. Anchor restraints to building structure by field bolting or welding. Overstress of the building structure must not occur. Do not support overhead supported equipment from slab diaphragms between beams unless specifically approved. Restraint anchoring is allowed to the following building structures:

1. Flanges of structural steel beams
2. Cast-in-place inserts or drilled in mechanical type anchor, Hilti or equal, in concrete. Shot pins and adhesive type anchors are not allowed.

F. Install Type III restraints with slack as required, 1/2 inch maximum, to prevent excessive seismic motion for vibration isolated systems and equipment and to allow for thermal movement where applicable. Install Type III restraints taut elsewhere. Provide two sided, seismically rated, beam clamps when securing to steel structural members.

G. Contractor shall notify special inspection agency/engineering consultant 48 hours in advance of work being completed for required special inspections. Contractor shall cooperate with and shall provide free access to work for the special inspection agency/engineering consultant.

H. Deliver equipment roof curbs and/or rails to Roofing Contractor for installation.

I. Roof Curbs or Rails: Install in accordance with detail on Architectural Drawings. Bolt to concrete using cast-in-place inserts or drilled in adhesive type anchor (shot pins are not allowed.

3.5 VIBRATION ISOLATION, APPLICATION

A. General

1. The static deflections of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment

1. Unless otherwise shown or specified, set all floor mounted major equipment on 4 inch- high housekeeping type concrete pad properly doweled or bolted to floor to meet site specific anchoring forces. Size pad to extend far enough beyond restraint to develop full rating of restraint in accordance with isolation manufacturer's instructions.
2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as specified in the “Design Requirements” article in Part 1 of this section.
3. Provide thrust restraints on equipment as called for in the schedule or as specified or as required whether or not scheduled or specified to limit movement to 1/4 inch maximum. As a minimum, provide thrust restraints for all suspended fans, all suspended or floor mounted axial flow fans and for other floor mounted fans developing 4 inches or more static pressure, unless the horizontal component of the thrust force can be demonstrated to be less than 10% of the equipment weight. Install thrust restraints on the discharge of the fan so that the restraint rods are in tension. Assemblies that place the rods in compression are not acceptable.

C. Miscellaneous Mechanical Equipment

1. Isolate the following miscellaneous pieces of mechanical equipment which are connected to isolated piping systems from the building structure:

    a. Heat Exchangers
    b. Storage Tanks
    c. Condensate Receiver Tanks
    d. Expansion or Compression Tanks

2. Isolate miscellaneous mechanical equipment listed with Type NP or Type HN isolators, selected for 0.1 inch static deflection unless their position in piping system requires a higher degree of isolation as called for under piping isolation.

D. Pipe Isolation

1. All chilled water, hot water, refrigerant, and drain piping shall be isolated from the building structure within the following limits:

a. Within mechanical rooms.
b. Within 50 feet total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, etc.).
c. All the above piping that is 6 inches or larger shall be isolated everywhere.

2. Piping shall be isolated from building structure by means of vibration isolation, resilient lateral supports and, except at penetration through fire-rated construction, resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall have the same deflection as used on the connected equipment isolation. When the required static deflection of these isolators is greater than 1/2 inch, Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2 inch, Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving not less than 1/4 inch static deflection.
4. Where lateral support of pipe risers is required within the specified areas, use resilient lateral support.
5. Isolate pipes within the specified areas that penetrate nonfire-rated building construction from the building structure by use of resilient penetrating sleeve/seals.
6. Check that drain piping connected to vibration isolated equipment does not contact the building structure or other nonisolated system unless it is resiliently mounted as described above.

3.6 VIBRATION ISOLATION, INSTALLATION

A. General

1. Select locations of all vibration isolation equipment for ease of inspection and adjustments, as well as for proper operation.
2. Install vibration isolation equipment in accordance with isolation manufacturer’s written instructions.
3. Prior to startup, verify that there are no isolation short circuits.
4. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Isolators

1. Align all vibration isolators squarely above or below mounting points of supported equipment.
2. Locate isolators for equipment with bases on the side of the bases which are parallel to equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein or shown on the drawings.
4. If a housekeeping pad is provided, isolators and the isolator base plate must rest entirely on pad.
5. For steel framed structures, connect hanger rods for vibration isolated support to structural beams or joists, not to floor slab between beams and joists. Provide intermediate support members and joist reinforcing members as necessary.
6. Position vibration isolation hanger elements as high as possible in hanger rod assembly, but not in contact with building structure, so that hanger housing may rotate a full 360^{o} about rod axis without contacting any object.

7. Parallel running pipes may be hung together on a trapeze which is isolated from building. Deflections must be largest determined by provisions for pipe isolation. Do not hang isolated and non-isolated pipes on same trapeze.
8. Do not support pipes, ducts or equipment from other pipes or equipment.
9. Resiliently isolated pipes shall not contact building construction or other equipment.
10. The installed and operating heights of isolated equipment mounted on Type FSNTL isolators or Type BC-1 bases shall be the same. Limit stops shall be out of contact during normal operation. Adjust isolators to provide ¼-inch clearance between limit stop brackets and isolator top plate, and between travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so isolated equipment is level and in proper alignment with connecting ducts or pipes. Leveling bolts shall not be used to level equipment if unevenness exceeds 1/8 inch as measured by the longest dimension of the equipment base. If leveling of equipment requirements are greater than 1/8 inch, grouting of the base shall be used in order to achieve a level equipment mounting platform.

C. Bases

1. Equipment shall not bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by equipment manufacturer. This provision applies whether or not a base frame is called for on the schedule. In the case that a base frame is required for equipment because of equipment manufacturer's requirements and a base frame for the equipment is not specifically called for on equipment schedule, Contractor for DIVISION 23 shall provide the base frame recommended by equipment manufacturer at no additional expense.
2. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch between steel rails, steel frame bases or inertia bases and the concrete housekeeping pad or floor beneath the equipment. Position isolator mounting brackets, so that required clearance is maintained. Check and clean clearance space to ensure that no construction debris has been left to short-circuit or restrict proper operation of vibration isolation system.

D. Vibration Isolation Thrust Restraints: Attach thrust restraints at the vertical centerline of thrust on each side of the unit, and so that thrust rods are in tension only. Install the two rods of the thrust restraint parallel to the thrust force. This may require modified brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Adjust restraints to constrain equipment movement to the specified limit.

E. Resilient Penetration Sleeve/Seals: Install penetration seals to maintain an airtight seal around penetrating element and to prevent rigid contact of penetrating element and building construction. Fit sleeve tightly to building construction and seal airtight on both sides of construction penetrated with acoustical sealant.

F. Grommets: Where grommets are required at hold-down bolts of isolators, properly size bolt holes to allow for grommets. The hold-down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized for galvanized isolators and stainless steel elsewhere.

3.7 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install seismically rated flexible connections in piping where they cross building seismic expansion joints, where adjacent sections or branches are supported by different structural elements, and where

the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping Systems" for piping flexible connections.

3.8 FIELD QUALITY CONTROL

A. Upon completion of installation of all vibration isolation devices, the isolation manufacturer's representative shall inspect the installation and certify in writing to the Contractor that all isolation devices are installed in compliance with the written quality assurance document as furnished by the isolation manufacturer.

B. All independent Special and Periodic Inspections must be performed and submitted on components as outlined in Part 1 of this Section.

3.9 HVAC VIBRATION-ISOLATION DEVICE SCHEDULE

VIBRATION ISOLATION SCHEDULE				
Equipment	Base Type	Isolator		Remarks
		Type	Defl. (In)	
Rooftop Air Handling Unit	BC-1	FSNTL-SR	1.50	
Chiller, Outdoor Grade Mounted	-	NP	0.25	
Boilers	-	NP	0.25	
Base Mounted Pumps (Up to 15 Hp) (Chilled Water and Hot Water Pumps)	BIB	FSNTL-SR	0.75	
Base Mounted Pumps (>15 Hp)	BIB	FSNTL-SR	1.50	
Condensing Unit (Outdoor)	RIRS	FSNTL-SR	1.5	
Fan Coil Unit, Suspended	-	HSN	0.75	
Unit Heater, Suspended	-	HN	0.25	
Curb Mounted Fans (Non-Isolated)	BC-4	-	-	

(1) Computer Room A/C Unit shall be welded or bolted to welded structural steel stands.

END OF SECTION 23 05 48

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. HVAC Piping Insulation
2. HVAC Duct Insulation
3. HVAC Equipment Insulation
4. Adhesives, mastics, tapes

B. Related Sections

1. Pipe insulation insert and shields are specified in Section 23 05 00, “Common Materials and Methods for HVAC”.

1.3 DEFINITIONS

A. Cold Surfaces: Normal operating temperatures less than 75^{o} F.

B. Density: Is expressed in pcf (pounds/cu. ft.).

C. Dual Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

D. Hot Surfaces: Normal operating temperatures of 100^{o} F or higher.

E. Thermal Conductivity ("k" value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of (Btu x inch)/(h x sq. ft. x ^{o} F).

F. Through Resistivity ("R" value): Represents the reciprocal of thermal conductivity ("k" value).

1.4 REFERENCES

A. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

B. ASTM E84 Surface Burning Characteristics of Building Materials.

C. MICA Standards: National Commercial & Industrial Insulation Standards published by the Midwest Insulation Contractors Association. Endorsed by National Insulation Contractors Association (NICA) and its regional associations.

D. NFPA 90A Installation of Air Conditioning and Ventilating Systems.

E. NFPA 255 Test of Surface Burning Characteristics of Building Materials.

F. UL 723 Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, as applicable).

B. Product Schedule or List: Prepare a summary of products required and clearly indicate location of their intended use.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.

1.6 QUALITY ASSURANCE

A. Materials, job conditions and installation shall be in compliance with the applicable Building and Mechanical Codes and NFPA 90A.

B. Installation shall be done in a workmanlike manner by skilled and experienced workers who are regularly employed in commercial/industrial insulation work, in accordance with manufacturer's recommendations and instructions and best practices of the trade.

C. Comply with the more stringent of the requirements of this specification or the requirements of the MICA standards.

D. Insulation materials manufacturing facilities must be certified and registered with an approved registrar for conformance with ISO 9000 quality standard.

E. Fire Performance Characteristics

1. Insulation, jacketing materials, PVC covers, tapes, adhesives, mastics, cements and finish coatings shall have a composite noncombustible fire and smoke hazard rating and label, as tested in accordance with United States Public Health Service requirements, ASTM E84, NFPA 255 and UL 723 not exceeding Flame Spread 25 and Smoke Developed 50.
2. Indoor Recovering Canvas Jackets: UL listed fabric, 6 ounce per square yard, unless otherwise specified, attached with a lagging fire retardant and waterproof adhesive.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Deliver materials to job site in original unbroken factory packaging, labeled with manufacturer's density and thickness and store in a safe, dry place.

B. No insulation material shall be installed that has become damaged in any way.

C. Do not install, and remove from the site, any insulation material that has become wet because of transit or job site exposure to moisture or water. Remove insulation from ductwork, piping and/or equipment which has become wet. Reinsulate as required.

1.8 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Common Materials and Methods for HVAC."

B. Coordinate clearance requirements with installing contractor for insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing of piping and duct systems. Insulation application may begin on segments that have satisfactory test results.

B. Schedule insulation application on chilled water piping prior to circulating chilled water and schedule application on supply air ductwork prior to delivering conditioned air. Do not install insulation to surfaces where condensation is present.

C. Do not install any insulation before building is adequately closed in. Where it is necessary to install insulation in any section of building that is not adequately closed in, secure prior permission and, where permission is granted, such insulation shall be in place to form a waterproof covering. Remove and replace all insulation installed that becomes water saturated because of failure to comply with this requirement, at no increase in the Contract sum.

1.10 ALTERNATIVES

A. Alternative insulations are subject to Architect's approval. Alternatives shall provide, at normal conditions, thermal resistance within 5% of resistance of materials specified.

B. Where alternative thermal conductivity ("k") differs from specified thermal conductivity by more than 5%, increase or decrease insulation thickness as follows:

$$\text{New Thickness} = \frac{\text{Actual "k"}}{\text{Specified "k"}} \times \text{Specified Thickness}$$

PART 2 - PRODUCTS

2.1 PIPING INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armacell
3. Owens-Corning Fiberglass
4. Knauf Insulation
5. Certain Teed

B. Insulation Type P1:

1. Piping: Fine fibrous glass insulation, with factory applied vapor barrier jacket, molded to conform to piping, "k" value at 75° F maximum 0.23. Johns Manville "Micro-Lok AP-T Plus" with jacket of white Kraft reinforced with fiberglass yarn and bonded to aluminum foil, and having a pressure sensitive tape closure system bonded to the longitudinal lap.
2. Valves and Fittings:

    a. Glass fiber insert of equal thickness to adjacent pipe insulation and premolded PVC cover, Johns Manville "Zeston" and "Hi-Lo Temp Inserts" for valves and fittings.
    b. Factory molded fibrous glass fitting covering for fittings of equal thickness to adjacent pipe insulation. Cover with 6-ounce canvas on concealed piping and 8-ounce canvas on exposed piping.
    c. Mitered sections of pipe covering for valves.

C. Insulation Type P2:

1. Piping: Type P1 with additional aluminum jacket of Alloy No. 5005 or No. 3003 with minimum thickness of 0.016 inches. Johns Manville "Micro-Lok ML".
2. Valves and Fittings: Mitered sections of Type P2 piping insulation with miter seals and snap-straps.

D. Insulation Type P3:

1. Piping: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum water vapor transmission rating of 0.05 perms. Insulation shall not drip or melt when exposed to flame. Polyethylene or polyolefin not allowed. Armacell "AP Armaflex", "AP Armaflex SS" and "AP Armacell W" (maximum 0.2 perms). Exposed insulation shall be white.
2. Valves and Fitting: Mitered sections of Type P3 insulation. Factory produced or field fabricated.

2.2 EQUIPMENT INSULATION

A. Acceptable Manufacturers

1. Johns Manville
2. Armacell
3. Owens Corning
4. Knauf

B. Insulation Type E1 - Cold Equipment: Rigid fibrous glass insulation, density approximately 4.25 pcf, with factory applied reinforced aluminum foil vapor barrier, "k" value at 75° F maximum 0.23. Johns Manville "815 Spin- Glas" with FSK jacket.

C. Insulation Type E2 - Hot Equipment Up to 350° F: Rigid fibrous glass insulation, density approximately 6 pcf, with factory applied reinforced aluminum foil vapor barrier, "k" value at 75° F maximum 0.23. Johns Manville "817 Spin-Glas" with FSK jacket.

D. Insulation Type E3L - (and E3H) Hot Equipment Up to 1200° F: Asbestos free hydrous calcium silicate, "k" value at 200° F and 500° F maximum 0.42 and 0.50 respectively. Johns Manville "Thermo-12 Gold". Flat, pipe, scored block or radius shape to suit equipment shape.

E. Insulation Type E4 – Cold Equipment: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum vapor transmission rating of 0.05 perms. Armacell "AP Armaflex Sheet Roll" and "AP Armaflex SA Sheet".

2.3 DUCTWORK INSULATION

A. Acceptable Manufacturers:

1. Johns Manville
2. Armacell
3. Owens Corning
4. Knauf
5. Certain Teed

B. Insulation Type D1: Semirigid fibrous glass ductwork and casing insulation, density approximately 4 pcf with factory applied reinforced aluminum foil vapor barrier, "k" value at 75° F maximum 0.23. Johns Manville "815 Spin-Glas" with FSK jacket.

C. Insulation Type D2: Flexible fibrous glass ductwork insulation with factory applied reinforced aluminum foil vapor barrier, density approximately 0.60 to 0.75 pcf, "k" value at 75° F maximum 0.31 Johns Manville "Microlite" with Type FSK jacket.

D. Insulation Type D3: Foamed plastic of closed cell structure, "k" value at 75° F maximum 0.25. Maximum vapor transmission rating of 0.05 perms. Armstrong "AP Armaflex" and "AP Armaflex SA".

E. Insulation Type D4: Ductwork Up to 1200° F. Asbestos free hydrous calcium silicate, "k" value at 200° F and 500° F maximum 0.42 and 0.50 respectively. Johns Manville "Thermo-12 Gold". Flat, pipe, scored block or radius shape to suit duct shape.

PART 3 - EXECUTION

3.1 PREPARATION

A. Determine clearances required for installation of work and review such requirements with trades responsible for installing various piping systems, ducts and equipment to be insulated. Where it is determined that working clearances between equipment and material to be insulated and adjacent work will restrict or prohibit proper installation of work, immediately report such conditions to all interested parties and arrange to have affected material relocated or preinsulated before erection, as approved. Failure to so comply will not relieve Contractor of full responsibility for providing specified insulation.

B. Do not install covering before piping, ductwork and equipment has been tested and approved, or before ductwork has been sealed.

C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with applicable requirements of Division 23 Section, “Common Materials and Methods for HVAC”.

B. Adhesives and mastics materials shall be compatible with insulation material, jackets and substrates. Apply insulation and adhesives in accordance with manufacturers' instructions.

C. Clean excess adhesive, mastic or cement used in performance of work from all exposed surfaces of insulation jacketing materials. Clean smudges and dirt from all exposed surfaces of insulation jacketing materials at conclusion of this work.

D. Apply insulation on all cold surfaces with a continuous, unbroken vapor seal. Install hangers outside of insulation for all piping subject to sweating (e.g., chilled water supply and return, refrigerant suction, dual temperature water supply and return, drain piping for air conditioning equipment, glycol heat recovery piping, etc.) and provide inserts - refer to and coordinate with Section 23 05 00, Part 3, Article titled "PIPING SYSTEMS – COMMON REQUIREMENTS", paragraph titled "Pipe Insulation Inserts and Shields". For all equipment subject to sweating, insulate and vapor seal hangers, supports, anchors, etc., that are secured directly to cold surfaces to prevent condensation.

E. Extend all surface finishes to protect all surfaces, ends and raw edges of insulation.

F. Install insulation on and at access doors to allow easy use of access door without damage to insulation.

G. Finish insulation neatly at hangers, supports and other protrusions.

H. Install insulation with least number of joints practical. Locate insulation, or cover seams, in least visible locations.

I. Finish installation with systems at operating conditions. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

J. Be responsible for proper curing of insulation, etc., in accordance with manufacturers' requirements.

3.3 PENETRATIONS

A. Refer to Division 23 Section “Common Materials and Methods for HVAC” for additional requirements.

B. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

C. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

D. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

E. Insulation Installation at Non-Rated Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.

F. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07. Coordinate requirements for sleeves and clearance between finished surface of penetrating item and penetrated construction to achieve proper installation of through-penetration fire-stop system.

G. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Carry pipe insulation through sleeves and through hangers which are specified to be installed outside insulation.

C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
9. Insulate flexible connections and expansion joints on cold piping with removable insulation section. Install insulation on flanges, valves and unions so that it can be removed and replaced without damaging adjacent insulation.

D. Terminate insulation neatly and finish all exposed ends with plastic material troweled on bevel.

E. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

F. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

G. Insulation Type P1

1. Seal longitudinal laps of jackets and wrap butt joints with 3-inch wide strip of jacketing material securely sealed in place.
2. Where premolded PVC fitting covers are used, apply factory precut insulation insert in accordance with manufacturer's instructions and then apply one piece cover. Use two or more layers of inserts on hot piping as required to limit outer surface temperatures of insert(s) to 150^{o} F maximum. Use two layers of inserts on chilled water and refrigerant piping. On concealed hot piping, covers may be secured with staples. On exposed hot piping, secure covers by taping ends to adjacent insulation. Seal seam edges of covers on concealed and exposed cold piping with Zeston vapor-barrier adhesive and wrap edges of covers with Zeston vapor-barrier pressure sensitive color matching tape.
3. Where factory-molded fibrous glass fitting covering is used, finish insulation on concealed and exposed hot piping with same jacketing material as adjacent insulation lap-sealed and finished with Foster 30-36, Childers CP-50A or equal. Finish insulation on cold piping same as for hot piping except that sealer shall be Foster 30-35 or Childers CP-30LO vapor sealer.
4. Finish valve covering in hot and cold piping systems same as specified above for fittings.
5. Recover exposed piping in finished areas with 0.02 mil thick PVC jacket and less than 8 ft above floor in mechanical room with 0.02 mil thick PVC jacket or aluminum jacket, except use Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, adhered and then finished with Foster 30-36 or Childers CP-50A at steam pressure reducing stations and when piping systems are specified to be painted.

H. Insulation Type P2

1. Secure metal jacket in place by a continuous longitudinal friction type joint. Seal circumferential joints with 2 inch wide, .016 inch aluminum preformed snap-strap and clip containing a permanently plastic weatherproof sealant. Where outside diameter of the insulation is over 12-3/4 inches, lock snap-strap in place using 3/4 inch wide, .015 inch thick, No. 302 stainless steel bands. Apply snap-strap with appropriate banding wrench.
2. Use mitered sections of metal jacketed insulation for valves and fittings. Seal joints with sealing compound and preformed aluminum bands.
3. Entire installation of metal jacketed insulation shall be weatherproof.

I. Insulation Type P3

1. Where possible, slip insulation over tubing as a full cylinder. Push insulation on to pipe. Do not pull insulation on pipe. Where necessary to longitudinally cut, and at all butt joints, tightly butt edges and join by sealing with waterproof vapor barrier adhesive, Armaflex 520. For Self-Seal type, peel adhesive paper from surface and apply firm pressure along entire longitudinal joint.
2. Cover fittings and valves with equivalent thickness of insulation material.
3. Finish outdoor insulation with two coats of manufacturer's recommended weather-resistant and ultraviolet-resistant protective finish: Armacell WB Armaflex, white. DO NOT TINT FINISH.

    a. At Contractor's option (for all outdoor piping), use aluminum jacket, as specified for insulation Type P-2.
    b. Secure metal jacket in place by a continuous longitudinal friction type joint. Seal circumferential joints with 2 inch wide, .016 inch aluminum preformed snap-strap and clip containing a permanently plastic weatherproof sealant. Where outside diameter of the insulation is over 12-3/4 inch, lock snap-strap in place using 3/4 inch wide, .015 inch thick, No. 302 stainless steel bands. Apply snap-strap with appropriate banding wrench.
    c. Use mitered sections of metal jacketed insulation for valves and fittings. Seal joints with sealing compound and preformed aluminum bands.
    d. Entire installation of outdoor piping shall be weatherproof.

3.5 PIPING INSULATION SCHEDULE

Service Temp	Systems Description	Indoor			Outdoor or Unheated Space			
		Type	Pipe Size	Thickness	Type	Pipe Size	Thickness	Heat Trace
40-60F	Chilled Water	P1 or P3	≤ 3/4"	1"	P2 or P3	≤ 3/4"	2"	Yes
			1" to 1 1/2"	1 1/2"		1" to 1 1/2"	2 1/2"	
			≥ 2"	2"		≥ 2"	2 1/2"	
40-60F	Make-up Water	P1	≤ 1 1/2"	1/2"	P2	All	2"	Yes
			≥ 2"	1"				
40-60F			≤ 1 1/4"	1/2"	P3	All	2"	

	Condensate Drain (Cooling Coil, Heat Recovery Coil, Heat Pump)	P1 or P3	≥ 1 1/2"	1"				
140-200F	Heating and Reheat Hot Water	P1	≤ 1"	1 1/2"	P2	All	2 1/2"	Yes
			≥ 1 1/2"	2"				
140-200F	Refrigerant Hot Gas; All Heat Pump Refrigerant Piping	P1	≤ 1 1/2"	1 1/2"	P2	All	2 1/2"	
			≥ 2"	2"				
	Refrigerant Liquid	-	-	-	P3	All	3/4"	
<40F	Refrigerant Suction	P3	≤ 3/4"	1 1/2"	P3	≤ 3/4"	1 1/2"	
			≥ 1"	2"		≥ 1"	2"	
	Chemical Treatment	Same as system served						

Note:
1. Insulation for underground piping systems is specified in Section 23 24 13.
2. Outdoor or Unheated Space insulation thickness shall extend through wall inside the building or heated space minimum of 2 feet.
3. Insulation can be omitted from Condenser Water System located indoors in mechanical rooms and in spaces within buildings that are not humidified only when approved by Architect/Engineer.
4. Where systems are required that don't exactly match the systems description listed on the schedule, provide insulation based on the appropriate service temperature range.

3.6 INSTALLATION, EQUIPMENT

A. Apply insulation with edges tightly butted and joints staggered. Provide sufficient clearances around opening for normal operation of equipment. Do not cover cleanouts and nameplates, and bevel insulation at such openings.

B. Insulation Type E1 and E2: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches on center in both directions.

d. Do not overcompress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
11. Seal all joints with vapor barrier mastic, Foster 30-35, Childers CP-30LO or equal. Over insulation apply tack coat of Foster 30-36, Childers CP-50A or equal, and imbed into wet coating Alpha Assoc. Fiberglass Scrim Fabric "Luben 58" (20 x 10) white, Childers "Chil-Glass" or equal, smoothing to avoid wrinkles, and overlapping all seams at least 2 inches. Apply finish coat of Foster 30-36, Childers CP-50A or equal.
12. When applying to hot equipment, bring insulation up to operating temperature and provide space ventilation in accordance with manufacturer's recommendations.

C. Insulation Type E3L

1. Secure with No. 16 gauge galvanized annealed steel wire for small areas and No. 12 gauge stainless steel annealed steel wire or 1/2 inch x 0.15 inch aluminum or stainless steel bands on 12 inch maximum centers for large areas. Where required, provide welded studs, clips or angles as anchors for wires and bands.
2. Tightly stretch 1 inch hexagonal mesh in place over insulation and secure by wiring to anchors, with edges tied together. Reinforce corners with corner bead. Finish with hydraulic Insulating and Finishing Cement or approved equal applied 1/4 inch thick in one coat, troweled to smooth finish.

D. Insulation Type E3H: Install same as Type E3L, except provide air space between insulation and covered surface by means of 1 inch high V-rib, standoff expanded lath.

E. Insulation Type E4

1. Install using manufacturer's recommended adhesive (Armacell 520). Use full adhesive coverage attachment, including seams and joints. Coat both surfaces to be joined. Seal longitudinal seams and end joints.
2. Finish outdoor insulation with two coats of manufacturer's recommended weather-and ultraviolet-resistant protective finish Armacell WB Armaflex, white. DO NOT TINT FINISH.

    a. At Contractor's option (for outdoor insulation), use manufacturer's factory applied UV resistant jacket adhered to Type E4 insulation. Armacell Armatuff Plus.

F. Removable Insulation: For strainers, casings of pumps handling chilled, etc., which require access for service and maintenance, provide insulated removable and replaceable 20 gauge galvanized steel cover painted with Foster 30-35. Apply insulation to all inside surfaces of cover using adhesive as recommended by insulation manufacturer. Seal all seams and joints to provide vaportight enclosure for indoor equipment and weathertight for outdoor equipment. Provide flanged joint, gasketed and bolted, for convenient removal and replacement.

G. Insulation Installation on Pumps: Adhere insulation Type E4 directly to pump casing. Joints shall coincide with splits in pump casing. Provide removable insulation piece at pump nameplate. Do not insulate over drain and vent tappings.

3.7 EQUIPMENT INSULATION SCHEDULE

Equipment	Type	Thickness
Air Separator (Chilled Water, Condenser Water)	E1 or E4	1 1/2"
Chilled Water Storage Tank	E1 or E4	2"
Chilled Water Expansion Tank, Chemical Treatment Feeder	E1 or E4	1"
Heat Exchanger (Chilled Water, Cooling Water)	E4	1 1/2"
Pump Casing (Chilled Water, Dual Temperature, Glycol Heat Recovery)	E4	1"
Water Chiller (Not Factory Insulated) - Evaporator Shell, Heads, Water Boxes	E4	2"
Air Separator (Heating Water)	E2	1"
Heating Water Expansion Tank	E2	1"

Equipment	Type	Thickness
Heat Exchanger (Heating Water)	E2	2"
Flash Tank	E2	1"
Steam Separator Type Humidifier - Body of Separator	E2	1 1/2"
Boiler Vent Pipe (Other than Pre-Fabricated Vent Stack)	E3L or E3H	2"
Emergency Generator Piping from Engine to Muffler	E3L	2"
Emergency Generator Muffler	E3L	2"

3.8 DUCTWORK AND CASINGS INSULATION INSTALLATION

A. Penetrations Through Construction:

1. Except at penetrations through fire or smoke rated construction, ensure that insulation is continuous through floors, walls and partitions. Where duct is enclosed in a fire rated shaft, carry insulation through penetration of intermediate floors in shaft.
2. Omit insulation on portion of duct passing through fire rated construction. Terminate insulation at each face of construction. Provide appropriate vapor seal at termination for ductwork subject to condensation.

B. Insulation Type D1:

1. Apply with edges tightly butted. Impale on pins welded to duct and secure with speed clips. Cut protruding ends of pins flush. Space pins as required to hold insulation firmly in place but not less than one pin per square foot. Seal all joints, exposed ends, speed clips and penetrations of the vapor barrier with minimum 3-inch-wide strip of the vapor barrier material applied with Foster 85-75 or Childers CP-82 to both surfaces or with pressure sensitive tape to match facing.
2. Outdoor Installation: Cover with sheet metal jacketing; minimum 26 gauge aluminum in conformance with ASTM B209M, having lock forming corner bead and joint capability. Interlocking seams and corner beads completely sealed and made water tight.

C. Insulation Type D2

1. Cut insulation to length longer than duct perimeter to minimize compression and maximize installed "R" value as recommended by manufacturer. Allow maximum fullness at corners of rectangular ductwork and avoid excessive compression.
2. Insulation shall be firmly butted at all joints with a maximum allowable compression of 25%. Secure insulation to underside of ducts 18 inches or greater in width with mechanical fasteners welded to duct and speed clips spaced approximately 18 inches on center. Cut protruding ends of pins flush. Additionally secure to sides of ducts 18 inches or greater in

depth and to the two larger sides of all vertically installed ductwork with mechanical fasteners in the same fashion as for the underside of ducts 18 inches or greater.

3. Overlap all joints at least 2 inches and staple in place. Seal stapled seams, speed clips and breaks in the vapor barrier facing with a minimum 3-inch-wide pressure sensitive tape designed for use with the duct insulation. Use pressure sensitive tape and apply additional Foster or Childers sealant in concealed spaces to provide a complete sealed thermal break installation.

D. Insulation Type D3

1. Verify that horizontal rectangular ductwork is properly pitched to avoid ponding before installing insulation.
2. Install using manufacturer's recommended adhesive (Armacell Armaflex 520). Metal surface must be clean and dry before application. Use full adhesive coverage attachment, including seams and joints. Coat both surfaces to be joined. Apply pressure to the surface of the insulation to assure a tight bond. Make sure all joints are under compression.
3. Install on each surface and butt joint at corners. Do not continuously wrap around corners on rectangular duct causing insulation to be in tension.
4. Outdoor Installation: Finish, using manufacturer's recommended procedures, with two coats of manufacturer's recommended weather-resistant and ultraviolet-resistant finish (Childers Vi-Cryl CP-10 white, with elastic reinforcing cloth (Vimasco Dynel Elastafab #894 8 x 8 mesh) blended into the first coat. DO NOT THIN THE MASTIC. Overlap seams of reinforcing cloth a minimum of 6 inches at each corner of rectangular ductwork. Completely cover mesh with second coat, applied immediately after the first coat has taken its set.

E. Insulation Type D4

1. Secure with No. 16 gauge galvanized annealed steel wire for small areas and No. 12 gauge stainless steel annealed steel wire or 1/2 inch x 0.15 inch aluminum or stainless steel band on 12 inch maximum centers for large areas. Where required, provide welded studs, clips or angles as anchors for wires and bands.
2. Tightly stretch 1 inch hexagonal mesh in place over insulation and secure by wiring to anchors, with edges tied together. Reinforce corners with corner bead. Finish with hydraulic Insulating and Finishing Cement or approved equal applied 1/4 inch thick in 1 coat, troweled to smooth finish.

F. Insulation Type D5

1. Apply with edges tightly butted. Impale on pins welded to duct and secured with speed clips, located and spaced as recommended by manufacturer to prevent sagging, but not less than one pin per square foot. Secure with 3/4 inch wide, minimum 0.015 inch thick aluminum or stainless steel bands, spaced as recommended by manufacturer, but not more than 12 inch maximum centers. Where required, provide welded studs, clips or angles as anchors for bands. Cut protruding ends of pins flush and seal with tape patch.
2. Tightly stretch 1 inch hexagonal mesh in place over insulation and secure by wiring to anchors, with edges tied together. Reinforce corners with corner bead. Finish with an all-purpose (AP) jacket. Seal all joints with 3-inch-wide strip of matching material applied with Foster 85-75 or Childers CP-82 to both surfaces or with pressure-sensitive tape to match jacket.

G. Insulation Type D6: Install in strict accordance with terms of the UL listing and the manufacturer's instructions, including insulation of hanger system.

3.9 DUCTWORK AND CASING INSULATION SCHEDULE

A. Minimum Thickness

1. Insulation thickness indicated hereinafter in this article and/or on the drawings is minimum thickness. Where duct is constructed with flanged, angle, standing, factory fabricated or similar joints or reinforcing, increase thickness to provide minimum 1/4 inch cover on edge of joint or reinforcing.
2. Increased thickness section shall be a minimum of 6 inches wide, centered on flange or reinforcing with exposed ends sealed as specified in this article for concealed ductwork. Increase thickness throughout entire length of duct to provide a uniform thickness and appearance for all exposed ductwork.

B. Type

1. Exposed Indoor Rectangular Ductwork - Type D1.
2. Concealed Rectangular Ductwork - Either Type D1 or Type D2 at Contractor's option.
3. Apparatus and Equipment Casings – Type D1 Indoors, Type D3 Outdoors
4. Indoor Round and Oval Ductwork - Type D2.
5. All Outdoor Ductwork - Type D1 in double wall duct so that insulation is not exposed to supply and return airstream).

C. Thickness Schedule:

Location	Thickness* Type D1 and D3	Thickness* Type D2
1. Equipment Casing		
a. Indoor (Type D1)	2 Inches	Not Allowed
b. Outdoor (Type D3)	3 Inches	Not Allowed
2. Ductwork Location		
a. Outdoors		
1) Supply air	3 Inches	Not Allowed
2) Return air	3 Inches	Not Allowed
3) Exhaust air	1-1/2 Inches	Not Allowed
b. Indoors (Type D1 or D2)		
1) Penthouse or Mechanical Room with Roof	1-1/2 Inches	Not Allowed
2) Mechanical Room without Roof	1-1/2 Inches	Not Allowed
3) Air Conditioning Supply and Return Between Roof and		

	Suspended Ceiling	1-1/2 Inches	2 Inches
4)	Shaft with Exterior Wall	1-1/2 Inches	2 Inches
5)	Other Than Above	1 Inch	1-1/2 Inches

*Subject to compliance with Paragraph A., of this article, where ductwork or apparatus casing or equipment casing is acoustically lined, reduce insulation thickness by equivalent thickness of lining so that combined "R" of lining and insulation is equal to or greater than "R" of specified insulation thickness. Increase thickness at flanged or standing joints to provide minimum 1/4 inch cover over edge of flange or joint.

D. Listing of Ductwork and Casings to be Insulated:

1. All air conditioning system supply air ductwork, casings and plenums.
2. Air conditioning system return air and relief air ductwork, casings and plenums located in:

    a. Mechanical equipment room.
    b. Ceiling space or plenum where there is roof above.
    c. Shaft with exterior wall(s) or shaft passing through non-air conditioned space.
    d. Non-air conditioned space, including shaft not surrounded by air conditioned spaces on all sides and ceiling space or plenum with non-air conditioned space either above or below.

3. Fire damper, smoke damper, combination fire and smoke damper sleeve for damper installed in acoustically lined ductwork. Insulate only the portion not within the penetrated construction.
4. Air conditioning system return air ductwork, casings and plenums located outdoors.
5. Casings of heating and air conditioning systems and equipment which are not factory insulated, including plenums (supply, return, mixing), filter sections, access sections, sound attenuator casings and all other areas subject to condensation, heat gain or heat loss.
6. Combustion air duct.
7. Flexible ductwork not factory insulated.
8. Heating and ventilating system return ductwork located in crawl space, attic or other nonheated spaces, including shaft with exterior wall, ceiling space or plenum with roof above or with either nonheated space above or below.
9. Heating and ventilating system supply ductwork, except ductwork exposed in spaces heated by the system.
10. Autoclave and similar high humidity exhaust ducts passing through air conditioning system supply or return air plenum, air conditioned spaces, nonheated spaces and any space where normal space temperatures can cause condensation within duct and all such ductwork located outdoors or on roof.
11. Outside air ductwork, casings and plenums.
12. Reheat coil sections of air volume control boxes. Extend insulation minimum of 4 inches upstream and downstream of coil connection.
13. Supply air diffuser plenums/back pans that are not either insulated or acoustically lined at the factory.
14. Fume hood exhaust air ductwork, casings and plenums located outdoors.
15. Ductwork and casings shown on the Drawings to be insulated, whether or not listed above.

END OF SECTION 23 07 00

SECTION 23 09 00 – LABORATORY AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and

1.2 SUMMARY

A. The airflow control system (ACS) shall be furnished and installed under this Section. The ACS shall be capable of operating as a standalone system or as a system integrated with the Building Automation System (BAS).

B. Related Sections include the following:

1. Section 25 09 00 “Instrumentation and Controls for HVAC”
2. Section 25 09 33 “Sequence of Operations for HVAC Controls”

1.3 REFERENCES

A. Abbreviations and Acronyms

1. ACS – Airflow Control System
2. ATC – Advanced Temperature Control
3. BAS – Building Automation System
4. VAV – Variable Air Volume

B. Reference Standards

1. ARI 880 Performance Rating of Air Terminals
2. ASHRAE/ANSI Standard 130, Methods for Testing Air Terminal Units
3. ANSI/ASHRAE 135: BACnet® - A Data Communication Protocol for Building Automation Systems (including Standard and all published Addenda)

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. The ACS representative shall coordinate all details of the installation with the successful mechanical contractor. This effort shall include complete coordination of the sheet metal layout drawings to assure that the ductwork layout and sizing is based on the actual sizes of the airflow control valves for this project.

B. Pre-installation Meetings

1. The ACS representative shall review the proper installation of the system with the sheet metal contractor and the building automation system (BAS) contractor.
2. Project Installation Phase – The ACS representative shall make periodic visits to the project jobsite to assure that the system is being installed properly to assure optimal performance and that the location and orientation of the control valves is consistent for proper operation and future owner maintenance. Any discrepancies shall first be brought to the attention of the appropriate subcontractor. If no action is taken by said contractor, the representative shall bring these issues to the project manager, engineer or owner's representative for resolution.

1.5 SUBMITTALS

A. General: Submit listed Submittals in accordance with Conditions of the General Contract and Division 1 Submittal Procedures Section. ACS submittals shall contain, at a minimum, the following information:

1. Product Data Sheets
2. Equipment Schedule Sheets containing Room#, Tag#, Min/Max flows, Catalog# and other configuration data as required to provide a fully engineered ACS.
3. Installation Instructions
4. Project-specific Wiring Diagrams
5. Sequences of Operation
6. Points Lists

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided as closeout submittals.

1.7 QUALITY ASSURANCE

A. Certifications

1. The airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2008.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Prior to installation, the ACS shall be stored in dry conditions within an environment complying with ACS product specifications as shown on product data sheets within the submittals.

2. The ACS products shall be handled and transported in a manner consistent trade practices for control systems and instruments.

1.9 SITE CONDITIONS

A. The ambient environmental conditions during installation and operation shall comply with ACS product specifications as shown on the product data sheets within the submittals.

1.10 WARRANTY

A. The Warranty shall commence upon the date of shipment and extend for a period of 60 months for all airflow control devices and 36 months for all other control system components.

1.11 SYSTEMS INTEGRATION

A. Contractor for Division 25 will be responsible for the integration of various building systems, including third party control systems, into the Building Automation System (BAS). This shall include connection of third party control systems onto the BAS network, mapping of all available points from the third party control systems and communication cards to the BAS, programming of all control functions required between third party systems and the BAS, calculation of the net energy use and processing of data as required for communication between the BAS and the campus-wide Data Historian System (PI OSIsoft).

B. Contractor for this section shall be responsible for providing all labor, equipment, materials and service as necessary to support the integration of their system into the BAS system.

C. Contractor for this section shall be responsible to attend coordination meetings with the Division 25 contractor for the purposes of planning and executing the full system integration.

D. System servers, controllers and other communication devices shall provide communication to the BAS utilizing open architecture of either EIA standard 709.1, LonTalk protocol, MODBUS RTU and/or ANSI/ASHRAE Standard 135, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk, MODBUS and BACnet protocols are required to assure that the project is fully supported by the BAS. Provide associated certification as part of submittal (LONMARK for LonTalk, BTL for BACnet, and Certified Conformance Testing for MODBUS). Systems that use proprietary communication protocols will not be accepted.

E. Coordinate equipment with the Division 25 Contractor to achieve compatibility with equipment interfaces.

F. Furnish a listing of all Input/Output points that will be available for communication to the BAS for the purposes of control functionality and system monitoring. Manufacturer shall indicate which points are monitoring points versus control points that can be remotely changed via the BAS.

G. Coordinate point naming standards with the Contractor for Division 25, who will develop naming standards for the entire project. Naming conventions must be coordinated prior to submittal review and included in submission.

H. System Integration Mock-up: A mock-up of the BAS will be provided as specified in 25 09 00 and is intended to demonstrate system performance. Contractor for this section shall provide labor, equipment, materials and service as necessary to support the completion of the mock-up and include transport of materials and staff to the mock-up location. Include hardware, software and equipment to visually illustrate successful integration of systems.

1.12 COMMISSIONING

A. Commissioning of components, equipment and/or system specified in this division is part of the construction process. Documentation and testing of these components, equipment and/or system, as well as training of the Owner's operation and maintenance personnel on these components, equipment and/or system, is required in cooperation with the Owner's Representative and Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13 - General Commissioning Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with all performance requirements, provide airflow control system from one of the following manufacturers:

1. Phoenix Controls (Traccel)

2.2 AIRFLOW CONTROL SYSTEM

A. Each space shall have a dedicated airflow control system.

B. The airflow control system shall maintain specific airflow (±5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change, airflow change or quantity of airflow control devices on either the supply air or exhaust air manifold (within 0.3” to 3.0" WC, pressure drop).

C. The airflow control system shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as rapid changes in duct static pressure. Systems using differential pressure measurement or velocity measurement to control room pressurization are unacceptable.

D. The airflow control system shall maintain specific airflow (±5% of signal) with a minimum airflow turndown as indicated elsewhere in the specifications to ensure accurate pressurization at low airflow and assure maximum energy efficiency.

E. In the event of a power failure, airflow control devices shall fail to the last position and continue to maintain flow control within ±5% of signal within one second of a change in duct static pressure.

2.3 COMPONENTS

A. Airflow Control Device - General

1. The airflow control device shall be a venturi valve.
2. The valve assembly manufacturer's Quality Management System shall be registered to ISO 9001:2008.
3. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure-independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure regardless of the magnitude of pressure drop and/or flow change or quantity of airflow controllers on a manifolded system.
4. The airflow control device shall maintain accuracy within ±5% of signal over an airflow turndown range of no less than:

Pressure Drop Across Valve	Valve Body Type	Airflow Range	Minimum Turndown
Low 0.3-3.0" WC	Standard	Up to 1,000 CFM	11 to 1
	Standard	Up to 1,400 CFM	7 to 1
	Shut-off	Up to 900 CFM	9 to 1
	Shut-off	Up to 1,000 CFM	5 to 1

5. No minimum entrance or exit straight length of duct shall be required to ensure accuracy and/or pressure independence.
6. The airflow control device shall be constructed as one of the following types, depending upon application:

a. Class A: The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft, shaft support brackets, and internal mounting link shall be made of 316 stainless steel. The pivot arm shall be made of aluminum for standard valves and 303/304 stainless steel for shut-off valves. The pressure-independent springs shall be a spring-grade stainless steel. All shaft-bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite.

b. Class B:

1) The airflow control device for corrosive airstreams, such as fume hoods and biosafety cabinets, shall have a baked-on, corrosion-resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal "S" link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces

shall be made of PP (polypropylene) or PPS (polyphenylene sulfide) composite.

2) Sound attenuating devices used in conjunction with potentially corrosive exhaust (fume hoods, biosafety cabinets) shall be constructed using 24-gauge 316 stainless steel. No sound absorptive materials of any kind shall be used.

7. A standard-speed electric actuator shall be used to modulate the airflow over the range of the specific valve size. The maximum time to modulate from minimum to maximum flow shall be less than 60 seconds for standard valves and 90 seconds for shut-off valves. A UL or CSA listed electronic actuator shall be factory mounted to the valve. The actuator shall have sufficient torque to modulate the airflow against the maximum duct static pressure (within product specifications). Loss of main power shall cause the valve to maintain its last airflow position. This position shall be maintained until power is restored. During loss of power, the valve shall maintain pressure independence.
8. Provide integral differential pressure switch to alarm low differential pressure.
9. Ductwork connections: Airflow control device shall be connected to adjoining ductwork using a gasketed draw band clamp.
10. Certification

    a. Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than ±1% of signal (5,000 to 250cfm), ±2% of signal (249 to 100cfm) and ±3% of signal (99 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to ±5% of signal at a minimum of 48 different airflows across the full operating range of the device.
    b. Each airflow control device shall be marked with the room number, tag number, serial number, and model number. All information shall be stored by the manufacturer for use with as-built documentation.

11. Insulation: Provide all supply and exhaust valves with factory insulation of 3/8 inch flexible closed cell polyethylene with flame/smoke spread rating not greater than 25/50 (ASTM E84), density of 1.5 lb/ft^3, water vapor permeability of 0.0 perm per inch (ASTM E96) and water absorption of 0.0% (ASTM C209).
12. Airflow control devices that are not venturi valves and are airflow measuring devices (e.g., pitot tube, flow cross, air bar, orifice ring, vortex shedder, etc.) shall only be acceptable provided these meet all the performance and construction characteristics as stated throughout this specification and:

    a. The airflow control device employs transducers manufactured by Rosemount, Bailey, Bristol, or Foxboro. Accuracy shall be no less than ±0.15% of span (to equal ±5% of signal with a 15 to 1 turndown) over the appropriate full-scale range, including the combined effects of nonlinearity, hysteresis, repeatability, drift over a one-year period, and temperature effect. 316L stainless steel materials shall be provided for all exhaust applications. The use of 304 stainless steel or aluminum materials shall be provided for all supply air applications.
    b. Airflow sensors shall be of a multi-point averaging type, 304 stainless steel for all supply and general exhaust applications, 316L stainless steel for all fume hood, canopy, snorkel, and biosafety cabinet applications. Single point sensors are not acceptable.

c. Suppliers of airflow control devices or airflow measuring devices requiring minimum duct diameters shall provide revised duct layouts showing the required straight duct runs upstream and downstream of these devices. Coordination drawings reflecting these changes shall be submitted by the supplier of the ACS. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower and all associated electrical changes shall be borne by the ACS supplier.

d. Airflow control devices using flow measurement shall be readily removable for periodic inspection, cleaning and recalibration. Device locations and surrounding clearances shall be coordinated to allow the required maintenance.

B. Exhaust and Supply Airflow Device Controller

1. One controller shall be provided for both the supply airflow control device and the corresponding exhaust airflow control device. The controller shall be a microprocessor-based design and use closed-loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.
2. The airflow control valve and controllers shall be designed to operate between 32-122°F ambient and 10-90% non-condensing RH.
3. In flow tracking applications where an exhaust device and or a return device is tracking a supply device, flow data for each device (up to 3 valves total) shall be downloaded to the controller in the factory.
4. The airflow control device shall store its control algorithms in non-volatile, rewritable memory. The device shall be able to stand alone or to be networked with other room-level digital airflow control devices through an industry standard protocol.
5. Room-level flow tracking control functions shall be embedded in and executed by one controller mounted on one of the airflow devices.
6. The room-level control network shall communicate by using BACnet® MS/TP protocol. The control device must meet the requirements of a BACnet Application Specific Controller (B-ASC Level Device), and be a BACnet Testing Laboratories (BTL) certified device. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:

   a. Files Functional Group
   b. Reinitialize Functional Group
   c. Device Communications Functional Group

   Refer to section *22.2 - BACnet Functional Groups*, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above.

   Standard BACnet object types supported shall include as a minimum Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types.

7. The airflow control device shall have integral 120/24V transformer.
8. The airflow control device shall be able to connect to a commissioning tool. Every node on the network shall be accessible from the BACnet Building Automation System (BAS).
9. The airflow control device shall include inputs with 10-bit resolution that accept 10K thermistors, 0–10 VDC, 0–5 VDC, 0–20 mA and dry contact signals. Controller shall include binary and analog outputs on board. Analog outputs shall be 5 VDC, 0–10 VDC,

2–10 VDC, or 0–20mA. Software shall include scaling features for analog outputs. Controller shall include a 24 Vdc voltage supply for use as power supply to external sensors.

10. Controller shall also include support for interface with digital display which allows display and modification of controller set point variables.
11. The airflow control device shall meet the following agency compliance requirements- FCC Part 15 Subpart J Class A, CE, and UL 916.

C. Sound Attenuation Device

1. All supply valves and exhaust valves shall include a Neutralizer, a tuned resonator which has been engineered to reduce noise produced by the Phoenix Controls airflow control valve, especially in the 1000, 2000 and 4000 Hz octave bands
2. Supply and general exhaust valve sound attenuators constructed of 24 gauge galvanized steel. Fume hood exhaust valve attenuators shall be constructed of 316 stainless steel.
3. All sound attenuators must be of a packless design with a maximum pressure drop not to exceed 0.30 inches of water column at 2000 fpm face velocity
4. Slip fit design, inserted into the duct work between the valve and the first take-off, and sealed in place by the installer.

D. Advanced Pressure Monitor, Network (BACnet) Version:

1. Provide network connected pressure monitors as indicated on the drawings completewith pressure pick-up ports for space and reference locations.
2. 2. Pressure monitors shall have a 4.3” color TFT touch screen capable of displaying the following information:

    a. Space differential pressure in inches of water column (“WC) or Pascals (Pa) and an optional pressure slide bar in relation to configured alarm set points.
    b. Intended space pressure relationship (Positive, Negative, Neutral or Standby)
    c. A four-color, touch selectable, customizable message banner shall display the room condition to staff.

        1) The message banner size shall be selectable between the left-hand 1/3rd of screen or the full screen. When in full screen mode, any alarm condition shall return the message banner to the left-hand 1/3rd size.
        2) Selection of different message banners shall also be capable of setting the occupancy state.
        3) Upon any alarm condition, the message banner shall turn red and display “Alarm”.

    d. Room ID (user configurable)
    e. Space temperature, humidity and air change rate shall be displayed simultaneously (or optionally can be individually selected or deselected for display)
    f. Heating and cooling temperature control set points shall be adjustable via touch screen input by user.
    g. With the addition of a remote pressure transducer, the pressure monitor shall be capable of monitoring two spaces and toggling the display with all variables listed above between the two spaces.

3. Pressure monitors shall have the following minimum environmental and performance specifications:

    a. IP-54 rated housing, resistant to spray washdown
    b. Resistant to decontamination chemicals (e.g. VHP, Clidox, Formaldehyde, sodium hypochlorite 3-6%
    c. Standard accuracy RSS of at least +/-0.5% full scale (non-linearity, hysteresis and non-repeatability)
    d. Optional high accuracy RSS of at least +/-0.25% full scale (non-linearity, hysteresis and non-repeatability)
    e. Integral zero and span adjustment
    f. Temperature effect on zero/span shift ±0.03 % FS/°F
    g. Pressure ranges, selected by engineer, shall be up to (+/-0.05" to +/-1.0" WC)
    h. Temperature Range: 32 to 120 deg. F

4. Monitor configuration can be copied to an external USB memory device for the purpose of duplicating configuration on like devices.
5. Pressure setpoints shall be externally switchable between positive, negative and neutral modes.
6. Monitor shall be directly connected to the BACnet MS/TP network

    a. Able to change occupied and unoccupied heating and cooling temperature setpoints via BACnet MS/TP
    b. Device shall be remotely configurable via BACnet MS/TP
    c. Device BACnet points list as shown in Table 3 of Section 2.06

7. Monitor shall store an audit record of the last five configuration changes (FIFO log)
8. Home screen language shall be selectable between English and French
9. Firmware upgradable via USB port
10. Alarms:

    a. Programmable visual alarm and adjustable audible alarm
    b. Programmable durations for audible alarm delay and silence periods
    c. Alarm on insufficient duct static pressure
    d. Includes (8) optional methods of alarm configuration to minimize nuisance alarms
    e. Shall have programmable high and low Air Change per Hour (ACH) alarms

11. Inputs:

    a. Analog Inputs (AI-1, AI-2):

        1) Multi-function input signal of 0-10VAC, 0-5VAC or 4-20 mA
        2) Used for secondary (remote) pressure transducer input or switching pressure alarm setpoints to equal and opposite ranges.

    b. Digital Input (DI-1):

        1) DI can be used for door status indication (contact open = door open, closed = door closed) or valve pressure switch indicator.
        2) DI is alarmable; visual on the LCD, yellow on door open
        3) DI is configurable; door open can disable alarming

12. Outputs:

    a. Analog output (AO-1):

        1) A filtered output signal of the primary room pressure differential
        2) Range is field selectable for 0-5Vdc, 0-10Vdc or 4-20mA.
        3) Speed of response shall be appropriate for high-speed pressure control algorithms with a 100ms speed of response maximum, 3 time constants.

    b. Alarm contact digital output (DO-1):

        1) SPDT, contact rating of 2.0A @ 30VAC/VAC, 0.6A @ 125VAC
        2) Adjustable alarm deadband of 0-10% of setpoint.
        3) Shall be capable of serving as external occupancy control

13. Installation

    a. Pressure monitor shall fit into standard commercially available triple-gang, double-deep electrical boxes (e.g. RACO 697, Appleton M3-350)

14. Acceptable Products

    a. Phoenix Controls model APM200-ENG-BAC

E. Central Display Monitor (BACnet)

1. The Central Display (CD) is a remote, 4.3” TFT color touch-screen display that monitors the status of APM2 units installed at the pressure zones.

    a. The CD shall be capable of monitoring up to eight (8) APM2 pressure zones via the BACnet MS/TP network. Each room shall be uniquely identified on the CD by the room name as assigned to the APM2.
    b. The CD shall auto-discover APM2 units on the same BACnet MS/TP LAN.
    c. The current status of each pressure zone shall be displayed at the CD in color: Green = Normal, Yellow = Warning, Red = Alarm, or Grey = Unoccupied/Standby.
    d. Touching the area of the screen for a specific pressure zone shall display the information from the associated APM2 at the CD.
    e. The CD shall be capable of audible alarms if any of the monitored APM2s go into an alarm state.
    f. The CD shall be capable of displaying the following points (provided the associated APM2 is configured accordingly):

        1) Room label
        2) Alarms
        3) Active or Standby condition
        4) Occupied or Unoccupied condition
        5) Pressure
        6) Temperature
        7) Humidity
        8) Door status
        9) Air Changes per Hour

g. The CD shall be capable of English and French language.
h. The CD shall provide cloning functionality for faster configuration.

2. Electrical and Power Requirements

a. Power 18-32 VAC, 50-60 Hz at 9.6 VA maximum.
b. Removable terminal block.

3. Environmental Parameters

a. Resistant to spray wash-down (IP-54).
b. Resistant to decontamination chemicals: vaporized hydrogen peroxide (VHP), formaldehyde, chlorine dioxide (clidox), perchloric acid, sodium hypochlorite 3-6% (bleach), quaternary ammonium 7% in 1:128 tap water (ammonia).
c. Mount in standard triple-gang, double-deep electrical box (RACO 697 or equal).
d. Faceplate and housing of fire-retardant plastic (UL94V-0).
e. Operating temperature 32 to +120 °F (0 to +50 °C).

4. 4. Regulatory Compliance

a. CE, CSA, RoHS, WEEE, Electro Magnetic Compatibility Directive 2004/108/EC

F. Room Air Pressure Sensor Plate

1. Provide shielded static air probes for sensing room pressure levels. Probes shall be flush-mounted in a standard 2" x 4" electrical box.
2. The pressure-sensing tubing shall be connected to the top of the probe with quarter inch tubing. Tubing shall also be extended from the pressure sensor to a stable common pressure reference port.
3. The exact placement of the sensor plates and means of establishing a stable common reference pressure shall be determined by the engineer.

G. Heating Coils

1. Capacity: As indicated in Section 3.04.A, based on scheduled entering water temperature.
2. Headers: Copper or Brass.
3. Fins: Aluminum.
4. Tubes: Copper, arrange for counter-flow of heating water.
5. Water velocity: 2.4 m/s (8 FPS) maximum with head loss not greater than indicated.
6. Provide vent and drain connection at high and low point, respectively of each coil.
7. Coils shall be guaranteed to drain.
8. Transitions: Provide transitions as indicated in Section 3.04.B.
9. Access panels (or doors): Provide panels large enough for inspection, adjustment and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit, even if there are no moving parts. Panels shall be insulated to same standards as the rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.

H. Temperature Controller

1. For zones that require hydronic reheat control, provide a low-voltage and microprocessor-based zoning thermostat-controller capable of 0-10Vdc analog control. The thermostat-controller shall operate in a stand-alone mode and be capable of BACnet MSTP communications.

    a. Thermostat-controller shall be pre-programmed, containing all required I/O to accomplish local HVAC temperature control for heating with reheat.
    b. Thermostat-controller shall be provided with two (2) floating or two (2) analog proportional-integral control outputs. Thermostat-controller shall have integrated changeover function, which will allow seamless switching between cooling and heating mode based upon temperature or a network value input.
    c. Thermostat-controller shall achieve accurate temperature control using a PI proportional-integral algorithm. Differential-based thermostat-controllers are not acceptable. Thermostat-controller shall have an adjustable deadband.
    d. Thermostat-controller shall have an on-board 10K NTC thermistor and the capability for a remote temperature sensor that will replace the on-board temperature sensor.
    e. Thermostat-controller shall be capable of local or remote override during unoccupied mode. The thermostat-controller shall resume occupied setpoints and will revert back to unoccupied setpoints after a set time adjustable from 0 to 24 hours. Thermostat-controller shall also have configurable temporary or permanent local override setpoints. When the “temporary setpoints” mode is enabled, once the temporary occupancy timer expires, the setpoints will revert back to their default values. Thermostat-controller shall have adjustable local unoccupied heating and cooling setpoint limits as well as maximum heating and minimum cooling limits.
    f. Thermostat-controller shall also provide; (2) additional configurable inputs for remote night setback, occupancy sensing, door contact, remote override, or filter alarm as required. (1) additional configurable input for dry contact or analog sensor changeover, or for other temperature sensor monitoring as required. (1) configurable auxiliary output to be used for heating or local digital output.
    g. Thermostat-controller shall be equipped with 2-line, 16-character LCD dual intensity backlit display with two status LEDs for heating or cooling mode, and be capable of displaying temperatures in Celsius or Fahrenheit.
    h. Thermostat-controller shall utilize EEPROM memory to back up local configuration parameters in the event of power failure. Thermostat-controllers requiring batteries or have no provisions for retention during loss of power shall not be acceptable.
    i. Thermostat-controller shall have (4) adjustable keypad lockout levels limiting access to changes of occupied and unoccupied setpoints.

I. Fume Hood Face Velocity Monitor (FVM)

1. Provide fume hood sash sensor, face velocity monitor and alarm, and face velocity display integral with the LACS.
2. A fume hood monitor shall be provided to receive the sash sensor output. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity. Audible and separate visual alarms shall be provided for flow alarm and emergency exhaust conditions. The fume hood monitor shall incorporate the following capabilities:

    a. LED display with the ability to display face velocity in feet per minute (fpm).

b. Alarm Muting option, which silences the audible alarm for an adjustable time period when the mute button is pushed. If another alarm is generated during the mute period, the new alarm will override the mute delay and the alarm will sound again.
c. Auto Alarm Muting option, which sets the alarm to mute automatically after 20 seconds.
d. Emergency Exhaust button with LED, which activates an emergency exhaust mode. In this mode, the exhaust air is at its maximum flow. When activated, the alarm will sound and the LED will flash. To activate emergency exhaust mode, push the button. Push the button again to cancel emergency exhaust mode.
e. Flow Alarm LED, which illuminates to indicate an unsafe airflow condition. The audible alarm will also activate and may be muted.
f. Broken retracting cable alarm, an audible alarm with a flashing LED that indicates whether a vertical sash sensor cable is detached, thereby ensuring the fume hood users' safety.

2.4 SUBSTITUTION REQUIREMENTS

A. Manufacturer List

1. The plans and specifications for the airflow control system are based on systems and equipment manufactured by Phoenix Controls.
2. The airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical and non-critical spaces using a Quality Management System registered to ISO 9001:2008.

B. Substitute Limitations

1. The engineer and owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle costs.
2. Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening will be returned without review.
3. Any alternate proposal shall describe the manner of compliance with this minimum performance specification, with an emphasis on the following areas: proposed equipment, experience, performance verification, and maintenance. This proposal shall be separate from any BAS proposal(s), and include the scope of information and services detailed in paragraphs a through c of this subsection.

    a. Proposed Equipment

        1) Technical specification data sheets shall be provided for all proposed system components and devices.
        2) All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance obtained from testing in accordance with ARI Standard 880.

b. Experience

1) The airflow control system supplier shall provide a list of at least three similar airflow control systems installed in the state or province as part of this proposal.
2) The airflow control system supplier shall provide the names, addresses and telephone numbers of the consulting engineer and the owner's representative for each of these installations.

c. Performance Verification

1) The airflow control system supplier shall demonstrate a typical critical or non-critical space that includes a general exhaust and a supply airflow control device for the purpose of verifying the airflow control system's ability to meet the performance requirements indicated in this specification.

d. Maintenance

1) The ACS supplier shall provide at no additional cost to the owner during and after the warranty period five years of required preventive maintenance on all airflow sensors (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) and flow transducers provided under this section. Airflow sensors shall be removed, inspected, and cleaned annually during the five-year period to prevent inaccuracies due to long-term buildup from corrosion, tissues, wet or sticky particles, or other materials that foul the sensor. If impractical to remove the airflow sensors, the ACS supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor. The transducer shall be checked and recalibrated annually to ensure long-term accuracy. Note that auto-zero recalibration of transducers is not acceptable as a substitute for annual recalibration.

2.5 OPERATION SEQUENCES

A. Room Volumetric Offset Control

1. The airflow control system shall control supply and exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure. The offset represents the air volume that enters or exits the room from the corridor or adjacent spaces.
2. The airflow control system shall maintain the fixed volumetric offset as the supply and exhaust venturi valves increase or decrease flow to meet temperature, occupancy, or ACH demands.
3. The offset control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. This offset shall be adjustable from the BAS or locally through commissioning software installed on a laptop computer.
4. The offset control algorithm shall consider non-networked airflow control devices that consist of supply and exhaust flow devices that provide an analog signal scaled to reflect

actual flow and any number of constant volume devices where the total of the supply and exhaust devices or may be included in the offset control algorithm.

B. Space Temperature Control

1. The airflow control system shall regulate the space temperature through a simultaneous combination of programmable volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The controller shall calculate separate cooling and heating set points based on a single writable set point from the BAS, with the option of a local set point offset adjustment.
2. Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with the supply and exhaust airflow devices responding simultaneously to maintain the desired offset. Heating shall be provided through modulating point control actuator of a properly sized control valve connected to the selected reheat coil.

C. Humidity Monitoring

1. The airflow control system shall have an optional embedded humidity control function, which allows the monitoring of the relative humidity level in the pressurized zone. The airflow devices shall have the ability to monitor the relative humidity level of the space.

D. Occupancy Override Control

1. The airflow control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, to reduce energy consumption when the space is not occupied. Two occupancy modes shall be available: occupied and unoccupied. The occupancy state may be set by the BAS as a scheduled event to set the space to unoccupied for a predetermined interval.
2. Unoccupied Override: Based on a signal from the Lighting Control System room occupancy sensors indicating that a room is occupied, the associated zone SACs and EACs shall be overridden to operate in Occupied Mode.

E. Purge Mode Control

1. The airflow control system shall provide a means of receiving a local or network command to drive both supply and exhaust valves to their maximum CFM positions while maintaining the same volumetric offset and pressurization.

F. BACnet Multi-Use Inputs

1. In addition to the dedicated inputs for standard control functions, each BACnet venturi valve controller shall provide multi-use inputs for the following local monitoring or control functions:

    a. Discharge Air Sensor
    b. Volumetric Cooling Override
    c. Occupancy Sensor
    d. Humidity Sensor

e. Pressure Monitoring
f. Pandemic Switch
g. Emergency Switch
h. Additional Flow Inputs (Supply and Exhaust)
i. Local Offset Selection Switch

2.6 BACnet INTERFACE TO BUILDING AUTOMATION SYSTEMS

A. The airflow control system network shall interface digitally with the BAS via BACnet MS/TP. All room-level points shall be available to the BAS for monitoring or trending. At a minimum, the airflow controller shall be BACnet Testing Lab (BTL) certified as an Application Specific Controller (B-ASC).

B. All room-level points shall be available to the BAS for monitoring or trending.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The BAS contractor shall install any required routers and repeaters or supervisory controllers in an accessible location in or around the designated space.

B. The BAS shall install an appropriately sized and fused 24 Vac transformer suitable for NEC Class II wiring.

C. All cable and conduit shall be furnished and installed by the BAS contractor. The BAS contractor shall terminate and connect all cables as required.

D. Contractor for this section shall define requirements (length, quantity, material) of all cabling, conduits and components to be provided by Division 25.

E. The mechanical contractor shall install all airflow control devices in the ductwork and connect all airflow control valve linkages.

F. The mechanical contractor shall coordinate with Construction Manager for installation of fume hood face velocity monitor to be either shipped to fume hood manufacturer for installation, or field installation by Division 23.

G. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.2 SYSTEM STARTUP

A. System start-up shall be provided by a factory-authorized representative of the airflow control system manufacturer. Start-up shall also provide electronic verification of airflow, supply, make-up, general exhaust, system programming and integration to BAS. Successful bidders shall have at least 3 local certified factory-authorized technicians available for start-up and service.

B. The balancing contractor shall be responsible for final verification and reporting of all airflows.

C. The airflow control system supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.

D. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

3.3 CLOSEOUT ACTIVITIES

A. Training

1. The ACS supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, general procedures for verifying airflows of air valves and general troubleshooting procedures.
2. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

B. Maintenance

1. The airflow control valve utilizing flow metering and volumetric offset shall require no scheduled maintenance.
2. Systems using airflow management sensors/transducers (e.g., pitot tube, flow cross, orifice ring, air bar, hot wire, vortex shedder, side wall sensors, etc.) shall provide at no additional cost to the owner during and after the warranty period five years of required preventive maintenance on all airflow sensors.

    a. Airflow sensors shall be removed, inspected, and cleaned semi-annually during the five-year period to prevent inaccuracies due to long-term buildup of dust, lint corrosion, wet or sticky particles, or other materials that foul the sensors.
    b. If impractical to remove the airflow sensors, the critical airflow control system supplier shall include in the proposal the cost of supplying and installing duct access doors, one for each sensor, so that they may be cleaned in place.
    c. The transducer shall be checked and recalibrated every 6 months to ensure long-term accuracy.
    d. Note that auto-zero recalibration of transducers is not acceptable as a substitute for semi-annual recalibration.

END OF SECTION 23 09 00

SECTION 23 09 10 – GAS DETECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Gas Detection, Monitoring and Alarm System

B. Related Sections include the following:

1. Division 23 Section “Electrical Requirements for HVAC Equipment.”
2. Division 25 Section “Instrumentation and Control for HVAC.”

1.3 REFERENCES

A. NFPA 70: National Electric Code.

B. UL: Underwriters Laboratories, applicable standards.

C. ETL: Electrical Testing Laboratories, applicable standards.

D. NEMA ICS-6: Enclosures for Industrial Controls and Systems.

1.4 SUBMITTALS

A. Product Data: Include manufacturer’s technical literature for each control device. Indicate dimensions, performance characteristics, electrical characteristics, displays, and installation and start-up instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies, components, and indicate dimensions, weights, loads, required clearances, method of assembly.

1. Bill of Materials of equipment indicating quantity, manufacturer, and model number.
2. Wiring Diagrams: Power, signal and control wiring.
3. Details of control panel interfaces including controls, instruments, and labeling.

C. Qualification Data: For installer and manufacturer.

D. Field quality control test reports.

E. Operation and Maintenance Data: In addition to items specified in Division 01, include the following:

1. Maintenance instructions and lists of spare parts for each type of device.
2. As-built interconnection wiring diagrams.
3. Operator's Manual.
4. All commissioning documentation.
5. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
6. Calibration record and list of set points.

1.5 WARRANTY

A. Provide all services, materials, and equipment necessary for the successful operation of the entire system for a period of one year after acceptance. The adjustment, required testing, and repair of the system includes all controller equipment, transmission equipment and all sensors and devices. Provide cost for second year.

B. Provide extended warranties as specified elsewhere in this section.

PART 2 - PRODUCTS

2.1 GAS DETECTION SYSTEM

A. Acceptable Manufacturers:

1. MSA
2. Vulcain

B. General:

1. Provide a NEMA 4X microprocessor based gas detection, alarm and control panel for continuous monitoring of atmospheric conditions. The gas monitor shall continuously measure and display the concentrations of up to three (3) sensors. Gas detection system to be provided at gas cylinder room in Level 2 (Phase 1) and labs utilizing CO2 in Level 2 Phase 1, such as Conv Test Lab.
2. Gas Type: 0-25% O2, 0-5,000 ppm CO2.
3. Number of points: Three: (2) remote, (1) integral.

C. Monitor Requirements:

1. The monitor shall have a reset button for resetting latched alarms.
2. Monitor set-up and start-up shall not require that the enclosure be opened during the process.

3. The monitor shall provide a Modbus RTU output.
4. The monitor shall have a Piezo horn with silence button.
5. Provide integral red alarm strobe.

D. Monitor Display:

1. A local scrolling display will indicate the gas type being monitored and the concentration of gas present. The display will alternate between the sensors.
2. The monitor display shall indicate all diagnostic check/fault conditions with a scrolling message detailing the condition. Error codes shall not be used.
3. The monitor will display three levels of alarm. Alarm levels will be adjustable by means of a hand-held infrared controller. The display will be present at all times, will not be required to be turned on or off, and will be visible from a distance of five feet. This readout will be a three and one-half inch (3-1/2") digit Liquid Crystal Display (LCD).

E. Smart Sensor Technology:

1. Sensors shall be contained in sensor modules externally mounted to the main enclosure. All toxic and oxygen sensor modules shall be replaceable without the need for tools and while the unit is under power (hazardous areas).
2. Sensor modules shall contain all relevant sensor information, including the sensor manufacturer part number within the module.
3. The sensor module shall store all calibration data, enabling offsite calibration and field-installation without requiring re-calibration. The sensor module shall not require a battery or power source to store this data.

F. Multi-Sensing Capabilities:

1. The monitor shall operate up to (3) sensors at one time.
2. The sensor units can be remotely located from a monitor/readout unit by up to 100’.
3. Remote Oxygen sensors shall be provided with 100 feet of pre-wired shielded cable.

G. Non-Intrusive Calibration:

1. All monitors can be calibrated without opening any enclosures. Do not specify the use of flashlight-type devices, magnets or clamp-on devices to achieve calibration. The acceptable method uses an infrared handheld device.
2. There is the capability to calibrate the sensors with the push-button, this allows for zero, span and iCAL capabilities along with resetting latching alarms.

H. LED/Relays:

1. The monitor shall have red and green status relays, viewable from 50’.
2. The monitor shall have three common adjustable relays. Relays shall be rated at five amps @ 30VDC, five amps @ 220VAC, single-pole, double-throw and consist of three relays for alarm levels and one relay for fault.

I. Power supply requirements:

1. The Internal Power Supply Monitor shall be integrally powered by a built-in supply of 85-256 VAC / 24 VDC. Requires 120 VAC power.

J. Manufacturer Capability Requirements: As a minimum, the gas monitoring equipment manufacturer must meet the following requirements:

1. The manufacturer must be capable of supplying all equipment used to check or calibrate the monitor units.
2. The manufacturer must be capable of providing on-site service with factory-trained personnel.
3. The manufacturer must be capable of providing on-site training for owner/operator.
4. The manufacturer must be capable of providing replacement parts within 24 hours.

PART 3 - EXECUTION

3.1 GAS DETECTION ALARM AND CONTROL SYSTEM INSTALLATION

A. Install gas detection alarm and controls system devices where shown on the drawings. Provide all interconnecting wiring, sampling tubes, etc., for a complete assembly and operating system.

B. Calibrate and adjust sensors and transmitters in accordance with manufacturer's recommendations.

C. Manufacturer to provide all necessary calibration equipment for system start-up and maintenance.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test and adjust field assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation. Remove and replace malfunctioning parts and retest.
2. Test and adjust controls and safeties.
3. Test calibration of controllers, sensors, transmitters by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test output relays and contacts.
5. Test electrical interfaces with BAS and fire alarm systems.
6. Test audio/visual alarm sequence.

3.3 COMMISSIONING

A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and

participate in the commissioning work in accordance with requirements of Division 01 Section “Commissioning”.

B. Ensure participation of major equipment manufacturers or their representatives.

C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

B. Upon completion of all work and tests, operate systems for a sufficient length of time to demonstrate to Owner, mode of operation and definitively determine whether the system as a whole is in first class working condition. Before systems are turned over to Owner, a final demonstration test of 48 continuous hours, during which systems shall operate without adjustment, shall be performed.

C. Before installation is accepted, provide certification to Owner and Architect that control system and equipment have been inspected and found to be properly installed and functioning satisfactorily.

END OF SECTION 23 09 10

SECTION 23 21 13 - HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and other related sections apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Pipe, valves and fittings
2. Strainers
3. Hydronic System Specialties and Accessories
4. Expansion Joints and Guides

B. Related sections include:

1. Hydronic flow meters are specified in Section 23 05 19 “Meters for HVAC”.

1.3 PERFORMANCE REQUIREMENTS

A. Design working pressure and temperature for all specialties and accessories suitable for system operating temperature and pressure 125 psig at 225º F minimum.

B. Base expansion calculations on 50º F installation temperature to 200° F for hot water heating, plus 30% safety factor.

1.4 SUBMITTALS

A. Product Data: For each type of factory fabricated item indicated, include pressure ratings, construction materials, data sheets, performance characteristics, and furnished accessories.

B. Field quality-control test reports.

C. Grooved joint couplings and fittings shall be shown on the drawings and product submittals and shall be specifically identified with the applicable style or series designation.

1.5 MANUFACTURER'S SUPERVISION/INSPECTION SERVICE

A. Expansion Joints, Offset Type: Provide service of manufacturer's authorized representative to inspect installation and to submit report of his inspection to Architect.

B. Flexible Pipe: Provide inspection services by manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and that connectors are performing satisfactorily.

C. Grooved Installations: The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor’s representative is not considered qualified to conduct the training or jobsite visit(s).)

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Gaskets shall not contain asbestos.

E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

F. Conform to Standards of Expansion Joint Manufacturer's Association.

G. All grooved joint couplings, fittings, valves, and specialties shall be products of a single manufacturer. Grooving tools shall be of same manufacturer as the grooved component.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B88, Type K.

C. DWV Copper Tubing: ASTM B306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22 for pressure fittings, ASME B16.29 for drainage fittings.

E. Cast Brass Fittings: ASME B16.18 for pressure fittings, ASME B16.23 for drainage fittings.

F. Flanges for Copper Tubing: Cast Bronze, ASME B11.24, Classes 150 and 300, solder joint.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; Type E, Grade B (electric resistance welded), wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Class 125 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Threaded Unions: ASME B16.39; Class 250 as indicated in Part 3 "Piping Applications" Article.

E. Unions in Welded Steel Pipes 2 Inches and Smaller: Class 3000 carbon steel socket welding union steel to steel seat and ground joint. Stainless steel in stainless steel piping.

F. Welded Fittings for Black Steel Pipe 2 Inches and Smaller: Forged steel socket welding fittings. ASTM A105 and ASME B16.11, wall thickness to match adjoining pipe. All elbows long radius.

G. Welding Fittings for Black Steel Pipe 2½ Inches and Larger: ASTM A234/A234M and ASME B16.9, wall thickness to match adjoining pipe. All elbows long radius.

H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

I. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

J. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts and nuts in accordance with applicable ASME standards. Flanges to be of slip-on, weld neck, threaded or solder type to suit piping system in which installed.

K. Flange Gaskets: Flexitallic spiral wound gasket with PTFE filler and stainless-steel inner ring rated for 500° F service temperature. Gaskets shall be 1/8 inch thick, color coded and selected for service conditions.

L. Grooved Mechanical-Joint Fittings and Couplings:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products manufactured by the following manufacturers without substitution:

a. Victaulic Company of America.
b. Anvil/Gruvlok (sizes 14 inches and smaller).

2. Operating Conditions: -30° F through +250° F temperature range according to gasket or valve lining selected and working pressure as shown in manufacturer's current product specification.
3. Couplings

    a. Cast of ductile iron conforming to ASTM A536. Alkyd enamel coating for black steel piping systems. Galvanized finish for galvanized piping systems. Couplings designed to engage, and lock grooved or shouldered piping and fitting ends. Rigid joints.
    b. Sizes 2-1/2 inches through 12 inches: Coupling housings cast with offsetting, angle pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
    c. Sizes 14 inch through 24 inches: Coupling housing key designed to fill the wedge shaped AGS groove and provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
    d. Gaskets composed of elastomer properties as designated by ASTM D2000. Gaskets for water service Grade "EHP" EPDM, with green color code.
    e. Coupling Assembly: Housing clamps in two parts, single C-shaped gasket, two or more electroplated steel bolts as required to assemble housing clamps. Couplings with more than 2 parts are not acceptable.
    f. Equal to Victaulic Styles107 or W07, for rigid joints.

4. Fittings: Full flow type fittings with grooves designed to accept couplings of the same manufacturer. ASTM A536 cast ductile iron, ASTM A234 forged steel, or ASTM A53 carbon steel, galvanized for galvanized piping systems.
5. Where grooved mechanical joints are use, Contractor may use:

    a. Grooved design strainers:

        1) T-Type 2-1/2 inches through 12 inches: 300 psi, ductile iron body, Type 304 stainless steel frame and removable mesh basket with No. 12 or No. 6 strainer sizes, 57% free open area. Victaulic Style 730.
        2) Y-Type: 300 psi, ductile iron body, Type 304 stainless steel perforated removable metal baskets with 1/16 inch or 1/8 inch diameter perforations. Victaulic Style 732
        3) T-Type 14 inches through 24 inches: 300 psi, AGS grooved end carbon steel body, Type 304 stainless steel frame and mesh basket with T-bolt hinged closure. Victaulic Style W730.

    b. As a substitute for Butterfly Valves, Victaulic Master Seal for sizes 2-1/2 inch through 12 inch, or AGS-Vic 300 for sizes 14 inches through 24 inches. Valve stem shall be offset from the disc centerline to provide full 360-degree circumferential seating. Gear operator for valves 6 inches and larger
    c. As a substitute for Spring Loaded, Lift Disc Check Valves; Victaulic Series 716 for sizes 2-1/2 inch through 12 inch and Series W715 for sizes 14 inch through 24 inch.

6. USE OF GROOVED FLANGE ADAPTERS IS PROHIBITED. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.

M. Steel Pipe Nipples: ASTM A733, made of same materials as pipe in which they are installed, Schedule 80.

2.3 VALVES, GENERAL REQUIREMENTS

A. Valves are specified by valve type. Where more than one valve type is listed for a service, use any of the listed types, unless otherwise specified or indicated, but selection must be consistent throughout the work.

B. Bronze Valves: NPS 2 and smaller with solder or threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Gear Drive: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

J. Solder Ends: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840^{o} F for angle, check, gate, and globe valves. For ball valves and calibrated orifice balancing valves, manufacturers shall verify that valve construction is satisfactory for use with non-lead solders.

K. Threaded Ends: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

M. Automatic Temperature-Control Valves, Actuators and Sensors: Comply with requirements specified in Division 25 Section "Instrumentation and Control for HVAC".

2.4 COPPER-ALLOY BALL VALVES

A. Acceptable Manufacturers

1. Two-Piece, Copper-Alloy Ball Valves, NIBCO, Inc., series listed, or equivalent product manufactured by:

a. Conbraco Industries, Inc.; Apollo Div.

b. Crane Co.; Crane Valve Group; Crane Valves
c. Metso; Jamesbury, Inc.
d. Milwaukee Valve Company
e. Watts Industries, Inc.; Water Products Div.
f. Worcester

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Bronze body with full-port, stainless steel ball and trim; PTFE seats and packing; and 600-psig minimum CWP rating and blowout-proof stem. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM B62 Alloy C83600 (Threaded) or Bronze ASTM B61, ball and/or trim. Forged or yellow brass bodies will not be accepted. NIBCO T-585-70-66 and 5-585-70-66.

2.5 HIGH-PRESSURE (HIGH PERFORMANCE) BUTTERFLY VALVES

A. Acceptable Manufacturers: NIBCO, Inc. figure number listed or approved equal by:

1. DeZurik
2. Crane Co.; Crane Valve Group; Flowseal
3. Metso; Jamesbury, Inc.
4. Posi-Seal
5. Tyco International, Ltd.; Tyco Valves & Controls; Keystone Valves

B. High-Pressure Butterfly Valves:

1. General: MSS SP-68. 6 inches and larger for Balancing Service, except not allowed for pump discharge or cooling tower balancing service 2½ inches or larger where used for shutoff service only, except not allowed for boiler shutoff service) for Hot or Chilled Water Service.
2. Butterfly valves to have full-lug carbon steel ASTM A216 lug body, one-piece stainless-steel stem with stainless steel bearings and stainless-steel disc manufactured in conformance with MSS SP-68, MSS SP-25, and API-609. Valve shall be capable of bi- directional dead-end service at full pressure rating of the valve with no downstream flanges required. Drive end of shaft to be designed to accept universal ISO 5211 Actuator Mounting top works. The stem journals will be a multiple seal design providing for completely independent seals. Positive stem retention to be provided using 316 stainless steel keys locked in place, to permit removal of handle or actuator while under full operating pressure. Design discs with an offset flat face to reduce dynamic torque, decrease turbulence and maximize flow capacity. Provide disc-to-shaft locking keys of stainless steel and of the tangential or compressive type. The valve seats to consist of replaceable PTFE seating surface with a stainless-steel retaining ring. Shaft and thrust bearings to be of combination permanently lubricated reinforced PTFE with 316 stainless steel. Provide packing of multiple PTFE and graphite V-ring design with adjustable stainless steel gland follower and gland.
3. Valves 3 to 6 inches to be supplied with multi-position, lever-lock handles; size 8 inch and larger to be supplied with gear operator. Valve body to be full-lug pattern to comply with MSS-SP-68 and be compatible with ANSI 150 or 300 pattern flanges of appropriate pressure rating. Similar to NIBCO series ANSI Class 150 LCS-6822-3, 3 to 6 inches; LCS-6822-5 8 inches and larger). ANSI Class 300 LCS 7822-3, 3 to 6 inches; LCS-7822-5 (8 inches and larger).

2.6 BRONZE CHECK VALVES

A. Acceptable Manufacturers:

1. Type 1, Bronze, Lift Check Valves with Metallic Disc:

a. NIBCO, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves
c. Milwaukee Valve Co.

2. Type 3, Bronze, Swing Check Valves with Metallic Disc:

a. NIBCO, Inc.
b. Crane Co.; Crane Valve Group; Crane Valves
c. Milwaukee Valve Company

B. Bronze Check Valves, General: MSS SP-80. Dezincification-resistant bronze body, Bronze ASTM B584 Alloy C84400 (Solder) or Bronze ASTM B62 Alloy C83600 (Threaded) or Bronze ASTM B61. Forged or yellow brass bodies will not be accepted.

C. Type 1, Class 125, Bronze, Horizontal or Vertical Lift Check Valves: Bronze body with PTFE disc and bronze seat. NIBCO T/S 480-Y.

D. Type 1, Class 300, Bronze, Horizontal or Vertical Lift Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 473-B.

E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 413-B.

F. Type 3, Class 300, Bronze, Swing Check Valves: Bronze body with renewable metallic disc and bronze seat. NIBCO T/S 473-B.

2.7 GRAY-IRON SWING CHECK VALVES

A. Acceptable Manufacturers:

1. Type II, Gray-Iron Swing Check Valves with Composition to Metal Seats:

a. NIBCO Inc.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Milwaukee Valve Co.

2. Grooved-End, Ductile-Iron Swing Check Valves:

a. NIBCO, Inc.
b. Mueller Co.
c. Victaulic Co. of America.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

C. Type I, Class 125, gray-iron, swing check valves with renewable metallic disc and seats. NIBCO F-918-B.

D. Type II, Class 300, gray-iron, swing check valves with renewable metallic disc and seats. NIBCO F-968-B; Class 250 cast iron.

E. 175-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends. NIBCO G-917-W; Cast Iron, Grooved, 250 psi, Swing Check; or KG-900-W; Cast Iron, Grooved, 250 psi, Silent Check.

F. 300-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends and stainless-steel disc and shaft. NIBCO KG-900-W-350; Cast Iron, Grooved, 350 psi, Silent Check.

2.8 SPRING-LOADED, LIFT-DISC CHECK VALVES

A. Acceptable Manufacturers:

1. Type III, Globe Lift-Disc Check Valves:

   a. NIBCO, Inc.
   b. Metraflex Co.
   c. Milwaukee Valve Company

2. Type IV, Threaded Lift-Disc Check Valves:

   a. NIBCO, Inc.
   b. Metraflex Co.
   c. Milwaukee Valve Company
   d. Mueller Steam Specialty

B. Lift-Disc Check Valves, General: FCI 74-1 or MSS-SP-125 (Type III), with spring-loaded bronze, PTFE or alloy disc and bronze or alloy seat.

C. Type III, Class 125, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends. NIBCO F-910-W.

D. Type III, Class 250, Globe Lift-Disc Check Valves: Globe style with cast-iron shell and flanged ends. NIBCO F-960-W.

E. Type IV, Class 125, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends. NIBCO T-480.

F. Type IV, Class 150, Threaded Lift-Disc Check Valves: Threaded style with bronze shell and threaded ends. NIBCO T-480.

2.9 BRONZE GLOBE VALVES

A. Acceptable Manufacturers:

1. Type 2, Bronze Globe Valves with Nonmetallic Disc:

    a. NIBCO, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves
    c. Milwaukee Valve Company
    d. Powell, Wm. Co.

2. Type 3, Bronze Globe Valves with Renewable Seats:

    a. NIBCO, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves
    c. Milwaukee Valve Company
    d. Powell, Wm. Co.

B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 2, Class 125, Bronze Globe Valves: Bronze body with PTFE disc and union-ring bonnet. NIBCO T/S 211-Y.

D. Type 3, Class 300, Bronze Globe Valves: Bronze body with renewable stainless-steel seats and union-ring bonnet. NIBCO T-276-AP.

2.10 CAST-IRON GLOBE VALVES

A. Acceptable Manufacturers:

1. Type I, Cast-Iron Globe Valves with Renewable Metal Seats:

    a. NIBCO, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Milwaukee Valve Company.

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 125, Cast-Iron Globe Valves: Gray-iron body with renewable bronze seats. NIBCO F-718-B; F-818-B (Angle).

D. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with renewable bronze seats. NIBCO F-768-B; F-869-B (Angle Stop/Check/Globe).

2.11 BRONZE, CALIBRATED-ORIFICE, BALANCING VALVES

A. Acceptable Manufacturers:

1. Armstrong Pumps, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries
3. Taco
4. Tour-Anderson; available through Victaulic Company

B. Body: Bronze, ball, globe or plug type with adjustable calibrated orifice capable of pre- calculating and pre-setting.

C. Ball: Brass or stainless steel.

D. Plug: Resin.

E. Seat: PTFE or Ametal copper alloy.

F. End Connections: Threaded or solder.

G. Pressure Gage Connections: Integral seals for portable differential pressure meter.

H. Handle Style: Lever, with memory stop to retain set position and marked position settings.

I. CWP Rating: Minimum 125 psig.

J. Maximum Operating Temperature: 250° F.

2.12 CAST-IRON OR STEEL, CALIBRATED-ORIFICE, BALANCING VALVES

A. Acceptable Manufacturers:

1. Armstrong Pumps, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries
3. Taco
4. Tour & Anderson; available through Victaulic Company

B. Body: Cast-iron or steel body, ball, plug, or globe pattern with adjustable calibrated orifice venture capable of pre-calculating and pre-setting.

C. Ball: Brass or stainless steel.

D. Stem Seals: EPDM O-rings.

E. Disc: Glass and carbon-filled PTFE.

F. Seat: PTFE.

G. End Connections: Flanged or grooved.

H. Pressure Gage Connections: Integral seals for portable differential pressure meter.

I. Handle Style: Lever, with memory stop to retain set position and marked position settings.

J. CWP Rating: Minimum 125 psig.

K. Maximum Operating Temperature: 250° F.

2.13 NEEDLE VALVES

A. Acceptable Manufacturers

1. Stockham
2. Nibco
3. Crane
4. Milwaukee

B. Bronze body and stem, working pressure to match piping system in which installed.

2.14 DRAIN AND VENT COCKS

A. Acceptable Manufacturer

1. Ernst Gage Co. or equal.

B. Bronze needle valve, duplex design, repackable stem, male outlet with cap. Service rating 300 psi steam pressure, 500 psi at 100° F gas liquid pressure.

2.15 DIAPHRAGM-OPERATED, PRESSURE-REDUCING VALVES

A. Acceptable Manufacturers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries
4. Conbraco Industries, Inc.
5. Taco, Inc.
6. Spence Engineering Company, Inc.
7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Design working pressure and temperature suitable for system operating temperature and pressure, 125 psig at 225° F.

C. Automatic Fill Valves: Pressure regulating type that will not stick nor allow pressure to build up on low side. Capable of field adjustment and set to maintain terminal pressure of approximately 5 psig in excess of static head on system, within a 2 pound maximum variation regardless of initial pressure fluctuation and without objectionable noise under any condition of operation. Brass body with non-corrosive valve seat and stem. Built-in anti-siphon check valve to prevent backflow of water when make-up water line pressure falls below the system pressure.

2.16 DIAPHRAGM-OPERATED, SAFETY VALVES

A. Acceptable Manufacturers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries

4. Conbraco Industries, Inc.
5. Taco, Inc.
6. Thrush
7. Spence Engineering Company, Inc.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Design working pressure and temperature suitable for system operating temperature and pressure, 125 psig at 225° F minimum.

C. ASME label and rated direct spring-loaded type, lever operated, thermostat of stainless steel or protected with a thermo-bonded coating, emergency fusible plug, non-adjustable factory set discharge pressure. Set for temperature and pressure limits of system.

D. Selection system relief valve capacity so that it is greater than make-up valve capacity and to exceed maximum btu/hr. rating of connected equipment. Use AGA temperature steam ratings when sizing for water heater.

2.17 PRESSURE/TEMPERATURE TEST PLUGS

A. Acceptable Manufacturers:

1. Peterson Equipment Company, Inc.
2. SISCO

B. Solid brass test plug with cap and seal, Nordel inner core for up to 300° F, extension to suit insulation thickness. Test plug capable of receiving either a pressure or temperature probe 1/8 inch O.D. Furnish number of 1/8 inch gauges with adapters and 5-inch stem pocket thermometers for appropriate ranges specified in Warranty and Contract Closeout article of Part 1 of this section. Provide one Master Test Kit containing a 2-1/2 inch test gauge and two 5-inch pocket thermometers.

2.18 AIR CONTROL DEVICES

A. Acceptable Manufacturers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries
4. Taco.

B. Design working pressure and temperature for all specialties and accessories, suitable for system operating pressure and temperature, 125 psig at 225° F minimum.

C. Air Vent

1. Manual Air Vent: Provide 1/4 inch vent cock.
2. Automatic Air Vent: Float type with isolating valve, brass or cast-iron body, copper float, stainless steel valve and valve seat. Suitable for system operating temperature and pressure, minimum 125 psig. Minimum 3/4 inch inlet for high-capacity type, 1/2 inch elsewhere, 1/4 inch outlet.

D. Air Separator

1. Centrifugal type similar to Bell & Gossett "Rolairtrol" Type R, with steel tank, perforated stainless steel air collector and drain connection, ASME stamped for 125 psi working pressure.
2. In-Line type similar to Bell & Gossett Type IAS, cast iron construction designed for 175 psi working pressure at 300° F with integral weir designed to decelerate system flow to maximize air separation.
3. Size in accordance with manufacturer's recommendations for circulating rate of system, but not less than adjacent pipe size.

2.19 EXPANSION TANK

A. Precharged and pressurized expansion tank, welded carbon steel ASME constructed and stamped for 125 psi, with sealed-in elastomer diaphragm suitable for temperatures to 240° F. Provide air charging fitting, pressure gauge, and drain fitting. Provide vertical unit with base for floor mounting.

2.20 STRAINERS GENERAL SERVICE

A. Acceptable Manufacturers

1. NIBCO, Inc.
2. Armstrong Machine Works
3. Hoffman Specialty, ITT
4. Illinois
5. Keckley
6. Mueller Steam Specialty
7. Spirax-Sarco

B. Cast iron (ASTM A126, Grade B), carbon steel (ASTM A216, Grade WCB) or brass (ASTM B62) body as required to meet system pressure and temperature requirements, screwed or flanged ends matching piping in which installed. Provide straight threaded gasket face cap with gasket for screwed end type, cast iron or hot rolled steel cover with gasket for flanged end type and bottom drain connection. Type 304 stainless steel screen unless otherwise required for application with net free area not less than three times the area of the inlet pipe. Maximum 2 psig pressure drop at design flow.

1. Size 4 inch and under, 1/32-inch (20 mesh) perforated screen.
2. Size 5 inch and larger, 1/8-inch perforated screen.

C. Y pattern, except basket pattern in low horizontal piping without sufficient clearance for Y pattern screen removal/replacement.

D. For Stainless Steel Piping: As above except ASTM A296 cast stainless steel body, 150 psig, flanged Y pattern. Mueller Steam Specialty 781-SS.

2.21 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers:

1. Anaconda
2. Flexonics
3. Korfund
4. Metraflex

B. General: Fabricate of multiple plys of nylon card, fabric, and neoprene, vulcanized so as to become inseparable and homogeneous.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: 2 inches and smaller threaded; 2-1/2 inches and larger flanged.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250° F.
6. Maximum Unit Lengths: 12 inches up to 3-inch size, 18 inches for sizes 4 inches and larger.

D. Provide control rods or cables to control extension of connector.

2.22 EXPANSION JOINTS

A. Acceptable Manufacturers:

1. Metraflex Co.
2. Adsco Manufacturing Corp.
3. Flexonics
4. Keflex, Inc.
5. Hyspan Precision Products Co.

B. General

1. Conform to the standards by Expansion Joint Manufacturers Association. Provide joints with design working pressure to match specified class of valves, flanges, and fittings of piping system in which installed and with material of construction suitable for piping system in which installed.
2. Provide joint(s) with rated stroke capable of absorbing 200% of maximum piping expansion at installed location.

C. Bellows Type Externally Pressurized Expansion Compensator for Pipe Sizes 4 Inches and Smaller

1. 150 psig minimum design working pressure, 2 inch rated piping system expansion (refer to Paragraph B.2. above), 1/2 inch rated piping system contraction.
2. For Copper Tubing: Packless all welded and silicon brazed construction, stainless steel housing, internal guide ring, externally pressurized 2-ply stainless steel bellows. Soldered ends for pipe sizes 2 inches and smaller. Factory or field installed soldered to bronze flanged ends for pipe size 2 1/2 inches and larger.
3. For Steel Pipe: Packless all welded construction, carbon steel or stainless steel, internal guide ring, externally pressurized 2-ply stainless steel bellows, internal antitorque device for threaded end models. Pipe sizes 2 inches and smaller welded or threaded ends to match piping

system in which installed. Factory or field installed slip-on or weld neck forged steel flanged ends for pipe sizes 2 1/2 inches and larger.

D. Bellows Type Externally Pressurized Expansion Joint, for all Copper Tubing or Steel Pipe Sizes

1. 150 psig or 300 psig minimum design working pressure to suit character of piping system in which installed, rated piping system expansion up to 8 inches (refer to Paragraph A.2. above) for single joint and 16 inches for dual joint, rated contraction 1/2 inch minimum to 2 inches for single joint, forged steel flanged ends.
2. Packless all welded construction, inner pipe and housing ASTM A53 Grade B of equal or greater schedule than piping system in which installed, internal guide ring with travel limited to rated expansion stroke plus 1/2 inch maximum, laminated or multiply stainless-steel bellows, housing drain and vent ports.
3. Factory or field installed reducer for pipe sizes smaller than 2 inches.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints. Nipples Schedule 80.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings up to NPS 3 (DN 80). Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Solder mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.
3. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings and welded and flanged joints. Nipples Schedule 80.
4. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints. Nipples Schedule 80.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings up to NPS 3 (DN 80). Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Solder mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.
3. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings and welded and flanged joints. Nipples Schedule 80.
4. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Grooved, mechanical joint coupling and fittings; and grooved, mechanical joints allowed in accessible locations only. Grooved couplings not allowed within shafts, furred spaces or above inaccessible ceilings. Weld mating flange to grooved piping section to connect directly to ANSI 125/150 flanged components.

E. Condensate-Drain Piping, NPS 1 and smaller shall be any of the following:

1. Type L, drawn temper copper tubing, wrought copper fittings, and soldered joints.

F. Condensate-Drain Piping NPS 1-1/4 and larger, shall be the following:

1. Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 PIPING INSTALLATION

A. Refer to Section 23 05 00, “Common Materials and Methods for HVAC”, for general piping installation requirements.

B. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

D. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe. Bull head tees are not allowed.

E. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in- line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of

strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 VALVE APPLICATIONS

A. Unless otherwise noted, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Throttling or Balancing Service: Angle, ball, butterfly, or globe valves. Butterfly valves not allowed for balancing at pump discharge or for cooling tower balancing service.
3. Pump Discharge: Spring-loaded, lift-disc check valves (non-slam).

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

D. Install calibrated-orifice, balancing valves at each branch connection to return main.

E. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

H. Safety relief valve vent lines shall not connect to piping serving other relief devices or equipment.

I. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

J. Chilled-Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two piece, 600-psig CWP rating, copper alloy.
4. High-Pressure (High Performance) Butterfly Valves, NPS 2-1/2 and Larger: Threaded Lug Type, Class 300.
5. Lift Check Valves, NPS 2 and Smaller: Type 1, Class 125, horizontal or vertical, bronze.
6. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
7. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
9. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 250, cast iron.
10. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze- mounted cast iron.

K. Condenser Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.

2. High-Pressure (High Performance) Butterfly Valves, NPS 2-1/2 and Larger: 300.
3. Lift Check Valves, NPS 2 and Smaller: Type 1, Class 125, horizontal or vertical, bronze.
4. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
6. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125
7. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 250, cast iron.
8. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
9. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze- mounted cast iron.

L. Heating Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 125, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
4. High-Pressure Butterfly Valves, NPS 2-1/2 and Larger: Threaded Lug Type, Class 300.
5. Lift Check Valves, NPS 2 and Smaller: Type 1, Class 125, horizontal or vertical, bronze.
6. Swing Check Valves, NPS 2 and Smaller: Type 3, Class 125, bronze.
7. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
8. Spring-Loaded, Lift-Disc Check Valves, NPS 2 and Smaller: Type IV, Class 125 minimum.
9. Spring-Loaded, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Type III, Class 250, cast iron.
10. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze- mounted cast iron.

3.4 VALVE INSTALLATION

A. General

1. Provide valves at locations shown, where specified and where required to properly control piping systems. Provide valves recommended or required by equipment manufacturers and codes for proper operation of equipment and shutoff valves to allow isolation of each main and branch service line, whether or not indicated or specified.
2. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
3. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
4. Examine threads on valve and mating pipe for form and cleanliness.
5. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
6. Do not attempt to repair defective valves; replace with new valves.
7. Install valves in horizontal piping with stem at or above the center of the pipe.
8. Install valves in a position to allow full stem movement.

B. Check Valves: Provide lift check type after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.

C. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.

3.5 HYDRONIC SPECIALTIES INSTALLATION

A. Air Vents

1. Provide as indicated or required to fully vent air from the system.
2. Provide manual type air vents for fan coil units, small water coils, and similar equipment.
3. Provide float type, automatic air vents with valved inlet and discharge piped to floor drain for large capacity water coils, as in air handling units, for large piping mains and other major equipment in equipment rooms, and where indicated on Drawings.
4. Provide manual type air vents at high points of water circulating systems with pipe size air chamber, minimum 2 inches. Where high points are not readily accessible, provide 1/4 inch piping and tubing to manual air vent and locate valve in an accessible location.

B. Expansion Tank

1. Provide expansion tank for the following systems:

    a. Chilled Water
    b. Heating and Reheat Water

C. Pressure/Temperature Test Plugs: Provide nipple as required to locate cap of P/T plug outside of surface of pipe insulation.

D. Relief Valves

1. Provide as required or shown on all water systems and equipment. Aggregate relieving capacity as required by ASME Code. Install valve(s) furnished by boiler manufacturer if not factory installed.
2. Select system relief valve capacity so that it is greater than makeup pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
3. Pipe relief valve outlet to nearest floor drain.
4. Safety relief valve vent lines shall not connect to piping serving other relief devices or equipment.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections. Provide full size service to equipment with reducers at equipment connections.

B. Install control valves in accessible locations close to connected equipment.

3.7 COOLING COIL CONDENSATE DRAIN PIPING

A. Comply with requirements of applicable mechanical and plumbing code.

B. Drain piping for central air conditioning units may not be shown on the Drawings. Provide as required, whether or not indicated.

C. Provide drain piping for room air conditioning units.

D. Provide water seal traps of sufficient depth to maintain water seal against system static pressure. Enter building drainage system only through an air gap. Run piping to nearest convenient floor drain or as indicated. Pitch at least 1/4 inch per foot unless otherwise noted or directed.

E. Provide plugged "TY" at each change in direction and at approximately 60 foot centers on straight runs. Provide cleanout at base of vertical risers as required.

3.8 FLEXIBLE PIPING CONNECTIONS

A. Install where shown, where specified and at all base-mounted pumps, chillers and elsewhere where required. On pipes connected to equipment supported by vibration isolation, install parallel to axis of rotation. Install one end immediately adjacent to the isolated equipment and anchor other end.

B. Flexible piping connections shall not be used to correct misalignment between equipment and connected piping.

C. Except for drainage piping, provide for piping that crosses a building seismic expansion joint in such a manner that building movement cannot be accommodated by pipe offsets or loops.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor’s representative is not considered qualified to conduct the training or jobsite visit(s).)

C. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure for a minimum of 4 hours with no drop in pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. At the beginning of the pressure test, and periodically during the test, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

D. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 23 - HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following HVAC Pumps:

1. Centrifugal Pump, Base Mounted, End Suction, Flexible Coupled
2. Pump Suction Diffuser

B. Related sections include the following:

1. Variable Frequency Motor Speed Controllers furnished by Division 23 are specified in Division 26
2. Refer to Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”
3. Refer to Division 23 “Hydronic Piping Systems”

1.3 PERFORMANCE REQUIREMENTS

A. Pump Selection

1. For pumps, both pump manufacturer and contractor shall be responsible for providing pumps and motors sized and selected so that manufacturer's pump curve crosses the system curve for both single pump operation and combined pump operation. Submit verifying parallel pump operating curve.
2. Ensure pump operates at specified system fluid temperatures without vapor binding and cavitation, has non-overloading motor in parallel or individual operation at every point on pump curve, operates within 25% of midpoint of published maximum efficiency curve.
3. Select pump so that ratio of impeller diameter used to maximum impeller diameter shown on pump curve shall not exceed 0.95. Impeller diameter may be increased to not greater than 95% of casing cut-water diameter provided that submittal includes either certified letter from factory or published literature listing pump cut-water diameter.
4. Select all pumps for full non-overloading at every point on pump curve.

1.4 REFERENCES

A. ASTM A36 - Specifications for Structural Steel.

B. ASTM A48 - Specification for Gray Iron Castings.

C. ASTM A532 - Specification for Abrasion-Resistant Cast Irons.

D. ASTM B36 - Specification for Brass Plate, Sheet, Strip and Rolled Bar.

E. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.

F. ASTM B548 - Specification for Copper Alloy Sand Castings for General Applications.

1.5 SUBMITTALS

A. Product Data: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

B. Manufacturers Seismic Qualification Certification: Submit Certification that pump(s) components and accessories will withstand seismic forces defined in Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems.”

C. Certificates:

1. Manufacturer’s start up certificate for all pumps.

1.6 MANUFACTURER’S SUPERVISION AND STARTUP

A. Base-Mounted Centrifugal Pump: Provide startup service supervised by manufacturer's representative, who shall certify in writing that pump operates in accordance with the intent of the specifications and has been checked, and corrections made, when necessary, for:

1. Rotation
2. Lubrication
3. Absence of pipe strain.
4. Suction and discharge pressures.
5. Current and voltage readings
6. Alignment, Flexible Coupled Only: $\pm$ 0.005 Inch, 4 ways.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer. Deviation from this requirement will be acceptable where only one acceptable manufacturer is listed for a particular pump.

B. Electrical Components, Devices, and Accessories: Shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Standards: Comply with the requirements of the following:

1. "Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps" for design, manufacture and installation.
2. NEMA MG-1: Motors and Generators.

3. NEMA ICS-6: Enclosures for Industrial Control and Systems.
4. NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum).
5. NFPA 70: National Electrical Code.

D. Finish: Manufacturer's standard paint, factory applied.

E. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surface and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings and nozzles with wooden flanges or screwed inserts.

F. Casing and Impeller Construction: Unless otherwise specified or required or recommended by pump manufacturer, materials of construction shall be as follows:

1. Cast iron pump casing: ASTM A48, minimum class as specified. Class as recommended by pump manufacturer where not specified.
2. Cast bronze pump casing or impeller: ASTM B124.
3. Cast brass impeller: ASTM B36 or B62 as recommended by pump manufacturer for application.

G. Mechanical Pump Seals: Mechanical seal suitable for continuous duty with water/liquid and temperature specified or scheduled and with water treatment specified elsewhere in Division 23. Fabricate mechanical seals with carbon rotating seal face ring, Type 316 stainless steel springs and, as required and recommended for application.

1. Ni-Resist ceramic or tungsten carbide stationary seat.
2. Brass or Type 316 stainless steel retainer.
3. Buna N or EPT elastomers.

H. Slingers: Provide for close coupled pumps so that leakage past pump seal cannot enter motor bearings

I. Statically and dynamically balance all rotating parts.

J. Pump bearings shall be re-greasable ball type with grease fitting unless otherwise specified.

K. All pumps shall have drain and vent ports on casing.

L. Motor and Starting Equipment

1. Motor and starting equipment shall comply with requirements of Section 23 05 13 “Electrical Requirements for HVAC Equipment”.
2. Motor sizes shown are maximum.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL, BASE MOUNTED PUMPS

A. Acceptable Manufacturers:

1. Bell & Gossett ITT

2. Patterson Pump Co.
3. Aurora Pump
4. PACO Pumps
5. Armstrong
6. Taco, Inc.

B. General

1. Provide pump casing with inlet and outlet gauge tappings.
2. Unless otherwise indicated or specified, provide bronze statically and dynamically balanced impeller keyed to shaft, replaceable bronze case wear rings.
3. Provide mechanical seals for all pumps.
4. Mechanical Seal and Shaft: Metallic parts of seal stainless steel with 225° F. seat for general hot and cold-water service. Shaft of carbon steel with either Type 316 stainless steel or bronze sleeve and O-ring gasket between sleeve and impeller hub unless otherwise specified hereinafter.
5. Provide seal flushing line for all pumps, internal or external type as required by pump manufacturer.
6. Coupling for Flexible Coupled Pump: Flexible, capable of absorbing torsional vibration
7. and shaft misalignment. Provide flexible-spacer type, with flange and sleeve section that can be disassembled and removed without removing or moving pump or motor.
8. Mounting Frame: Welded-steel frame and cross members, factory-fabricated from ASTM A36 channels and angles. Fabricate for mounting pump casing, coupling guard, and motor. Grind welds smooth before application of factory finish. Field-drill motor-mounting holes for field-installed motors.
9. Motor: Secured to mounting frame, with adjustable alignment.
10. Provide manufacturer's startup service as specified in Part 1 of this section.

C. End-Suction, Flexible Coupled

1. Supported volute, vertically split case back pullout design for complete servicing without disturbing piping, centrifugal, equipped with cast iron casing, Class 30 minimum, rated for greater of 175 psig.
2. Connections 2 inches in size and larger flanged, ANSI Class 125.
3. Flexible coupling drive with OSHA approved, removable coupling guard covering exposed shafting.
4. Mount pump and motor on heavy steel or cast-iron base plate.

2.2 PUMP SUCTION DIFFUSER/STRAINER

A. Acceptable Manufacturers:

1. Pump Suction diffuser shall be provided by pump manufacturer properly matched to the pump.

B. Unit shall consist of cast iron angle type body with easily removable end cap, pressure gauge tapping, stainless steel straightening vanes, stainless steel diffuser-strainer-orifice cylinder with free area equal to five times cross-sectional area of actual pump suction connection, removable permanent magnet located within the flow stream and adjustable foot to carry weight of suction pipe.

C. Design working pressure shall be 175 psig. Inlet shall be full line size as shown on the drawings. Outlet shall be same size as actual pump suction connection. Maximum pressure drop shall not exceed 7 feet water pressure drop.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to and comply with requirements specified in Section 23 05 00 “Common Materials and Methods for HVAC”.

B. Refer to Section 23 05 48 for vibration isolation and seismic restraints.

C. Where pump is installed on a concrete pad or concrete filled inertia base, grout pump to pad on base after concrete has cured. Refer to Section 23 05 00 for additional requirements.

D. Install all equipment as recommended by manufacturer and in accordance with recommendations of Hydraulic Institute.

E. Align and verify alignment of base mounted pumps.

F. Where pump connection is smaller than pipe size indicated, valves, strainers and other pipe line accessories shall be line sized.

G. Support piping adjacent to pump such that no weight is carried on pump casings.

H. Suspend in-line pump independent from piping.

I. Provide drains for bases, piped to floor drains.

J. Provide air cock and drain connection on horizontal pump casings.

K. Use eccentric suction reducer at pump suction and concentric discharge increaser at pump discharge.

L. Where elbows must be used at pump suction, provide long radius reducing type**.**

M. Provide line sized shutoff valve and strainer and pressure gauge on suction line and line sized soft-seated check valve, balancing valve and pressure gauge on discharge line.

N. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over and on smaller sizes as shown or necessary.

3.2 FIELD QUALITY CONTROL

A. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Lubricate bearings.
2. Check motor for proper rotation that matches direction marked on pump casing.
3. Check that pumps are free to rotate by hand. Pumps for handling hot liquids shall be free to rotate with pump hot and cold. Do not operate pump if it is bound or even drags slightly until cause of trouble is determined and corrected.

4. Check that pump controls are correct for required application.
5. Where applicable, set pump controls for automatic start, stop and alarm operation as required for system application.
6. Check alignment.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power:

1. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
2. Open circulating line valves since pumps must not be operated against dead shutoff.
3. Start motors.
4. Check general mechanical operation of pumps and motors.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and other related sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

B. Related Sections

1. Division 23, “Common Materials and Methods for HVAC”
2. Division 23, “Vibration Isolation and Seismic Restraints for HVAC Systems”
3. Division 23, ‘Unitary Air Conditioning”

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig
2. Suction Lines for Heat-Pump Applications: 535 psig
3. Hot-Gas and Liquid Lines: 535 psig

1.4 SUBMITTALS

A. Product Data: Include catalog cuts for factory fabricated items.

B. Welding certificates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 MANUFACTURER'S SUPERVISION/INSPECTION SERVICE

A. Refrigerant Piping System: Provide the services of the equipment manufacturer, or his authorized representative, to design and supervise the installation, cleaning and testing of the field installed refrigerant piping system. At the completion of the installation, the equipment manufacturer shall certify, in writing, to the Architect that the installation was made in accordance with his design and recommendations and shall provide record fabrication drawing schematics showing all pipe sizes and specialties of complete refrigerant piping systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube for Refrigerant Service: ASTM B 280, ACR copper tubing, Type K or L Hard, except soft tubing in coils may be used in sizes 7/8 ODS and smaller for final branch to equipment having flared connections. Pipe and fittings manufactured especially for refrigeration. All pipe cleaned, dried, charged with nitrogen and sealed with pressure tight plugs at the factory.

B. Copper Tube for Refrigerant Vent Service: ASTM B 88, Type L Hard copper tubing.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Cast Brass Fittings: ANSI B16.18, Tinned coat brass may be used in larger sizes where wrought copper is not available.

F. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

G. Brazing Filler Metals: AWS A5.8.

H. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Grade B black steel with plain ends; Schedule 40, nipples Schedule 80, coated with ASTM B6 slab zinc inside and outside by the hot-dip process.

B. Malleable Iron Threaded Fittings: ASTM A 197 black malleable iron. ANSI B16.3, Class 150 banded, with ANSI B1.20.1 standard taper pipe threads. Coated with ASTM B6 slab zinc inside and outside by the hot-dip process.

C. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
2. End Connections:

    a. NPS 2 and Smaller: With threaded-end connections.
    b. NPS 2-1/2 and Larger: With flanged-end connections.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 REFRIGERANT VALVES AND SPECIALTIES

A. Acceptable Manufacturers:

1. Henry Valve Co.
2. Sporlan Valve Co.
3. Superior Valve Co.
4. Mueller Brass Co.

B. Type REFV, Refrigerant Valves

1. Shutoff Valves: Brass, back seating ball, globe, and angle valves. Diaphragm packless type for 1-5/8-inch ODS and smaller, packed type with winged sealing cap for 2-1/8 inch ODS and larger.
2. Check Valves: Brass body and piston, stainless steel spring, screw cap for 5/8-inch ODS and smaller. Bronze body, floating piston, soft seat disc for 7/8-inch ODS and larger.

2.4 REFRIGERANT STRAINERS

A. Acceptable Manufacturers:

1. Henry Valve Co.
2. Sporlan Valve Co.
3. Superior Valve Co.
4. Mueller Brass Co.

B. Angle or Y pattern, brass body, renewable screen of 100 mesh monel metal reinforced with 10 mesh brass screen, not screen free area at least 10 times that of refrigerant line.

2.5 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane.

PART 3 - EXECUTION

3.1 REFRIGERANT PIPING APPLICATIONS

A. Suction Lines for Conventional Air-Conditioning Applications: ACR Copper, Type K or L, hard tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: ACR Copper, Type K or L, hard tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping NPS 2-1/2 and Larger: Schedule 40, galvanized steel pipe and galvanized fittings with threaded joints.

D. Safety-Relief-Valve Discharge Piping NPS 2 and Smaller: Copper, Type L, drawn- temper tubing and wrought-copper fittings with soldered joints.

3.2 REFRIGERANT PIPING AND SYSTEM INSTALLATION

A. Refer to Section 23 05 00 “Common Materials and Methods for HVAC”, for general piping installation requirements.

B. Install refrigerant piping according to ASHRAE 15, complete with hangers, fittings, valves, strainers, drier, oil traps, etc.

C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

D. Install refrigerant piping in protective conduit where installed belowground.

E. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

F. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Liquid lines may be installed level.

G. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

H. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

I. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

J. Bleed dry nitrogen through the lines when making joints.

K. Size and run refrigerant piping in accordance with common good practices, the recommendations of the equipment manufacturers and the Equipment Standards of the Air Conditioning and Refrigerating Machinery Association, Inc. Entire installation, including safety devices, testing and cleaning, conform to ANSI B9.1 and B31.5. Provide piping system, as required, with: liquid-suction heat exchangers, ASME coded liquid receivers, double risers, all necessary purge and charging valves and moisture indicating liquid line sight glass in each circuit, shutoff, relief and drain valves and connections, a full-flow removable cartridge type refrigerant drier and a strainer installed with a three valve bypass arrangement in the liquid line close to each condensing unit if not built into the equipment, a strainer in the suction connection to each compressor if the compressor does not have built-in scale traps, external strainers on the inlet side of each solenoid valve and each thermal expansion valve, regardless of any internal strainer that may be incorporated in the valve construction, hot gas muffler, and flexible connections at equipment mounted on resilient supports.

L. Provide appropriate refrigerant charging and recovery valves and fittings in each refrigerant circuit.

M. Provide pressure relief valves if required for venting. Pipe relief lines to outside of building, terminate with an ell turned down and a bug screen.

N. Isolation valves shall be low pressure drop design ball type, designed specifically for refrigerant system.

O. Provide necessary operating charges of refrigerant and oil.

P. Clean interior of any refrigerant piping, should it become dirty, by first rodding pipe with a wire brush and then rodding pipe with cheesecloth with refrigerant oil on it. Make at least three (3) passes with cheesecloth using a clean cheesecloth with clean refrigerant oil each time.

Q. Test as specified hereinafter under FIELD QUALITY CONTROL, and charge with refrigerant. If initial charging occurs at ambient temperature below 55 degrees F., recharge again when ambient is above 55 degrees F. Test and recharge with refrigerant as required during first full summer of operation, April 1, through October 31, without additional cost to Owner.

R. Support piping at no more than eight-foot intervals and pitch not less than 1 inch per 20 feet in direction of flow.

S. Provide the services of the equipment manufacturer, or his authorized representative, as specified in the Article titled "Manufacturer's Supervision/Inspection Services".

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with dry nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test (minimum 24 hours).
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.4 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.5 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 24 13 - UNDERGROUND DISTRIBUTION PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and other related sections, apply to this Section.

1.2 SUMMARY

A. This Section includes underground piping outside the building for distribution of heating hot water and chilled water. This section also includes prefabricated manholes and valve boxes for underground distribution piping systems.

B. Refer to Division 23 Sections for applicable aboveground piping system for piping, valves and accessories located inside manholes and valve boxes.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation suitable for system operating temperature and pressure.

1.4 SUBMITTALS

A. Product Data: Include for the following:

1. Cased piping

B. Shop Drawings:

1. Calculate requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from underground distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing underground distribution piping.

E. Welding certificates.

F. Manufacturer Certificates: Signed by manufacturers certifying that cased piping complies with requirements.

G. Field quality-control test reports.

1.5 MANUFACTURER'S SUPERVISION/INSPECTION SERVICE

A. Underground Distribution System(s)

1. Provide services of a factory trained field service instructor, a full-time employee of the manufacturer, who shall be present during critical stages of installation and tests including, but not limited to, unloading and handling of components, placing of system in trench, hydrostatic and air testing, placement of anchors and backfill. Field service instructor shall submit a report to Owner at each visit to jobsite certifying that piping system is being installed in accordance with manufacturer's recommendation and shall report to Owner immediately, any deviation from accepted installation procedures.
2. At completion of installation, deliver to Owner a certificate from the underground distribution piping system manufacturer certifying that system was installed in accordance with manufacturer's recommendations.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

B. ASME Compliance: Comply with ASME B31.1, Power Piping" and ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 CASED PIPING

A. Acceptable Manufacturers:

1. Rovanco Piping Systems, Inc.

2. PERMA-PIPE, Inc.
3. Thermacor Process, L.P.

B. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.

C. Piping Class UGCU

1. Type K copper tubing insulated with nominal 2 inch (50 mm) thick foamed-in-place polyurethane and sealed in full round, Type 1, Grade 1, HDPE jacket. Units: Nominal 20 foot lengths with factory installed watertight end seals.
2. Couplings: Machine cast bronze grooved for O-Ring seals. Insulated, jacketed and sealed same as pipe units.
3. Fittings: Wrought copper, except cast brass only in sizes where wrought copper is not available. Joints soldered with silver solder or brazing alloys melting at 1100° F minimum.
4. Provide plastic locator tape.
5. Provide manufacturer's supervision as specified in Part 1 of this section.

D. Piping Class UGTG

1. Black steel, ASTM A 53, Grade B carrier pipe insulated with nominal 2 inch thick foamed-in-place polyurethane and sealed in full round, Type 1, Grade 1, HDPE jacket. Units: Nominal 20 foot and 39 foot lengths with factory installed watertight end seals.
2. Pipe: Schedule 40.
3. Fittings and Couplings: ASTM A 234, welded, same schedule as piping. Manufacturer to furnish fitting and coupling protection same as pipe units, for field installation.
4. Provide plastic locator tape.
5. Provide manufacturer's supervision as specified in Part 1 of this section.

E. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General

1. Refer to and comply with Section 23 05 00 for basic requirements.
2. Refer to Division 31 Section "Earth Moving" for excavation, trenching and backfilling.

B. Manufacturers' Supervision/Inspection: Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer's supervision/inspection services and manufacturer's written certification as specified in Part 1 of this section, and shall at his own expense make any corrections/modifications to his installation work as required by the manufacturer.

3.2 PIPING APPLICATION

A. Chilled Water Piping

1. Piping Class UGCU
2. Piping Class UGTG

B. Hot Water Piping

1. Piping Class UGCU
2. Piping Class UGTG

3.3 PIPING INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

C. Remove any standing water in the bottom of trench.

D. Trenching and Backfill: Trench bottom shall be smooth and free from stones and rocks. If existing trench material is unsatisfactory, over-excavate trench 4 to 6 inches and fill with selected earth, sand or screenings. Backfill with select earth, sand or screenings and hand tamp to a depth of 12 inches above top of conduit. Remainder of backfill free of large stones, rocks, frozen earth or other foreign matter.

E. Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.

F. Install piping at uniform grade of 0.2 percent upward in direction of flow or as indicated.

G. Install components with pressure rating equal to or greater than system operating pressure.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Refer to Section 23 05 00 "Common Materials and Methods for HVAC" for general piping installation requirements, sleeves and mechanical sleeve seals through exterior building walls.

K. Secure anchors with concrete thrust blocks. Design Concrete Anchors and Thrust Blocks to resist imposed forces based on 2000 pounds per square foot soil bearing pressure. Install so as to bear against virgin (undisturbed) soil.

L. Connect to building piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 23 21 13, "Hydronic Piping Systems."

M. Building Entry: Provide wall sleeve and "Link Seal". Terminate conduit minimum 2 inches beyond inside face.

N. Piping Class UGCU

1. Anchor connecting copper piping at or near point of connection to avoid imposing any external forces on underground system.
2. Provide concrete thrust blocks, sized in accordance with manufacturer's recommendations at all changes in direction, horizontal and vertical, and at all tees.
3. After each unit has been installed, make partial backfill in middle of each section, leaving joints exposed for inspection of hydrostatic test. Test piping hydrostatically at 150 psi for a period of four hours with no leakage. Test soldered joints prior to pouring of thrust blocks. Test balance after thrust blocks are poured and cured.

O. Piping Class UGTG

1. Anchor connecting steel piping at or near point of connection to avoid imposing any external forces on underground system.
2. Provide concrete thrust blocks, sized in accordance with manufacturer's recommendations at all changes in direction, horizontal and vertical, and at all tees.
3. After each unit has been installed, make partial backfill in middle of each section, leaving joints exposed for inspection of hydrostatic test. Test piping hydrostatically at 150 psi (1034 kPa) for a period of four hours with no leakage. Test welded joints prior to pouring of thrust blocks. Test balance after thrust blocks are poured and cured.
4. Apply protective coating, furnished by system manufacturer, to fittings.

3.4 JOINT CONSTRUCTION

A. Refer to Section 23 05 00, "Common Materials and Methods for HVAC" for basic piping joint construction.

B. Keyed-Coupling Joints: Cut- or roll-groove pipes. Assemble joints with keyed couplings, gaskets, lubricant, and bolts.

C. Conduit and Cased Piping Joints: Assemble sections and finish joints with insulation, exterior jacket sleeve, and apply shrink-wrap seals as required by manufacturer's written installation instructions.

3.5 IDENTIFICATION

A. Identify location of all underground pipes outside of building by means of printed plastic tapes located so as to serve as a warning device to minimize accidental excavation. The tapes shall be not less than 6 inches wide by 0.004 inch thick; the material shall be resistant to chemicals normally found in the soil; and shall bear the legend "CAUTION - BURIED PIPE BELOW".

1. Install separate tape directly above each line and approximately 6 inches below the surface except that a single tape may be used above a group of small lines having an overall width not exceeding 10 inches.

2. Where more than 500 feet of tape is required for the Project, use different colors and legends to identify the various lines in accordance with ANSI A13.1 and OSHA.

3.6 FIELD QUALITY CONTROL

A. Prepare piping for testing according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Isolate equipment. Do not subject equipment to test pressure.
3. Install relief valve set at pressure no more than one-third higher than test pressure.
4. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
5. Use vents installed at high points to release trapped air while filling system.

B. Test piping as follows:

1. Subject to hydrostatic test pressure that is not less than 1.5 times the design pressure for a minimum of 4 hours with no drop in pressure.
2. At the beginning of the pressure test, and periodically during the test, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

C. Prepare a written report of testing.

END OF SECTION 23 24 13

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and other related sections apply to this Section.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. HVAC water-treatment chemicals
2. Chemical cleaning of new systems

1.3 DEFINITIONS

A. Complete Water Treatment Service: The Owner's personnel has no responsibility for the water treatment program.

B. Supervised Water Treatment Service: The water treatment is conducted by Owner's personnel.

C. MSDS: Material Safety Data Sheets.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

D. Contractor shall provide equipment and services necessary and reasonably incidental to proper completion of Water Treatment Systems shown on Drawings and specified herein, except where specifically noted as being furnished under other sections of specifications.

E. All equipment, once installed, will remain the property of the building Owner.

F. Provide complete water treatment service for the following systems:

1. Hot water heating
2. Chilled water

1.5 SUBMITTALS

A. Product Data: Include for each type of factory fabricated item indicated.

B. Include name of Water Treatment Subcontractor on Material List.

C. Informational Submittals:

1. Water Treatment Service Program: Submit a copy of the service contract for maintenance service and written description of the service program as described in this section.
2. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at project site.

D. Field quality control test reports.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Warranty

1. Products: comply with warranty and contract closeout requirement specified in Division 00.
2. Performance: Submit a written warranty, stating: conditions to be maintained and chemicals to be used; that the system of treatment prevents corrosion, scale formation and slime and algae growth; that the system of treatment is compatible with the materials in construction of component parts of system, such as pumps, pump seals, valves, piping, equipment; that the system of treatment complies with all applicable codes, rules and regulations.

1.7 SUPERVISION AND STARTUP

A. The water treatment contractor shall perform the following startup services:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed and filled with water, and are fully operational before introducing chemicals for water treatment system.
3. Place HVAC water treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.

1.8 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for

intended use.

1.9 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Engage Owner's current Water Treatment Contractor to provide chemicals and service program to maintain water conditions required herein to inhibit corrosion, scale formation, and biological growth for chilled-water piping, heating hot-water piping, and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

B. Existing Service Contract: Once the systems are started, the existing water treatment service contract shall be modified to include additional equipment/systems installed under this work.

1.10 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and for delivery to public sewage systems. Conform to all applicable EPA and local agency's guidelines and regulations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all chemical feed pumps, solution tanks, solenoid valves, controls, timers, meters, feeders, agitators, tubing, shutoff valves, strainers, etc., required for a complete and serviceable water treatment system.

2.2 CHEMICALS

A. Chemicals shall be as recommended by water treatment contractor that are compatible with piping system components and connected equipment, and that can attain water quality specified.

2.3 STAINLESS STEEL PIPES AND FITTINGS

A. Stainless Steel Tubing: Comply with ASTM A269, Type 316.

B. Stainless Steel Fittings: Complying with ASTM A815 / A815M, Type 316, Grade WP-S.

C. Three Piece, Full Port, Stainless Steel Ball Valves: ASTM A351, Type 316 stainless steel body; ASTM A276, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig WP rating.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Recommended conditions indicated hereinafter are furnished as a guideline only. Water Treatment Subcontractor shall obtain water sample, make a chemical analysis of same for pH, total alkalinity, hardness, total solids, chloride and silica and select/change chemicals which will be used to treat system as required for warranty in Part 1 of this section. Chromates shall not be used in Water Treatment System.

3.2 PIPING APPLICATIONS

A. Chemical Treatment Piping: Stainless steel piping and fittings.

3.3 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall adjacent to water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Install feeding equipment with valve connections in locations as directed by the water treatment subcontractor.

F. Insulate feed piping connections same as specified for system being treated.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Materials and Methods for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "Hydronic Piping Systems."

E. Refer to Division 22 for backflow preventers required in makeup water connections to potable-water systems.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Remove and replace malfunctioning units and retest as specified above.

D. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic.

E. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.6 COMPLETE WATER TREATMENT SERVICE

A. For complete water treatment service, Water Treatment Subcontractor shall:

1. Make service visits monthly to closed, recirculating systems to adjust feeding equipment, apply chemicals, obtain and analyze samples and regulate bleed-off, in order to maintain conditions as specified below.
2. Furnish all necessary labor, chemicals and feeding equipment required for the specified treatment. It shall not be necessary for the Owner to handle chemicals, take samples, make tests, regulate or operate the equipment.
3. Obtain a signed service card after each visit and leave a report indicating which systems were serviced.
4. Maintain complete records of treatment program for each system, such records to be made available, upon request, to interested parties.
5. Instruct Contractor in field on installation, piping and wiring of chemical feeding equipment.
6. Maintain chemical feeding equipment in proper working condition for term of contract.
7. Maintain specified conditions in each system.
8. Submit service reports as specified hereinafter.

B. Submit reports to Owner for each service call.

1. Include the following information as a minimum:

a. pH before and after treatment.
b. Dissolved solids - excluding water treatment compounds.
c. Methyl-orange alkalinity - before and after treatment.
d. Calcium hardness and total hardness.
e. Conductivity - before and after treatment.
f. Concentration of each water treatment material - before and after treatment.
g. Amount of makeup water used between visits, where water meter is provided in system.

2. Include items a, e and f on the closed system treatment.

3.7 SUPERVISED WATER TREATMENT SERVICE

A. For supervised water treatment service, Water Treatment Subcontractor shall:

1. Provide complete written instructions to Owner for chemical feeding, bleed-off, blowdown control and testing procedures.
2. Demonstrate to Owner's personnel proper application of written instructions.
3. Provide all chemicals required during contract period.
4. Provide all required test kits.
5. Obtain samples from all systems, at least once per month, analyze such samples and furnish written reports and recommendations to Owner.
6. Furnish chemical feeding equipment and instruct Contractor in field on installation, piping and wiring of chemical feeding equipment.

3.8 CLOSED RECIRCULATING SYSTEM (CHILLED WATER, HEATING HOT WATER)

A. Suggested Conditions:

1. For temperatures up to 140°F.

a. Molybdate - 50 to 100 ppm (500 to 1000 ppm Sodium Nitrite)
b. pH – 8.0 to 10.5

2. For temperatures greater than 140°F.

a. Molybdate -100 to 150 ppm (1000 to 1500 ppm Sodium Nitrite)
b. pH – 8.0 to 10.5

B. Feeding Equipment: Provide 5 gallon bypass feeder with bag filter installed as detailed on drawings. Material and operating pressure shall be consistent with system in which installed.

3.9 CHEMICAL CLEANING OF NEW SYSTEMS

A. Boiler Systems: Obtain recommendations from boiler manufacturer and boil out new boiler(s) in accordance with boiler manufacturer's instructions with an alkaline type boiling out compound to remove grease, oil, mill scale and other foreign matter. Compound should be used at the rate of 1-1/2 lbs. per 20 boiler HP unless otherwise recommended by boiler manufacturer. After boiling out period, completely drain, flush and refill boiler with fresh water.

B. Piping Systems

1. The contractor shall provide chemicals and labor for the pre-operational cleaning of all piping systems installed under this Division. This cleaning method is not intended for potable water systems. The cleaning chemicals shall be provided by the Water Treatment Contractor.
2. Contractor shall provide a portable, 20 micron filter with pump for initial system flush. Coordinate procedure and duration with water treatment contractor.
3. Do not use system pumps for cleaning and flushing without prior approval from Owner. In the event system pumps are used, Contractor shall be responsible for extending the warranty period to include duration of cleaning and flushing.
4. The contractor shall flush all systems, including mud from drop legs. Remove, clean and replace all strainers. All systems shall contain the highest quality of water available.
5. Complete circulation must be achieved during the cleaning procedure. A minimum flow rate of 3 ft/sec. needs to be maintained to ensure that the cleaning chemicals will work properly. All manual, electrical, air and thermostatic operated valves must be open. All dead end runs must be looped together with piping not less than 1/3 the size of the run. This piping is to remain in place until cleaning is complete.
6. A minimum of 1-1/2" ball valve is to be permanently installed in the low point of each system for the purpose of draining each system.
7. The cleaning solution shall be formulated to remove light grease, cutting oils, loose mill scale, organics and extraneous construction debris. The cleaner shall contain corrosion inhibitor, a dispersant and an oil emulsifier. The cleaner shall be as recommended by the water treatment contractor. Enough cleaner should be used to treat all of the piping to remove oil and grease to permit a uniform passivating film to form. This aids in the prevention of flash corrosion when the system is most vulnerable to corrosive attack. The mechanical contractor will provide the water treatment vendor with an estimate of system volume for proper dosage of cleaner. The cleaner shall not require external heat to ensure its effectiveness.
8. Add recommended quantity of passivation chemical directly into the closed loop system before the recirculating pumps to ensure rapid mixing and distribution throughout the system.

9. Recirculate the system for 48 - 72 hours.
10. Open and drain mud legs and low points periodically during the cleaning process.
11. Drain system completely paying particular attention to mud from drop legs and all low points.
12. Refill the system with clean, potable water, check all strainers, re-circulate and drain completely.
13. Refill the system again. The length of time between the completion of the cleaning procedure and addition of the corrosion inhibitor shall not exceed twenty-four (24) hours.
14. Add the recommended level of closed loop inhibitor. The system is now ready for operation. The product must also contain an inert tracer that is colorless in the system for use in closed loop leak detection and volume studies.
15. A service report will be generated on-site by the water treatment representative certifying that the system has been cleaned in accordance with the above procedures. Submit a copy of the service report to the Architect and Owner for record.
16. Chemical test parameters shall include onsite testing of pH, conductivity, phosphate, total iron, ferrous iron, and copper after the preclean is completed to verify all cleaner is removed and iron and copper levels are low. Total iron must be < 5 ppm, Ferrous Iron < 2 ppm, and Copper < 0.5 ppm.

3.10 ELECTRICAL WIRING

A. Contractor for DIVISION 26 will provide 115 volt, single phase junction box near the chilled water system control panel and the boiler control panel. Contractor for this section shall provide all additional wiring required in accordance with requirements of Division 26.

END OF SECTION 23 25 00

SECTION 23 30 00 – DUCTWORK AND DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Sheet metal ductwork and fittings
2. Sheet metal casings and plenums
3. Duct Accessories; including dampers, flexible connectors, flexible duct, access doors
4. Air volume control boxes
5. Diffusers, registers and grilles

B. Related Sections include the following:

1. Duct mounted smoke detectors are specified in Division 28
2. Airflow measuring stations are specified in Division 25
3. Motorized control dampers are specified in Division 25
4. Specialty exhaust and venting systems are specified in Section 23 51 00, “Specialty Venting”

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For acoustically lined ducts and casings, maintain sizes inside lining. For rectangular ductwork in plan, first dimension indicates width and second dimension indicates height.

B. Pressure Class: The numerical duct construction pressure classification that identifies permissible SMACNA Duct Construction Standards.

C. Seal Class: Identifies the extent of sealing of duct joints, seams and penetrations per SMACNA Duct Construction Standards.

D. Leakage Class: Identifies permissible leakage as described in SMACNA HVAC Air Duct Leakage Test Manual.

E. Low Pressure Ductwork: 3 inch wg and less.

F. Medium Pressure Ductwork: 4 inch wg and 6 inch wg.

G. High Pressure Ductwork: Greater than 6 inch wg.

1.4 REFERENCES

A. SMACNA: HVAC Duct Construction Standards – Metal and Flexible

B. SMACNA: HVAC Air Duct Leakage Manual

C. ARI 880: Air Volume Terminals

D. UL: Applicable Standards

1.5 SUBMITTALS

A. Product Data:

1. Provide booklet of Shop Standards, including the following:

a. Duct construction classification and fabrication, assembly, and installation details including SMACNA Tables and Figure numbers clearly marked to identify which are to be used.
b. Details of shop fabricated items, fittings, reinforcing details and spacing, seam and joint construction.
c. Installation details of duct mounted equipment and accessories, including dampers, coils, access doors, hangers and supports.
d. Product data for factory fabricated equipment, dampers, access doors, flexible duct, etc.

2. For each type of product indicated, include performance characteristics, rated capacities, data sheets, and furnished accessories.
3. Shop Standards shall be submitted for review prior to submission of sheet metal shop drawings. Any sheet metal shop drawings submitted prior to the shop standard review will be returned as “Rejected”.

B. Product Schedule or Lists: Include Diffuser, Register and Grille Schedule, indicating Drawing designation, room location, quantity, model number, size and accessories furnished.

C. Shop Drawings: Prepare CAD-generated shop fabrication drawings to a scale of not less than 3/8 inch per foot. Show complete ductwork and casing layout, including:

1. Duct layout indicating sizes and pressure classes.
2. Elevations of top and bottom of ducts.
3. Dimensions of main duct runs from building grid lines.
4. Fittings.
5. Clearly show all duct accessories, including access doors, dampers, diffusers and grilles.
6. Acoustical lining and thickness as applicable.
7. Prepare duct layout based on routing indicated on the drawings, and make reasonable modifications to layout without increasing duct system pressure drop in order to coordinate with other trades. Refer to “Layout and Coordination with other Trades” specified in

Section 23 05 00. Do not submit duct shop drawings until multi-discipline coordination drawings specific in Division 1 are completed.

8. Clearly identify by circle and by note “Deviation” and/or “Interference” in large lettering any and all deviations from Drawings and any and all unresolved interference conditions and assume full responsibility for failure to do so.
9. Submit all shop drawings for review.
10. Modify shop fabrication drawings in accordance with Architect’s review comments, if any, and to show any subsequent shop or field changes. At completion of work, submit final shop fabrication drawings labeled “As-Built” to the Owner for record purposes.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.7 COORDINATION

A. Coordinate location of duct access doors to allow proper access to dampers, coils, fans, etc. Coordinate with General Contractor proper location of wall and ceiling access panels to permit access to duct access doors.

B. Coordinate location of duct mounted equipment (coils, humidifiers, filters, smoke detectors) furnished in other Sections for installation under this Section. Provide duct transitions as required.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; zinc coating each side, complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel

complying with ASTM A653/A653M and having G60 (Z180) coating designation. Factory-applied PVC coatings shall be 4 mils (0.10 mm) thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils (0.05 mm) thick on opposite surfaces.

D. Carbon-Steel Sheets: ASTM A366/A366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

E. Stainless Steel: ASTM A480/A480M, Type 316 and having a No. 2D finish for concealed ducts and No. 4 satin finish for exposed ducts. Use low carbon content material where welded joints are specified.

F. Aluminum Sheets: ASTM B209 (ASTM B209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

G. Reinforcements: Structural shapes (channels, angles, and plates) shall be of galvanized steel where installed on galvanized ducts, and Type 304 stainless steel where installed on stainless steel ducts.

2.2 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Acceptable Manufacturers, no substitution:

   a. CertainTeed Corp.; Insulation Group
   b. Johns Manville International, Inc.
   c. Knauf Fiber Glass GmbH
   d. Owens Corning

2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

   a. Thickness: 1 inch (25 mm).
   b. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

      1) Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
      2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into airstream.
      3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.3 SEALANT MATERIALS

A. Acceptable Manufacturers:

1. United McGill Corp.
2. H.B. Fuller Co., Foster Products Division
3. Precision Adhesives
4. Carlisle Hardcast
5. General Electric Co.

B. General:

1. The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
2. Sealants for air distribution systems shall be of liquid and/or mastic type in accordance with SMACNA.

C. All sealants shall be UL Classified and meet NFPA 90A, Class 1 requirements when applied in a manner consistent with its intended use. Ratings shall not exceed a Flame Spread of 25 or a Smoke Developed of 50. All containers and shipping cartons shall bear the UL label indicating flame and smoke ratings and shall include Fire Hazard Classification. Labeling shall also include Hazard Statement required by the Consumers Product Safety Act, CFR Title 16, Chapter II, subchapter C, Federal Hazardous Substances Act Regulations, Part 1500, Section 1-272.

D. Sealants for air distribution systems shall be compatible with the materials, application and operating temperatures of the system. Sealants used for systems handling fumes and chemicals shall be confirmed suitable for the specific application. Sealants used for systems serving clean rooms shall be FDA approved silicone sealant. Sealants exposed to the weather, shall be ultraviolet light and ozone resistant and provide watertight seal.

E. Sealants shall be applied in accordance with manufacturer’s instructions. Provide adequate ventilation and follow safety procedures as required. Adequate drying/curing time shall be allowed before operating or testing the systems.

F. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

G. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

H. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

I. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 DUCT PRESSURE CLASSIFICATION AND CONSTRUCTION

A. Construct ducts for pressure class indicated (positive or negative), and seal all seams and joints to achieve Seal Class A, Leakage Class 6 for rectangular duct and Class 3 for round duct, according to the following:

1. Supply Ducts between AHU and Fire or Smoke Damper: 10-inch wg positive.
2. Supply Ducts between AHU and Air Volume Control Box: 6-inch wg positive.
3. Supply Ducts between Air Volume Control Box and Diffuser: 2-inch wg positive.
4. Supply Ducts between Air Volume Control Box and Terminal Filter Diffuser: 3-inch wg positive.
5. Supply Duct Systems without Air Volume Control Boxes: 3-inch wg positive.
6. Outside Air Ducts: 2-inch wg negative.
7. Return Duct between Return Fan and AHU: 4-inch wg positive.
8. Return Ducts between Return Fan and Air Volume Control Box: 3-inch wg negative.
9. Return Ducts between Register or Grille and Air Volume Control Box: 2-inch wg negative.
10. Return Duct System without Air Volume Control Boxes up to inlet of Return Fan: 2-inch wg negative.
11. Exhaust Ducts between Exhaust Fan and Air Volume Control Box: 3-inch wg negative.
12. Exhaust Ducts between Register or Grille and Air Volume Control Box: 2-inch wg negative.
13. General Exhaust Duct System without Air Volume Control Boxes: 2-inch wg negative.
14. Laboratory Fume Hood Exhaust Duct System: 3-inch wg negative.

B. Material: All ducts shall be galvanized steel, except where specifically noted otherwise on drawings and as follows:

1. Exposed Exhaust Connections to Stainless Steel Canopy Hoods: Stainless steel to match hood construction. Welded joints.
2. BSL-3 Laboratory Exhaust Ducts:

    a. Type 316, stainless-steel, welded joints
    b. Flanged Joint Gaskets: PVC of 35 to 40 durometer or equivalent corrosion resistant material.

2.5 GENERAL DUCT FABRICATION

A. Detail and fabricate with the fewest possible joints in accordance with SMACNA standards and details, except where more stringent requirements are specified in this section, to keep resistance losses to a minimum.

B. Size round ducts installed in place of rectangular ducts, and vice versa, from ASHRAE table of equivalent rectangular and round ducts. Aspect ratio of rectangular ducts can be modified for coordination of layout, but in no case exceed 4 to 1, and without reducing free area of duct or increasing pressure drop.

C. Complete metal ducts within themselves with no single partition between ducts. Open corners are not acceptable.

D. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

E. Sleeves:

1. Construct sleeves of galvanized steel minimum 22 gauge unless noted otherwise.
2. Provide sleeves for fire dampers and combination fire/smoke dampers as specified in this Section "Fire and Smoke Dampers".

    a. Breakaway connections are not permitted

F. Square heel and throat elbows, with vanes, are used on Drawings for drafting convenience only. Where space allows, construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible on rectangular ductwork, provide smooth radius elbows with full length splitter vanes designed and constructed in accordance with SMACNA Duct Design and Duct Construction Standard to produce a loss coefficient of 0.15 or less, except as follows:

1. Where R/W is such that a vaned radius elbow will not produce the specified loss coefficient and on exposed ductwork in finished areas, provide mitered elbows with square heel and throat and with double thickness turning vanes set into vane runners with a radius of 4-1/2 inches on 3-1/4 inch centers, designed and constructed to produce a loss coefficient of 0.26 or less in accordance with above standards.
2. Increase/decrease duct sizes gradually, not exceeding 15^{o} divergence/ convergence wherever possible. Maximum divergence upstream of equipment to be 30^{o} and 45^{o} convergence downstream.

G. Unless otherwise indicated or specified, fabricate branch connections as follows:

1. Rectangular duct branch connection to rectangular ductwork, 45^{o} SMACNA entry/exit butt flange boot with corner filler pieces or proportional splits at Contractor's option. Where size of main duct is not large enough for a boot connection, fabricate ducts with proportional splits.
2. Round duct branch connections to round ductwork, conical tee.
3. Round branch connection to rectangular ductwork, bellmouth connection equal to Buckley BM or BMD or high efficiency boot connection equal to Buckley 3300 or 3300D.
4. Where round duct is connected to rectangular duct and rectangular duct width shown is not equal to or larger than overall diameter of connecting end of round connector BENDING OF FLANGES OF ROUND CONNECTOR FOR CONNECTION TO RECTANGULAR DUCT IS NOT ALLOWED. Either increase rectangular duct width as required or provide a rectangular 45^{o} SMACNA boot connection to the rectangular duct and a rectangular to round conversion for the round duct connection. For round connection to low pressure ductwork. Contractor may, at his option use a mini bellmouth connection equal to Buckley M-BM or M-BMD or a flat oval bellmouth equal to Buckley FOBM or FOBMD and an oval to round conversion for the round duct connection.
5. Spin-in, cinch lock or dovetail fittings not allowed except at duct connection to a transfer duct.
6. Connect branch to top, bottom or side of duct as indicated or as required, whether or not indicated, to suit surrounding conditions and avoid interferences.

7. Coordinate branch take-off locations with transverse joint spacing. Transverse joints interfering with branch take-offs will not be accepted. Modify joint spacing as required without exceeding maximum spacing.

H. Rigidly construct ducts with joints mechanically tight, substantially airtight without use of tape, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Where joints are not accessible for sealing, provide access doors and seal from inside.

I. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10% duct area, split into two ducts maintaining original duct area. No easements or penetrations allowed for medium or high pressure ductwork.

J. Fabricate goosenecks of aluminum equivalent to not less than 18 gauge galvanized steel. Rigidly reinforce and brace. Provide hinged 1/2 inch (13 mm) mesh aluminum hardware cloth bird screen. Fabricate for lowest edge of opening not less than 24 inches (600 mm) above finished surface of roof for exhaust, and 36 inches (900 mm) above roof for intakes.

2.6 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Construct ducts of minimum 24 gauge.
2. Do not install tie-rods in areas where system effects apply including upstream and downstream of fans and sound attenuators or within three times the published absorption distance of humidifiers.
3. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
4. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints with four bolted flange, fastened to duct section with spot welds (do not use screws), and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement. Ductmate Industries, Inc., Nexus Inc., Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details. Ductmate Industries, Inc. TDC or Lockformer.

1. Use joint reinforcing for T-24 or T-25 joints and sheet metal gauges as recommended by SMACNA Standards as a minimum. Do not use lighter gauges shown in joint manufacturer’s literature.

D. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant. Button punch snaplocks and pocket locks are not permitted.

E. Cross Breaking or Cross Beading: For duct pressure class 3 inch (750 Pa) or less, cross break or cross bead duct sides 18 inches (440 mm) and larger and 20 gauge thick or less, with more than 10 sq. ft. (0.93 sq. m) of nonbraced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

2.8 ROUND DUCT AND FITTING FABRICATION

A. Acceptable Manufacturer: Factory fabricated or shop fabricated but equal in all respects to factory fabricated items specified herein:

1. McGill AirFlow Corporation.
2. SEMCO Incorporated.

B. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

C. Round Duct and Fittings: Lock type spiral seam construction of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible Stamped elbows and fittings. Gored (segmented) elbows and fitting only for sizes where stamped elbows and fittings not available. Adjustable elbows are not permitted.

D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

F. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

G. Plastic coated where specified.

2.9 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Acceptable Manufacturers:

1. Lindab Inc.
2. McGill AirFlow Corporation
3. SEMCO Incorporated

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.

    a. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.

3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:

    a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
    b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
    c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
    d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.

4. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:

    a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
    b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
    c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.

2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

2.10 FLEXIBLE DUCTWORK

A. Acceptable Manufacturers: Type numbers indicated are those of Thermaflex.

1. Thermaflex
2. Flexmaster, Inc.

B. UL listed under UL-181 as Class 1 Air Duct Connector and conforming to NFPA 90A and 90B.

C. Minimum Rating: 10 inch WG positive all uses, 2 inch WG negative for return or exhaust use, velocity of 4000 feet per minute.

D. Type "M-KC". Continuous galvanized spring wire helix having a cover of woven fiberglass fabric, vinyl impregnated and coated, or continuous corrugated aluminum for low pressure supply use only, and insulated with 1 inch thick fibrous glass insulation having outer moisture barrier consisting of reinforced metalized Mylar/ neoprene laminate with integral attaching devices. "U" factor at 75^{o} F differential maximum 0.22 btu/sq.ft./^{o} F/hour.

E. Attachment: Duct clamp stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action in size to suit duct size.

2.11 HANGERS AND SUPPORTS

A. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters. Perforated strap hangers are not allowed.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Hanger fasteners shall not pierce medium/high pressure (greater than 3 inches w.g.) ductwork under any circumstance.

C. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.12 FLEXIBLE CONNECTORS

A. Acceptable Manufacturers

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or stainless steel, or 0.032-inch-thick aluminum sheets. Select metal compatible with connected duct system. Comply with SMACNA requirements.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd.
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

2.13 SHOP AND FIELD FABRICATED CASINGS

A. Fabricate casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", except where more stringent requirements are specified herein.

B. Shop fabricate casings, to greatest extent possible, with a minimum number of joints and to minimize field fabrication and assembly.

C. Fabricate casings with standing seams and angle reinforcements. Reinforce casings with galvanized- or painted-steel angles. Seal joints with liquid-type, high-pressure duct sealant to eliminate air leakage.

D. Fabricate casings with reinforced and braced openings for hinged access doors at least 24 inches (500 mm) wide by 48 inches (1200 mm) high and located for access to each item of equipment housed, or where shown on drawings for cleaning and inspection. Provide double wall access door when installed in insulated plenums.

E. Provide minimum 3 inch high reinforced concrete curb for floor mounted walls. At floor, rivet panels on 8 inch centers to steel angles.

2.14 FACTORY FABRICATED CASINGS

A. Acceptable Manufacturers:

1. Industrial Acoustics Company
2. Vibro-Acoustics, Co.
3. McGill Airflow Corporation
4. SEMCO Incorporated

B. Double-wall, insulated, pressurized equipment casing.

C. Panel Fabrication: Solid, galvanized sheet steel exterior shell and perforated, galvanized sheet steel interior shell; with 2- or 4-inch space between shells, as indicated.

1. Fabricate with a minimum number of joints.
2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
3. Exterior Shell Thickness: 0.040 inch minimum.
4. Interior Shell Thickness: 0.034 inch minimum.
5. Interior Shell Thickness: 0.034 inch minimum, with 3/32-inch perforations at 3/16-inch staggered spacing for 23 percent open area.
6. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.
7. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant, and vermin proof, and that complies with NFPA 90A.
8. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.

D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

E. Access Doors: Fabricate personnel access doors at least 24 by 60 inches and other access doors in sizes indicated.

1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch solid, interior and exterior, galvanized sheet steel shell.

2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.
3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.

F. Structural Performance: Fabricate plenum to be self-supporting and capable of withstanding internal static pressures as scheduled, without any panel joint exceeding deflection of L/200 where "L" is the unsupported span length within completed casings.

G. Acoustic Performance: Certified by an independent acoustical testing agency listing sound-absorption and transmission-loss characteristics of panel assemblies.

H. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

2.15 VOLUME DAMPERS

A. General: Factory fabricated, or shop fabricated but equal in all aspects to factory fabricated items, with required hardware and accessories in accordance with SMACNA duct standards except as noted herein.

B. Damper and damper frames shall be constructed of same material as duct in which they are installed. Fabricate single blade damper of minimum 20 gauge. Fabricate multi-blade damper of minimum 16 gauge.

C. Damper blades in rectangular ductwork shall be maximum 8 inches wide. Dampers having two or more blades shall be opposed action type with connecting bar and linkage. Multiple blade dampers shall be mounted in frames. Splitter dampers not allowed.

D. Provide for multiple section damper (larger sizes), appropriately sized jackshaft with bearing assemblies mounted on supports at each mullion and at each end of the multiple damper section. Provide appropriate length and number of mountings to connect linkage of each damper to the jackshaft.

E. Stiffen blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Device shall include indication of damper position. Provide end bearings and gaskets for damper components to seal duct consistent with pressure class.

F. Damper Hardware: Dampers shall be provided with all hardware including zinc plated, die-cast core with dial and handle made of 3/32 inch (2.4-mm) thick zinc plated steel, and a ¾ inch hexagon locking nut. Include center hole to suit damper operating rod size. Include raised quadrant for mounting on insulated duct. Improvised shop or field fabricated hardware will not be accepted.

2.16 REMOTE CEILING DAMPER REGULATOR

A. Acceptable Manufacturers

1. Young Regulator

B. System specifically designed for remote manual adjustment of duct mounted volume damper.

C. Damper controller and cable shall be concealed above the ceiling or on wall (only permitted in utilitarian areas). Cable to consist of Bowden cable 0.054 inch stainless steel control wire encapsulated in 1/16 inch flexible galvanized spiral wire sheath. Maximum 50 feet length of cable distance between damper and control kit.

D. Damper:

1. Round damper constructed of heavy duty galvanized steel spiral shell design with rolled in stiffening beads for rigidity. Spiral shell shall have one crimped end and one straight end for ease of installation. Damper to include "V" style 20 gauge galvanized steel blade secured with ½ inch diameter steel shaft and Teflon bushings. Young Regulator Model 5020-CC.
2. Rectangular damper to be opposed blade type constructed of heavy duty extruded aluminum frame and blades. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched stainless steel connecting slide rails that facilitate blade movement and alignment. Young Regulator Model 830A-CC.
3. Damper shall include all necessary hardware to ensure compatibility with Bowden remote cable control system.

E. Control Shaft: Shall be D-styled flatted ¼ inch diameter with 265 degree rotation providing graduations for positive locking and control, and 1 ½ inch linear travel capability.

F. Control Kit: Shall be designed for use with internally or externally controlled round or rectangular dampers and shall consist of 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit mounting bracket can be field mounted on ceiling framework, behind grilles, on or inside plenum slot diffusers, or on diffuser back pan. Include wrench for damper adjustment. Young Regulator Model 270-275.

2.17 REMOTE CEILING DAMPER REGULATOR (ELECTRONIC)

A. Acceptable Manufacturers

1. Young Regulator

B. System specifically designed for remote electronic adjustment of duct mounted volume damper via a 12V DC signal from battery powered hand-held controller.

C. Cable shall be plenum rated consisting of five (5) conductor wire. Typical cable runs are 50 feet in length with maximum 75 feet distance between damper and wall unit control station.

D. Damper:

1. Round damper shell and blade shall be constructed of 20-gauge galvanized steel. Shaft shall be ½" plated steel with oil impregnated bronze bushing.
2. Power requirements: 12V DC, <0.5 Watts and <20 mA. 12 seconds for 90 degree rotation with 16 lbs-in of torque max.

E. Control Kit: hand-held controller for damper positioning control. 9V battery powered with LCD display.

F. Wall unit control station: 12-port with double gang box and cover plate.

2.18 BACKDRAFT DAMPERS

A. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Air Balance, Inc
4. American Warming and Ventilating Co.

B. Low Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action gravity balanced backdraft damper with minimum .050 inch aluminum blades a maximum of 6 inch width having flexible vinyl sealing edges, linked together in rattle-free manner and with adjustment device to permit setting for varying differential static pressure. Blade pivot pins mounted in nylon bearings in a minimum 0.050 inch extruded aluminum mounting frame. Constructed for up to 1500 feet per minute face velocity and 1/2 inch water gauge static pressure. Suitable for horizontal or vertical applications as indicated.
2. Provide minimum 0.050 inch extruded aluminum wall frame with mounting flange for wall mounted damper.

C. High Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action, gravity balanced backdraft damper with airfoil blades a maximum of 6 inch width having flexible vinyl sealing edges and neoprene jamb seals.
2. Pressure drop for a 24 inch x 24 inch damper shall not exceed 0.2 inch water gauge when tested in accordance with AMCA Standard 500, Figure 5.3 with ductwork upstream and downstream of damper.
3. Blades interconnected with on-blade linkage. Provide external counterbalance on extended shaft, field adjustable for system flow and pressure.
4. Minimum 14 gauge, galvanized steel, 8 inch by 2 inch formed channel frame with minimum 18 gauge galvanized blades mounted on minimum 3/4 inch zinc plated shafts rotating in 3/4 inch bore ball bearings. Designed for up to 4,500 feet per minute face velocity and 7 inches water gauge static pressure for Class 2 fans.

2.19 FIRE AND SMOKE DAMPERS

A. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Pottorff

B. General: All dampers operable at pressures and velocities required by systems in which installed. Provide single or multiple framed assemblies as required for size of duct in which installed in order to maintain UL listing of entire damper assembly.

C. Fire Damper (FD):

1. General: Fire dampers shall be UL labeled, constructed in accordance with UL 555.
2. Rating: 1 ½ hour for use in rated walls 2 hours and less, otherwise 3 hour.
3. Link: Provide replaceable fusible link rated for 165 deg F.
4. Materials: Galvanized steel, except stainless steel for installation in stainless steel, aluminum, or plastic coated ductwork. Provide rectangular to round adapter when installed in round duct.
5. Sleeve: Factory installed as part of damper assembly furnished by manufacturer, or field fabricated and installed. Construct sleeves for rigid connection to adjoining ductwork in accordance with UL 555 as follows:

    a. Dampers less than 24 inches, 16 gauge
    b. Dampers 24 inches and greater, 14 gauge
    c. Use heavier gauges if required by SMACNA construction standards for pressure class indicated.

6. Type:

    a. Fire dampers for transfer air application shall be shutter type for vertical mounting only.
    b. Fire dampers for other than air transfer, and other than listed below, shall be curtain blade type with closure spring to assure positive closure for either horizontal or vertical mounting with “fans on”. Blades retained in a recess out of the air stream, including multiple section applications.
    c. Where UL sizing limitations will not permit the use of a curtain blade damper, or elsewhere as indicated, shall be multi-blade type spring loaded to assure closure for either horizontal or vertical mounting with “fans on”. Blades shall be single skin 16 gauge with airfoil profile. Damper linkage rod extended to outside of frame. Bearings shall be stainless steel sleeve in an extruded hole.

2.20 DUCT SOUND ATTENUATORS

A. Acceptable Manufacturers:

1. Price
2. VAW Systems Incorporated
3. Vibro-Acoustics Company
4. Dynasonics
5. Semco
6. Ruskin

B. General: Factory fabricated and tested, rectangular, round, or elbow duct silencer with performance characteristics as indicated.

C. Fire Performance: Adhesives, sealants, and packing materials shall have fire ratings not exceeding 25 for flame spread index and 50 for smoke developed index when tested according to ASTM E 84.

D. Rectangular and Round Units: Fabricate outer casing with a minimum 22 gauge solid galvanized steel, and inner casing with a minimum 26 gauge perforated galvanized steel. 1/8 inch diameter perforations for inner casing and baffles.

E. Elbow Units: Fabricate outer casing with a minimum 18 gauge solid galvanized steel, and inner casing with a minimum 22 gauge perforated galvanized steel.

F. Fabricate to form rigid unit that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Unit shall not experience air leakage up to differential pressure of 6 inch wg from inside to outside. Seams and joints lock formed and sealed or continuously welded. Do not use nuts, bolts, or sheet metal screws for unit assemblies.

G. Fill Material: Provide with the following as indicated:

1. Inert and vermin-proof fibrous material, packed under not less than 5 percent compression, mylar lined resistant to erosion.
2. Moisture proof non-fibrous material.
3. Resonate chamber with no media fill “packless” type.

H. Source Quality Control: Factory test according to ASTM E 477. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000 fpm (10 m/s) face velocity. Test methods shall eliminate effects due to test room conditions. Published performance data shall include all octave bands (63 Hz to 8000 Hz).

I. Performance: The dynamic insertion loss in decibels (dB) shall not be less than that scheduled on drawings throughout all octave bands.

2.21 ACCESS DOORS

A. General: Factory fabricated double wall access doors in accordance with SMACNA standards except as specified herein. Improvised shop or field fabricated access doors will not be permitted.

B. Fabricate doors airtight and suitable for duct pressure class. Access doors shall be double wall constructed of the same material as the ductwork in which they are installed except that doors located in ducts constructed of plastic, FRP and PVC coated steel shall be constructed of Type 304 stainless steel.

C. Rectangular Duct: Provide door with closed cell full sealing gaskets and quick turn fastening locking device. Provide hinged doors with butt or piano hinge and 2 cam latches. For medium and high pressure duct, hingeless with minimum 4 cam latches and factory installed retaining cable.

D. Round Duct: Provide double wall insulated and gasketed door with minimum 2 compression latches.

E. For insulated ductwork, fabricate double wall with insulation fill and thickness not less than adjacent duct insulation. Provide raised hinge type.

F. Access door size 16 inches by 20 inches unless otherwise indicated. Where size of duct will not accommodate this size, provide size as large as possible, minimum 12 inch by 6 inch. Provide view window where indicated.

2.22 INSTRUMENT TEST HOLES

A. Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness. Ventlock 699 by Ventfabrics, or approved equal.

2.23 DUCT ROOF CURBS

A. Welded galvanized steel, insulated mounting curb without cant strip and with treated wood nailer suitable for duct roof penetration. Fibrous glass insulation minimum 1 ½ inch thick. Curb height as required for top of curb not less than 18 inches above finished roof surface. Roof will be sloped. Provide sloped roof curb as required to maintain level top surface. Refer to Architectural drawings for exact roof slope at location of duct roof curb. As manufactured by ThyCurb, Pate, Penn Ventilator, or equal.

B. Furnish roof curb to Division 07 for installation.

2.24 AIR VOLUME CONTROL BOXES (LABORATORY)

A. Acceptable Manufacturers:

1. Accutrol
2. Phoenix Controls
3. Price

B. General:

1. Factory fabricated assembly consisting of casing, damper, airflow sensor and other accessories as specified herein.
2. The assembly operation shall be pressure independent and shall reset to any airflow throughout entire operating range.
3. Performance ratings shall be certified in accordance with ARI 880 and shall bear the ARI seal. Sound ratings calculated in accordance with ARI 885.
4. Identification: Provide label on each box indicating identification number shown on drawings, maximum and minimum airflow range, scheduled airflow and calibration curve.
5. Units listed and labeled as defined in NFPA 70 by a testing agency applicable to authorities having jurisdiction, and marked for intended use.

C. Configuration:

1. Boxes shall be suitable for electric powered pressure independent air volume control system and temperature control system as specified in this section. Boxes shall include airflow sensor and damper with extended shaft compatible with unit mounted controller.
2. Provide integral power transformer 120/24 volt of each air volume control box.

D. Casing:

1. Minimum 20 gauge 304 stainless steel. galvanized steel housing. Airflow sensor shall be polycarbonate plastic, UL94-VO, control module enclosure shall be 16 gauge aluminum
2. Low leakage casing: Construct and seal casing and access panel for leakage not to exceed 1% of unit rated airflow, or 5 CFM, whichever is greater, at 1.5 inch wg pressure.

E. Damper:

1. Damper constructed of two heavy gauge metal plates sandwiched around gasketed blade seal with solid one piece aluminum shaft rotating in self lubricated bearings extended outside of unit casing. Construct of materials that cannot corrode and do not require periodic servicing. Hollow metal shaft is not permitted.
2. Provide damper blade seals and shaft bearing bushings to satisfy required leakage. Damper shaft shall include an integral marker at the end of shaft to indicate damper position.
3. Damper leakage for closed damper shall not exceed 1% of the nominal catalog rating at 3 inch wg inlet pressure. ARI 880 rated.

F. Air Flow Sensor:

1. Center tapped cross flow, center-averaging sensor located in inlet collar, constructed of plastic meeting UL fire resistance reinforced to prevent damage.
2. Sensor shall amplify pressure signal by a factor of not less than 1.7 and shall maintain control accuracy within plus or minus 5% or 5 CFM (whichever is greater) throughout operating range with the same size inlet duct in any configuration. Sensor shall not require any minimum length of straight duct to maintain control accuracy.
3. Sensor shall have a minimum of 3 static pressure and 4 total pressure measurement points on all inlet sizes. Pressure sensing tubes shall be extended to the outside of casing for connection to the airflow controller. Tubing secured to casing with grommets.
4. Sensor shall be aerodynamically designed with negligible pressure drop or noise contribution.

G. Control Package:

1. Provide factory mounted electric damper motor for air volume control and velocity reset controls for pressure independent operation throughout entire operating range.
2. Include all required accessories and box controls to accomplish sequence of operation specified in Division 25.
3. Submittals shall clearly indicate accessories, normal damper position (open or closed), etc. for sequences specified, in plain English, without the need for interpretation of manufacturer’s part number or model number to determine what is being provided.
4. Box manufacturer shall be fully responsible for coordinating and verifying compatibility of air volume control box with sequences specified in Division 25.
5. Coordinate for direct attachment of damper actuator to shaft. Additional linkages, swivels, or levels are not acceptable.

6. Electric Controls: Provide electrically operated pressure independent air volume control and temperature control system.

    a. Damper Actuator: 24-volt AC, powered closed, powered open.
    b. Provide transformer to step down incoming voltage to 24 volt, service disconnect switch, low voltage fuse and fuse block, line voltage disconnect switch, and line voltage fuse and fuse block.
    c. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain airflow dictated by thermostat with 5 percent of set point while compensating for inlet static pressure variations up to 4 inch (1000 Pa); shall be suitable for either reverse acting or direct acting and field adjustable for either normally open or normally closed damper position. The controller shall have auxiliary flow setpoint to be referenced through contact input, and provide line velocity readout.
    d. Temperature Sensor: Wall mounting electronic temperature sensor, with concealed cover latches to prevent tampering and adjustable stops for locking or limiting temperature setpoint slider movement.
    e. Factory controller to integrate with building automation system allowing to view and control points as shown on the control diagrams on the contract drawings.

2.25 AIR VOLUME CONTROL BOXES (GENERAL)

A. Acceptable Manufacturers:

1. Price Industries
2. Tuttle & Bailey
3. Titus
4. Nailor Industries

B. General:

1. Factory fabricated assembly consisting of casing, damper, airflow sensor and other accessories as specified herein.
2. The assembly operation shall be pressure independent and shall reset to any airflow throughout entire operating range.
3. Performance ratings shall be certified in accordance with ARI 880 and shall bear the ARI seal. Sound ratings calculated in accordance with ARI 885.
4. Identification: Provide label on each box indicating identification number shown on drawings, maximum and minimum airflow range, scheduled airflow and calibration curve.
5. Units listed and labeled as defined in NFPA 70 by a testing agency applicable to authorities having jurisdiction, and marked for intended use.

C. Configuration:

1. Boxes shall have an integral electric powered pressure independent air volume control system and temperature control system. Boxes shall include airflow sensor and damper with extended shaft compatible with unit mounted controller.
2. Provide integral power transformer 120/24 volt of each air volume control box.

D. Casing:

1. Minimum 22 gauge galvanized steel housing. Inlet collar minimum 2 inch depth for securing duct connection. Outlet slip and drive connection.
2. Provide insulated double wall access door or removable panel for access to all interior components and coil cleaning.
3. Provide sheet metal frame in box casing and gasket seal to obtain specified maximum leakage.
4. Standard casing: Construct and seal casing and access panel for leakage not to exceed 2% of unit rated airflow, or 10 CFM, whichever is greater, at 1.5 inch wg static pressure.
5. Low leakage casing: Construct and seal casing and access panel for leakage not to exceed 1% of unit rated airflow, or 5 CFM, whichever is greater, at 1.5 inch wg pressure.

E. Insulation:

1. Fibrous glass: 3/4 inch thick 1½ pound density fibrous glass insulation, coated with a durable fire and damage resistant surface to prevent erosion complying with ASTM C 1071; secured with adhesive. All exposed edges shall be coated.
2. Polymer foam: ¾ inch thick closed cell polymer foam, complying with UL 181 erosion requirements, and having maximum flame spread index of 25 and maximum smoke developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
3. The unit insulation shall be fully enclosed with solid 22 gauge galvanized sheet metal or equivalent gauge aluminum liner. All edges sealed within metal nosing or with NFPA 90A approved sealant.

F. Damper:

1. Damper constructed of two heavy gauge metal plates sandwiched around gasketed blade seal with solid one piece aluminum shaft rotating in self lubricated bearings extended outside of unit casing. Construct of materials that cannot corrode and do not require periodic servicing. Hollow metal shaft is not permitted.
2. Provide damper blade seals and shaft bearing bushings to satisfy required leakage. Damper shaft shall include an integral marker at the end of shaft to indicate damper position.
3. Damper leakage for closed damper shall not exceed 2% of the nominal catalog rating at 3 inch wg inlet pressure. ARI 880 rated.

G. Air Flow Sensor:

1. Center tapped cross flow, center-averaging sensor located in inlet collar, constructed of plastic meeting UL fire resistance reinforced to prevent damage.
2. Sensor shall amplify pressure signal by a factor of not less than 1.7 and shall maintain control accuracy within plus or minus 5% throughout operating range with the same size inlet duct in any configuration. Sensor shall not require any minimum length of straight duct to maintain control accuracy.
3. Sensor shall have a minimum of 3 static pressure and 4 total pressure measurement points on all inlet sizes. Pressure sensing tubes shall be extended to the outside of casing for connection to the airflow controller. Tubing secured to casing with grommets.
4. Sensor shall be aerodynamically designed with negligible pressure drop or noise contribution.

H. Hot Water Heating Coil:

1. Factory mounted, copper tubes ½ inch OD, 0.017 inch thick tube wall mechanically expanded into 0.0045 inch thick aluminum fins. Minimum 0.03 inch galvanized steel casing.
2. Coils tested and certified in accordance with ARI 410. Leak test coil with 250 psi hydrostatic pressure.
3. Provide access door or removable panel for access upstream of coil.

I. Fan Powered Air Volume Control Box:

1. Provide forward curved direct drive fan, vibration isolation mounting, fan speed adjustable at control panel, recirculation air filter.
2. Motor shall be Electronically Communicated Motor (ECM), brushless, complete with and operated by single phase integrated controller/invertor, designed for synchronous operation.
3. Series flow, continuous operation. Airflow sensor to start fan on sensing primary airflow. Fan controlled to turn on if heating required when primary air is off. Speed control shall accept as standard (0-20 mA) for remote adjustment from BAS.
4. Provide 1-inch disposable filter on plenum air inlet.
5. Units shall incorporate single point electrical connection for entire unit. All electrical components shall be enclosed in a single box with an access panel and disconnect on side of assembly.
6. Boxes shall have an integral electric powered pressure independent air volume control system and temperature control system. Boxes shall include airflow sensor and damper with extended shaft compatible with unit mounted controller.

J. Sound Attenuator: Factory mounted discharge section, minimum 3 feet long. Casing and lining constructed same as unit construction.

K. Control Package:

1. Provide factory mounted electric damper motor for air volume control and velocity reset controls for pressure independent operation throughout entire operating range.
2. Include all required accessories and box controls to accomplish sequence of operation specified in Division 25.
3. Submittals shall clearly indicate accessories, normal damper position (open or closed), etc. for sequences specified, in plain English, without the need for interpretation of manufacturer’s part number or model number to determine what is being provided.
4. Box manufacturer shall be fully responsible for coordinating and verifying compatibility of air volume control box with sequences specified in Division 25.
5. Coordinate for direct attachment of damper actuator to shaft. Additional linkages, swivels, or levels are not acceptable.
6. Electric Controls: Provide electrically operated pressure independent air volume control and temperature control system.

    a. Damper Actuator: 24 volt AC, powered closed, powered open.

b. Provide transformer to step down incoming voltage to 24 volt, service disconnect switch, low voltage fuse and fuse block, line voltage disconnect switch, and line voltage fuse and fuse block.
c. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain airflow dictated by thermostat with 5 percent of set point while compensating for inlet static pressure variations up to 4 inch (1000 Pa); shall be suitable for either reverse acting or direct acting and field adjustable for either normally open or normally closed damper position. The controller shall have auxiliary flow setpoint to be referenced through contact input, and provide line velocity readout.
d. Temperature Sensor: Wall mounting electronic temperature sensor, with concealed cover latches to prevent tampering and adjustable stops for locking or limiting temperature setpoint slider movement.
e. Factory controller to integrate with building automation system allowing to view and control points as shown on the control diagrams on the contract drawings.

2.26 DIFFUSERS, REGISTERS, AND GRILLES

A. Acceptable Manufacturers:

1. Diffusers, Registers, and Grilles

a. Titus
b. Price Industries
c. Anemostat
d. Tuttle & Bailey
e. Krueger
f. Carnes

B. General:

1. Provide terminals of type and quantity as indicated on the drawings. Sizes and deflection patterns are shown for general guidance. Approved manufacturer shall be responsible for adjusting sizes to meet noise and throw performance requirements for CFM indicated.
2. Provide air terminals that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size and type device as listed in manufacturer's current data. Rate in accordance with ADC standards and certify catalogued performance.
3. Provide blow direction to direct air away from walls, columns or other obstructions and away from re-circulating and fume hoods within radius of supply air terminal operation.

C. Performance requirements: Base selection on maximum residual air velocity in breathing zone of 35 feet per minute and on space noise level of NC 35 unless otherwise indicated.

D. Ceiling and Wall Compatibility:

1. Refer to architectural drawings and general specifications for types of ceiling and wall systems and coordinate the specific ceiling and wall type at the location where air terminals are to be installed. Provide border styles compatible with ceiling and wall type that are specifically manufactured to fit into ceiling module with accurate fit and adequate support.

2. Air terminals installed in T-bar grid framed ceilings: Provide panel type frame sized to fit within lay-in tile grid system. For tegular tile ceilings, provide drop face terminal to align with ceiling surface.
3. Air terminals installed in Spline, or inverted T-bar, grid framed ceilings: Provide drop face panel type sized to fit within lay-in tile grid system and aligning with ceiling surface.
4. Air terminals installed in hard gypsum ceilings: Provide frame with gasket seal suitable for attachment to gypsum ceiling.
5. Air terminals installed in walls: Provide wall mounted terminals suitable for installation in concrete block or drywall partition.

E. Ceiling Diffuser (CD):

1. The square plaque diffuser shall be supplied to deliver a 360 degree radial, horizontal air flow pattern. The back cone shall be a one piece die-form design with smooth, aerodynamically designed and no corner joints. The contoured design shall protect the ceiling and help prevent smudging and streaking.
2. Finish: Factory applied baked on white enamel to match ceiling grid.

F. Linear Slot Diffuser (LD, RLD):

1. Extruded aluminum, linear slot diffuser. Provide supply diffuser with adjustable pattern deflectors capable of providing 180 degree pattern adjustment. Each slot shall include two independent deflector/dampers. Diffuser utilizing single axial blade type deflectors will not be accepted. Deflectors/dampers shall be black.
2. Provide number and size of slots as indicated.
3. Provide margin to overlap or recess in opening as required to fit finish.
4. Provide mounting frame with positive holding concealed fasteners. When used to form plaster/drywall openings, fabricate with rigid bracing to maintain opening size.
5. Fabricate in one-piece up to 6 feet in length. Butt continuous diffuser sections with hair line joints and provide with interlocking splines.
6. Plenum: Provide factory fabricated internally lined sheet metal distributing plenum with inlet collar. Deflectors to be in a “jet throw” pattern for high ceiling applications. Inlet size indicated on schedules.
7. When used for intakes; similarly constructed except without pattern deflectors.
8. Finish: Factory applied baked-on powered coat finish to match ceiling grid.

G. Supply Grille (SG):

1. The grille blades and border shall be steel construction.
2. Grilles shall be double deflection louver type, and shall have:

    a. One set of fully adjustable blades, with 3/4 inch on center blade spacing.

3. The grilles front blade orientation:

    a. Front blades parallel to the long dimension.

4. Paint finish:

    a. All components shall have a baked-on powder coat finish.

1) The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability test.
2) The paint film thickness shall be a minimum of 2.0 mills.
3) The finish shall have a hardness of 2H.
4) The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
5) The finish shall have an impact resistance of 80

H. Return, Exhaust, and Transfer Grille (RG, EG, TG):

1. The grille blades and border shall be steel construction.
2. Grilles shall be single deflection louver type, and shall have:

a. One set of fully adjustable blades, with 3/4 inch on center blade spacing.

3. The grilles front blade orientation:

a. Front blades parallel to the long dimension.

4. Paint finish:

a. All components shall have a baked-on powder coat finish.

1) The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability test.
2) The paint film thickness shall be a minimum of 2.0 mills.
3) The finish shall have a hardness of 2H.
4) The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
5) The finish shall have an impact resistance of 80

5. Opposed Blade Damper:

a. The register shall be supplied with a coated steel opposed blade damper. The damper shall be operable from the register face. Only install as indicated on the contract documents. Otherwise install manual volume damper as far away from air device as possible.

6. Border Style:

a. The grille shall be suitable for suitable for surface mounting complete with a 1 inch narrow frame border

I. Perforated Return Grille (RG-1):

1. The return diffusers shall consist of a perforated air distribution face of no less than 51 percent free area, a heavy gauge steel back pan with round inlet collars. The perforated

face screen construction shall be steel. The perforated face shall be removable from the diffuser face and shall be hinged for ease of removal of the face screen for cleaning purposes.

2. Finish: Factory applied baked on white enamel to match ceiling grid.

2.27 EXHAUST HEPA FILTER BANK

A. Acceptable Manufacturers, no substitutions:

1. Camfil-Farr
2. Flanders
3. American Air Filter

B. Housing

1. Construct terminal filtration diffuser housing of minimum 16 gauge 304 stainless steel with joints and seams factory welded and sealed airtight. Provide extended height on high velocity type filter housings as required. Provide minimum 16 gauge permanent 304 stainless steel perimeter trim around bottom edge of housing for installation into hard ceilings. Provide integral knife edge on housing inside perimeter of housing-to-filter seal; a fluid gel shall be used to seal the filters to the housing. The filter shall be secured in place by 4 captive retainers.
2. Provide round swaged inlet duct connection that extends a minimum of 3 inches from ribbed inlet collar to prevent connection from slipping off. Collar size to be as indicated on the drawings.
3. Provide a factory installed volume damper on the air entering side of the housing and shall not obstruct or be installed in the inlet collar. Provide a factory installed ATECS volume damper on the air entering side of the housing that shall not obstruct, be installed in, or supported by the inlet collar. Damper to be operated by a mechanical linkage or rack and pinion gear assembly. Butterfly, guillotine or any damper with rotary flex cable actuators are not acceptable. Damper to provide 100% shutoff capabilities by means of a rotary mechanism slotted for a screwdriver and to include a Dial Position Indicator to assure repeatability of damper settings. Damper shall be fixed when set into position, and operable against 5-inch w.g. of static pressure. Damper shall produce an airflow velocity within plus/minus 5 percent when measured 6 inches below the unit with filter installed.
4. Provide a labeled aerosol injection port located in the knife edge rim of the housing and dispersion manifold in the housing, accessible from the air outlet side, designed to introduce test aerosol at the filter air inlet for the filter penetration testing. The design shall produce an upstream mass aerosol concentration relative to standard deviation of less than 20%. Provide 3/8-inch stainless steel quick disconnect swagelock fitting with Viton O-ring seals and a snap in barbed connector for use with validation. Use of these fittings shall not diminish size of HEPA filter.
5. Provide a labeled test port in the housing, accessible from the diffuser air outlet side, designed to measure the static pressure and the test aerosol concentration at the filter air inlet. Documentation must show that measurements of mass aerosol concentration shall be within 10% of upstream mean mass concentration. Provide a separate 3/8 inch stainless steel quick disconnect swagelock fitting with Viton O-rings seals and a barbed connector. Use of this fitting shall not diminish size of HEPA filter.
6. Provide a removable perforated protective grille at the diffuser air outlets. Fabricate grille of Type 304 stainless steel minimum 22 gauge with 40% free area and a 2B finish. Grille

to be held to housing on its longest dimension with the use of a 304 stainless steel piano hinge and two quarter turn stainless steel fasteners which do not require the use of hand tools.

7. Provide factory-installed hanger brackets on the top edge of the housing at each of four corners. Provide factory installed filter corner guides to direct filter into proper position.
8. Two-inch fiberglass insulation with foil backing shall cover the entire hood. The insulation shall be tested in accordance with ASTM E84 and UL 723 to meet a rating of 25 flame spread, 50 fuel contained and 50 smoke developed. All seams to be taped with aluminum foil backed tape.
9. All seams and joints are to be welded airtight. Hood/backpan should be constructed to withstand up to 2-inch w.g. during normal operation. Hood shall be factory tested to 3 inch without distortion using a soap bubble leak test with an elastomeric pressure encoding device to achieve design pressure.

C. Filters: Provide high efficiency particulate air filter as indicated on the drawings.

1. Provide 4-inch deep HEPA filters complying with the requirements of IEST RP-CC-001.3 as Type C filter. Factory test each filter for resistance to airflow, penetration and face scan each filter at the factory using polystyrene latex spheres or equivalent; repair any leakage over 0.0005 percent at 0.12 micron prior to shipment. Testing using D.O.P. is not acceptable.
2. HEPA Filter Efficiency: Minimum 99.995 % at 0.3 micron.
3. Maximum clean filter pressure drop at a face velocity of 100 fpm shall not exceed 0.35 inch w.g. for 4-inch deep filters. Housing and filter combined pressure drop not to exceed 0.41 inch w.g. at 100 fpm filter velocity with this 4 inch HEPA pack.
4. Construct filter from all glass wet laid media. Pleats shall be constructed with dimple pleat type separators. No aluminum, ribbons of media, or glue is acceptable to maintain pleat spacing.
5. Replaceable Filters: Permanently bond the filter pack to an extruded aluminum, integral frame with a fire-retardant urethane sealant. Provide 3/4-inch deep channel integral with the filter frame on the perimeter of the air outlet filter face. Fill the channel at the factory with silicone gel; channel shall mate with the housing knife edge embedded in the gel to form the housing-to-filter seal.
6. Replaceable filters shall be packaged one filter per carton. Each filter shall be encased in a flanged, tight fitting linerboard sleeve that fits within the carton, leaving a minimum of 1-1/2-inch dead air space on the four sides of the filter. The top and bottom of the filter shall be protected with a folded linerboard cushion.
7. The entire assembly shall be constructed to withstand up to 2 inches w.g. dirty filter pressure drop during normal operations.

D. Shipment, Storage, Spare Stock:

1. Housings and filters shall be treated with the utmost care and stored as received in a conditioned, clean and dry environment remote from area of installation.
2. Furnish spare filters for each size filter installed, number of spare filters shall equal 20 percent of filters installed.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated, for the specified duct pressure classification with the fewest possible joints.

B. Install round and flat-oval ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.

C. Install fabricated fittings for changes in directions, size, and shape and for connections.

D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. On ductwork subject to internal condensation, pitch horizontal runs towards equipment, or source of moisture, minimum 1/8 inch per foot slope.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).

L. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Firestopping materials and installation methods are specified in Division 07.

M. Install ducts with hangers and braces in accordance with Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.

N. Paint interiors of metal ducts that do not have duct liner, for 24 inches (600 mm) upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.2 SEAM AND JOINT SEALING

A. Seal all duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated, and SMACNA's "HVAC Leakage Test Standards" for leakage and seal class indicated.

1. For pressure classes 2-inch wg (500 Pa) and lower, seal transverse joints.

B. Seal ducts before external insulation is applied. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

3.3 FLEXIBLE DUCT INSTALLATION

A. Use only where shown on the drawings, installed in accordance with SMACNA's "HVAC Duct Construction Standards" except as specified herein.

B. Do not install flexible duct on return or exhaust ductwork unless specifically noted on drawings.

C. Minimum length 48 inches (1.3 m) and maximum length of 60 inches (2 m). Install runs with minimum centerline radius of bends not less than twice duct diameter and with no more offsets than an equivalent 90^{o} elbow. Provide band strap hangers with saddle supports under flexible duct run to keep supports from sagging and kinking. Stretch duct enough to smooth out internal corrugations.

D. Connect both ends to collar of rigid ductwork and air delivery device with "3M Brand" EC800 or approved equal adhesive, and secure with sheet metal screws in addition to an approved stainless steel worm gear draw band. Plastic tie straps are not permitted.

3.4 FLEXIBLE CONNECTORS INSTALLATION

A. Provide flexible connections immediately adjacent to any equipment with a fan(s) to isolate and prevent transmission of vibration to ductwork and casings.

B. Connections shall be made with a 3 inch (75 mm) space between duct and equipment collars, installed in line, and with 1 1/2 inch (38 mm) excess material folded so as not to interfere with airflow through connection. Flexible connectors are not permitted as a means for correcting misalignment.

C. Do not install flexible connectors on internally isolated air-handling units.

3.5 VOLUME DAMPERS INSTALLATION

A. Provide volume dampers at all points on low pressure supply, return and exhaust systems where branches are taken from larger ducts as required for air balancing. Do not install volume dampers upstream of air volume control boxes in any circumstance.

B. Install volume damper as close to main as possible, minimum 2 duct widths from branch takeoff.

C. Install damper in acoustically lined ducts in such a manner to avoid damage to liner and to avoid erosion of duct liner.

D. Install orange ribbon tag tied on to volume damper handle for the purpose of visibly identifying volume damper locations.

3.6 FIRE AND SMOKE DAMPER INSTALLATION

A. Install dampers complete with required perimeter mounting angles and sleeves, in accordance with installation instructions furnished by manufacturer, conforming to installation required of UL as a condition of listing.

B. Install in such a manner to be accessible for testing and reset. Coordinate size and location access door. Increase duct size to accommodate minimum door size of 12 inch (300 mm) by 8 inch (200 mm) as applicable.

C. Furnish additional fusible links, one fusible link for every five dampers installed, to Owner.

3.7 ACCESS DOORS INSTALLATION

A. Install duct access doors to allow inspecting, adjusting and cleaning duct mounted accessories where shown on drawings and as follows:

1. Upstream and downstream of coils, filters, fans, humidifiers, control dampers, airflow measuring devices.
2. Downstream of air volume control boxes.
3. Adjacent to fire and fire/smoke dampers, providing adequate access to reset or reinstall fusible link.
4. Adjacent to fire/smoke dampers, providing adequate access to damper actuator/motor.
5. As required by NFPA requirements for duct cleaning.

B. Where access doors are required within shaft enclosures or above inaccessible ceilings, coordinate with General Contractor and advise proper location of access panel.

C. Identify all fire damper access doors by stenciling with bright red paint the words “FIRE DAMPER ACCESS”. For spring closure dynamic curtain type fire dampers use the words “CAUTION – DYNAMIC FIRE DAMPER ACCESS”.

3.8 AIR VOLUME CONTROL BOX INSTALLATION

A. Install connecting piping to allow access to unit mounted controller and access panel.

B. Connecting tubing and/or wiring for box installed in return air plenum ceiling to be “plenum rated” of type approved by applicable building code and local authority having jurisdiction for installation in ceiling air plenum.

C. Install straight run, minimum of 1-1/2 duct diameters but not exceeding 2-1/2 duct diameters of rigid duct connection to inlet, full size of inlet connection. Fan powered units shall be connected

with flexible connections on inlet and outlet. Inlet flexible connection shall be located upstream of straight run section, not at box collar connection.

D. Provide hanger support for air volume control boxes independent of ductwork.

3.9 AIR TERMINAL INSTALLATION

A. After installing terminal in ceiling grid, provide 12 gauge support wire fastened independently to structure. One wire for each device weighing 10 pounds or less, two wires (opposite corners) for device weighing 11 to 55 pounds, four wires for device weighing greater than 55 pounds. Wire shall not be in tension to lift device out of grid, but with minimal slack to allow device to sit on grid.

3.10 INSTRUMENT TEST HOLES INSTALLATION

A. Install instrument test holes where shown on the drawings and in the following locations:

1. Air handling unit supply duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate location with TAB Contractor.
2. Return fan duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate with TAB Contractor.
3. Exhaust fan duct mains.
4. Downstream of duct mounted coils.
5. Downstream of air volume control boxes.

3.11 DUCT MOUNTED SMOKE DETECTORS INSTALLATION

A. Install duct mounted smoke detectors furnished by Division 28. Obtain installation instructions and install in accordance with manufacturer’s instructions. Mount on ductwork at locations indicated on the drawings.

3.12 SOUND ATTENUATOR INSTALLATION

A. Install sound attenuator with rigid duct connections in accordance with manufacturer’s installation instructions.

B. Where multiple silencer units are grouped together in parallel within duct system, seal between units airtight with specified duct sealant.

3.13 DUCT HANGERS AND SUPPORTS INSTALLATION

A. Suspend and support ductwork, casings, and equipment in accordance with requirements of SMACNA Duct Construction Standards and as specified further in Sections 23 05 00 and 23 05 48, except as specified herein.

B. No hangers shall be attached to or suspended from any type of metal deck. Attachments made beneath metal deck areas may be made by positive fastening to building structural members (excluding bridging and bracing) in conjunction with the use of miscellaneous auxiliary structural steel. All such steel shall conform to ASTM A36. Attachments relying on friction are not permitted.

C. Whenever the distance between the top of duct and overhead supporting member is greater than 36 inches, the hangers shall be of structural angles or channels and shall include cross bracing as required to prevent sway. Do not use straps or rods.

D. Support horizontal ducts within 2 feet (60 mm) of each elbow and within 4 feet (1.3 m) of each branch intersection. Support vertical ducts at a maximum interval of 12 feet (4 m) and at each floor.

E. Hangers must be arranged to allow the duct insulation to pass through without insulating any part of the hanger.

F. Unless combined pipe/duct racks are shown on the drawings, provide dedicated hangers for support of ductwork.

3.14 EXTERIOR WALL LOUVER PLENUM INSTALLATION

A. Exterior wall louvers for exhaust/intake/relief air will be provided by Division 08.

B. Unless otherwise indicated, provide shop or field fabricated casings and plenums as specified elsewhere in this section for connection to exterior wall louvers. Where the connecting plenum is smaller than actual louver size, provide insulated blank off panel(s) for unused portions behind louver.

C. Insulate plenum/casing as specified in 23 07 00.

D. For suspended plenums, slope bottom of plenum down towards face of louver, minimum 1/8 inch per foot, and provide adequate flashing or weep holes at louver frame to allow entrained water to drain out through louver face.

E. Blank off panel shall be double wall construction with internal insulation having a total R value of not less than R-13. Fabricate of aluminum of gauge required by SMACNA for size of blank off required, 18 gauge minimum. Insulation shall be moisture proof, non-wicking, mildew resistant and shall comply with ASTM E84 Flame Spread and Smoke Developed ratings.

F. Blank-off panels shall be mounted directly behind louver blades and shall be integral with the flashing at the bottom of the louver.

3.15 CLEANING AND PROTECTION

A. Thoroughly clean all air stream surfaces of all equipment, devices and accessories in the air distribution systems and all air stream surfaces of ductwork, casings and plenums and maintain in a clean condition as the work progresses. Clean ductwork piece by piece, section by section as installed.

B. Protect openings of all equipment, devices and accessories with polyethylene film or another covering to prevent entrance of moisture, dust or debris until final ductwork/casing/plenum connections are made. Similarly protect openings in ductwork, casings and plenums.

C. After installation, either force air at high velocity through systems or use high power vacuum machines to remove accumulated dust. Protect equipment which may be harmed by dirt with filters, or bypass during cleaning. Provide adequate access into ductwork/casings/plenums for cleaning.

D. Clean external surfaces of all of the above of foreign substances which might cause corrosive deterioration of metal or, where to be painted, might interfere with painting or cause paint deterioration.

E. Wipe clean all air terminal units from dust entrained on face during construction.

3.16 FIELD QUALITY CONTROL

A. Perform duct leakage testing and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports.

B. Test all high and medium pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork.

C. Test low pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork.

D. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

E. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. Do not pressurize systems above maximum design operating pressure.

F. Conduct tests in the presence of TAB Contractor. Give seven days' advance notice for testing.

G. Maximum Allowable Leakage: Total leakage for pressure class shall not exceed permissible leakage for specified seal and leakage class. Acceptable duct leakage shall be less than the allowable leakage per ASHRAE Std 90.1 latest version.

1. The maximum total system leakage rate will be less than 5%.
2. The maximum acceptable duct leakage rate will be less than 3%.
3. The maximum acceptable duct leakage rate for supply and return ductwork located outdoors will be less than 2%.

H. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 23 30 00

SECTION 23 34 00 – FANS AND VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Down-blast Fans
2. Laboratory Exhaust Fans with Discharge Stack

B. Related Sections:

1. Motors are specified in Division 23 “Electrical Requirements for HVAC Equipment.”
2. Variable speed motor speed controllers furnished by Division 23 are specified in Division 26.

1.3 PERFORMANCE REQUIREMENTS

A. Base fan performance on sea level conditions unless noted otherwise.

B. Provide fans capable of accommodating static pressure variations of plus/minus 10 percent at scheduled airflow.

C. Fans and shafts statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

D. Equivalent fan selections shall not increase motor horsepower (wattage) from that specified and shall not increase noise level and tip speed by more than 10 percent or increase inlet or discharge air velocity by more than 20 percent.

E. Fan Class: If the fan selection indicates an operating point within 10 percent of maximum operational speed (RPM) limit for the fan class indicated by the selection point, provide fan with next higher class designation.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated. Provide multiple RPM curves. Single RPM curves not acceptable for belt driven fans or variable speed fans.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 DOWN-BLAST FAN

A. Manufacturers:

1. Greenheck
2. Loren Cook
3. Twin City Fan Company

B. Description: Centrifugal roof exhauster mounted on roof curb.

C. Wheel:

1. Material type: aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

D. Electronically Commutated Motor:

1. Motor enclosures: Open type
2. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications.
3. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
6. Motor shall be a minimum of 85% efficient at all speeds.

E. Housing:

1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing.
2. Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
3. Windband to include an integral rolled bead for strength.
4. Motor cover constructed of aluminum

F. Disconnect Switches

1. NEMA 4
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

G. Roof Curb

1. Type GPS
2. Mounted onto roof with fan
3. Material: Galvanized
4. Height: 18” minimum

H. Damper

1. Type: Gravity
2. Prevents outside air from entering back into the building when fan is off

2.2 LABORATORY EXHAUST FAN WITH DISCHARGE STACK

A. Manufacturers:

1. Greenheck
2. Loren Cook
3. Twin City Fan Company

B. Description: High-plume laboratory exhaust with bypass air plenum and stack

C. General

1. Base fan performance at standard conditions (density 0.075 Lb. /ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/- 15% of scheduled values.
3. Each fan shall be direct drive in AMCA arrangement 4 according to drawings.
4. Fans are to be equipped with lifting lugs.
5. Fasteners exposed to corrosive exhaust shall be 316 stainless steel.
6. Fan assembly shall be designed for a minimum of 125-mph wind loading, without the use of guy wires (unless otherwise indicated on the drawings).

D. Corrosion Resistant Coating

1. All fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion resistant coating system. Standard finish color to be RAL-7023, concrete gray.

E. Fan Housing and Outlet

1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan housing shall be centrifugal involute scroll, allowing all drive components including the motor to be serviced without contact of the contaminated airstream, and manufactured of welded steel. Housing to be corrosion resistant coated.
3. A high velocity discharge nozzle shall be supplied by the fan manufacturer designed to efficiently handle an outlet velocity of up to 7000 FPM.
4. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.
5. A bolted housing access door shall be supplied for impeller inspection.

6. Fan assembly shall be AMCA type C spark resistant construction minimum or as noted on the schedule.

F. Fan Impeller

1. Fan impeller shall be centrifugal, single width, single inlet, backward inclined airfoil blade design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.
2. Fan impeller shall be manufactured of welded and coated steel. Reference specification section 2.15 for corrosion resistant coating.
3. Fan impellers that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, and lower maximum tip speeds are not acceptable.

G. Bypass Air Plenum

1. For variable volume systems, the fan manufacturer shall provide a bypass air plenum as shown on drawings. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weatherhood and bird screen.
2. The plenum shall be constructed of welded steel and meet specification section 2.15 for corrosion resistant coating. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
3. The bypass air plenum shall be mounted on an insulated curb.
4. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of galvanized steel for structural rigidity as standard. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be equal to or exceed a heavy duty control damper. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.
5. Fan isolation damper(s), shall be parallel-blade design, airfoil design, fabricated of steel for structural rigidity as standard. Damper(s) shall be coated up to 4 mils of chemically resistant Hi-Pro Polyester resin, electrostatically applied and baked. Isolation damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be equal to or exceed a heavy duty control damper. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.
6. Plenum shall include a removable bypass air weatherhood that is properly sized for low inlet velocity of the bypass air, minimizing the possibility of moisture entrainment.

H. Fan Motors and Drive

1. Motors shall be premium efficiency, standard NEMA frame, 1200, 1800 or 3600 RPM, TEFC with a 1.15 service factor. A factory-mounted NEMA 4X disconnect switch shall be provided for each fan.
2. Motor maintenance shall be accomplished without fan or fan impeller removal, or requiring maintenance personnel to access the contaminated exhaust components.
3. Fan shaft to be turned and polished of 316 stainless steel as standard, coated with corrosion resistant coating.

4. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each fan class {Average life or (L-50) of 400,000 hours} Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be acceptable.
5. All shaft bearings and non-permanently lubricated motors shall have extended lube lines with Zerk fittings.
6. Motor, coupling, and bearings shall all be outside the contaminated exhaust, and be capable of replacement without disassembling fan and accessing hazardous and contaminated fan components.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb. Install units with clearances for service and maintenance.

B. Install floor-mounting units on concrete bases. Support floor-mounting units using vibration isolators as specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

C. Support suspended units from structure using threaded steel rods and vibration isolators as specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

D. Install roof mounted fans on roof curbs or roof support rails as indicated. Support fans mounted on roof rails using vibration isolators as specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

E. Make final duct connections with flexible connectors. Install ducts adjacent to fans to allow service and maintenance.

F. Belt Driven Units: Provide sheaves as required for final air balancing. Provide fixed sheaves on all fans provided with a variable speed motor controller.

G. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Refer to Division 01 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 34 00

SECTION 23 50 00 – CENTRAL HEATING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gas Fired Hot Water Condensing Boiler

B. Related Sections include the following:

1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors
2. Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems”
3. Division 23 Section “HVAC Water Treatment”
4. Division 23 Section “Venting for Gas-Fired Equipment”

1.3 REFERENCES

A. ASME: Boiler and Pressure Vessel Code

B. NFPA 31: Installation of Oil Burning Equipment

C. UL: Applicable Sections

1.4 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories, include plans, elevations, sections, details and attachments to other work. Include wiring diagrams for power, signal and control wiring.

C. Source quality control test reports.

1.5 WARRANTY

A. Special Warranty: Provide extended warranty and/or warranty service where specified in this section.

1.6 MANUFACTURER'S SUPERVISION/INSPECTION SERVICES

A. Boiler

1. The manufacturer shall include the cost of furnishing the services of a factory trained representative to supervise the initial cleaning, startup and testing of the boiler. The manufacturer shall certify in writing that the cleaning and installation is in accordance with their requirements and the unit functions properly and operates in accordance with the intent of the specifications.
2. Following test, startup, adjustment and balancing, the manufacturer shall also provide the services of a factory trained representative for instruction of the Owner's personnel in operation and maintenance of equipment. Supervision and instruction shall be for a minimum of two (2) normal working days.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers – Minimum Efficiency Requirements".

D. UL Compliance: Test boilers for compliance with applicable UL Sections. Boilers shall be listed and labeled.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases.

B. Coordinate layout and installation to maintain proper clearances around boilers, tanks and related equipment as to permit inspection, servicing repair, replacement and visibility of all gauges.

1.9 SOURCE QUALITY CONTROL

A. The packaged boiler shall receive factory-controlled fire testing on specified fuels to check construction, controls and operation of the complete assembled unit. Owner shall be given the option to witness all tests. Manufacturer shall provide two weeks prior notice of test date.

B. Include test procedures and results for boiler firing tests in final book to Owner.

1.10 DELIVERY OF EQUIPMENT

A. Equipment manufacturer shall prepare units for shipment. Units shall be fully cleaned and plastic shrink wrapped. Provide instructions for assembly.

B. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.

C. Contractor shall inspect equipment on receipt and shall report any damage to the Owner in writing. Barring such written notification, Contractor shall be fully responsible for and shall repair at their own expense and damage to the equipment resulting from receipt, unloading, storage, and installation of the equipment.

PART 2 - PRODUCTS

2.1 CONDENSING BOILER

A. Acceptable Manufacturers:

1. Fulton
2. AERCO
3. Patterson Kelly
4. Cleaver Brooks

B. General

1. Factory fabricated, assembled and tested, heat exchanger sealed pressure tight, built on steel base; including insulated jacket; flue gas vent; combustion-air intake connections; water supply, return and condensate drain connections; and controls. Boiler to be built for or provided with required options for outdoors.
2. Constructed in accordance with ASME Heating Boiler Code.
3. Jacket: Sheet metal, with snap in or interlocking closure panels. Baked enamel finish.
4. Insulation: Minimum 2-inch thick, mineral fiber insulation surrounding the heat exchanger.
5. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated boiler input. The boiler shall not contain any refractory, refractory lining or ceramic in the furnace or firebox.
6. The boiler shall be designed for operation in a condensing mode, in order to extract the latent heat from the combustion products. The boiler shall have a minimum acceptable fuel-to-water efficiency of 91% at a return water temperature of 80 °F and at the full rated input capacity of the boiler. Overall efficiency at the low fire rated input capacity will be 98%.
7. The boiler shall be able to operate without the use of a 3-way valves or primary/secondary piping loops.
8. The boiler shall have no minimum return water temperature requirements.
9. The boiler shall have no minimum flow rate requirements.
10. Gas Train: The boiler shall have an integral gas train, factory assembled and installed. The main gas train will include:

    a. One manual shut-off valve at gas inlet.

b. Gas inlet trap.
c. Gas regulator rated for a maximum14 inch wc supply pressure.
d. Two safety shut-off valves. One to be solenoid and one motorized valve.
e. Independent low and high gas pressure switches shall be supplied.
f. Spark or silicone-carbide hot surface ignition with 100 percent main valve shutoff with electronic flame supervision.

11. Burner: Natural gas, forced draft.
12. Blower: Centrifugal fan to operate during each burner firing sequence and during prepurge and postpurge of the combustion chamber.
13. Condensate drain neutralization kit.

C. Boiler Trim Equipment, Hot Water Boiler

1. Include devices to comply with ANSI B31.9 Building Services Piping.
2. Aquastat controllers: Operating, firing, and high limit.
3. ASME certified safety relief valve(s).
4. Pressure and temperature gauge(s).
5. Boiler air vent.
6. Drain valve.
7. Venting Kit: Provide combustion air opening and stainless steel vent discharge.

D. Control Panel

1. Factory assembled, wired and tested, mounted on the boiler. Include the following:

a. Control transformer.
b. Set point adjustments.
c. Sequence of Operation: Electric, factory fabricated and field installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in the heated space. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for all boilers.
d. High temperature cutoff.
e. Probe type low water cutoff.
f. Blocked inlet safety switch.
g. Audible alarm.
h. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control and display boiler status and alarms.
i. Provide hardwired points for monitoring including On-Off Status, Common Trouble Alarm. Provide hardwired points for control including On-Off operation, water supply temperature set point adjustment.
j. A communication interface with the building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through the building management system.

E. Power Panel

1. Single point field power connection. Factory installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single point field power connection to boiler.

F. Emissions

1. The boiler shall operate with CO emissions less than 100 PPM corrected to 3% O2 and shall with NOx emissions less than 50 PPM corrected to 3% O_2 over the entire turndown range.

2.2 BOILER LEAD / LAG CONTROL SYSTEM (Flexible Water-Tube, Condensing and Electric Hot Water Boilers up to 600 BHP)

A. General

1. Provide boiler control panel with a microprocessor based burner management control, totally enclosed and factory assembled and wired in NEMA 1 enclosure. The panel and system shall be UL 508A approved.
2. Supply a fully integrated boiler control system to coordinate the operation of two fully modulating hot water boilers and boiler primary water circulating pumps in order to maintain the Hot Water Supply (HWS) temperature at setpoint. The control system shall be microprocessor-based and suitable for wall mounting.
3. The control system shall incorporate a HWS header temperature PID control scheme. Boilers shall be modulated. Modulation signals shall be 4-20mA or 0-135 ohm (as required by the boiler) and shall be electrically isolated channel-channel and channel-ground. When the HWS Temperature control loop is in the “automatic” mode, the control system shall establish the HWS temperature setpoint based on the time of day, day of the week and the outside air temperature. When in “manual” mode the operator may set the HWS temperature via a front panel display. All temperatures and time/date data must be field adjustable through “fill-in-the-blanks” style displays. Alternately, the control system shall accept a 4-20 mA dc outdoor air temperature reset setpoint signal from an external Building Automation System (BAS).
4. The control system shall utilize both HWS temperature and boiler firing rate percent to start and stop the boilers and shall minimize the total number of boilers in operation. The controller shall start and stop boilers when the HWS temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize header temperature deviations, the control system shall start and stop the next boiler when the “lead” boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The lead boiler shall either automatically rotate every 1 to 168 hours or shall be manually selected by the operator. The boiler shall be run at low fire for warm-up for a preset low fire hold time. The base load ramp rate shall be field adjustable. The Control System shall reduce the firing rate to a minimum before stopping a boiler to prevent accumulation of fuel in the furnace.
5. Include independently operated primary water pump control to allow boiler warm-up to the return water temperature before the boilers start; continue water flow for an adjustable

cool down period after the boiler has stopped; and ensure water is always moving past the header temperature sensor even after the last boiler has been stopped. The pump shall immediately stop if any trips occur during pre-purge, pilot, or main flame trial for ignition.

6. The control system shall include a 16 line x 40 character (or greater) LCD display for boiler sequence control and status, alarm and event summaries, and setup menus for easy operation, tuning and troubleshooting. Alarms, events and operator actions shall be logged with Time/Date stamp and English language description. The control system shall include a minimum of 200 point memory. The Control System shall include a minimum 100x150 pixel historical trending display or paperless chart recorder or other videographic hardware to permit the logging of at least 32 data points for at least 45 days. Provide a minimum of 4 “pens” per chart with 8 minute thru 24 hour chart “width” selections available.
7. Include hard wired backup stations to permit manual operation of the plant should the control system require service. Manual operation must be possible when the microprocessor is not functioning. Hard wired “Hand-Off-Auto” control switches must be wired directly into every boiler and pump Start/Stop circuit. Each 4-20 mAdc or 0-135 ohm modulating control output must include a hard wired manual backup station with Auto/Manual switch, output control knob and output level indicator (bargraph, analog meter or digital display).
8. The Control System shall include simultaneous communication to a Data Acquisition System (DAS), Building Automation System (BAS) or Building Management System (BMS) via RS485 Modbus protocol and to a Personal Computer and an alphanumeric pager via standard telephone lines. The individual boiler limits, lockout, start/stop, warm standby, and firing rate status shall be readable. Header setpoint, plant firing rate, boiler quantity called to start, boiler selected as lead and all setup parameters shall be readable and writable.
9. The control system shall be manufactured and labeled in accordance with UL508 requirements (CSA C22.2 #14 for use in Canada). Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL).
10. The control system shall be a Preferred Instruments Model JC-CDHWBP-Z118-JNB, or equivalent.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Before boiler system installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

B. Drawings indicate general arrangement of piping, fittings, and specialties. Coordinate piping installations and specialty arrangements with Drawings and requirements specified in piping systems to provide a complete boiler and boiler feed system.

C. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Materials and Methods for HVAC".

D. Vibration Isolation: Provide in accordance with Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems”.

E. Assemble and install boiler trim furnished with boiler but not factory mounted.

F. Install in accordance with manufacturer’s instructions and comply with ASME and other applicable codes, rules, and regulations.

G. Install piping adjacent to boiler to allow service and maintenance.

H. Install electrical devices and controls furnished with boiler but not factory mounted.

I. Install control wiring to field mounted electrical devices.

J. Connect breeching full size to boiler outlet.

K. Install gas-fired boilers according to NFPA 54.

L. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

M. Install oil-fired boilers according to NFPA 31.

N. Connect oil piping full size to burner inlet with shutoff valve and union.

O. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection. Install piping from safety relief valves to nearest floor drain.

P. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

Q. Install flue-gas recirculation duct from vent to burner.

3.2 MANUFACTURER’S SUPERVISION/STARTUP SERVICE

A. Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer, to provide the specified manufacturer’s supervision and startup services and manufacturer’s written certification as specified in Part 1 of this Section, and shall at his own expense make and corrections/modifications to his installation work as require by the manufacturer.

END OF SECTION 23 50 00

SECTION 23 51 00 – SPECIALTY VENTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Emergency Generator Engine Exhaust

B. Related Sections include the following:

1. Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems”

1.3 REFERENCES

A. NFPA 37: Standard for the Use of Stationary Combustion Engines and Gas Turbines

B. NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

C. UL: Applicable Sections

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

B. Shop Drawings:

1. Scaled drawings depicting the actual layout.
2. Include plans, elevations, sections, and attachment details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail fabrication and assembly of hangers and seismic restraints.

1.5 WARRANTY

A. The exhaust system shall be warranted against functional failure due to defects in material and manufacturer’s workmanship for a period of 15 years from date of installation.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents

B. Source Limitations: Obtain listed system components through one source from a single manufacturer.

C. Provide factory-built system tested and listed by the Underwriters’ Laboratories, Inc.

D. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.7 COORDINATION

A. Coordinate layout and installation to maintain proper clearances and access to clean-outs and access doors.

1.8 DELIVERY OF EQUIPMENT

A. Equipment manufacturer shall prepare units for shipment. Units shall be fully cleaned and plastic shrink wrapped. Provide instructions for assembly.

B. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer’s instructions.

C. Contractor shall inspect equipment on receipt and shall report any damage to the Owner in writing. Barring such written notification, Contractor shall be fully responsible for and shall repair at their own expense and damage to the equipment resulting from receipt, unloading, storage, and installation of the equipment.

PART 2 - PRODUCTS

2.1 EMERGENCY GENERATOR ENGINE EXHAUST

A. Acceptable Manufacturers:

1. Selkirk Metalbestos
2. Van Packer

B. Factory prefabricated, UL listed for positive pressure emergency generator exhaust, laboratory tested, proved and certified for use as described in Chapter 6 of NFPA 37. Suitable for continuous operation with exhaust gases to 1400^{o} F Provide accessories as required for a complete installation including, but not limited to, thimble, explosion relief valve near connection to muffler, flip top, required supports, etc.

C. Double wall system. Outer jacket of aluminum coated steel 0.025-inch-thick inside of building and Type 304 stainless steel 0.025 inch thick outside of building. Inner gas carrying pipe Type 304 stainless steel .035 inch thick.

D. Inner pipe joints sealed by use of V-bands and high temperature joint cement suitable for continuous operation at 1400^{o} F.

E. Outer surfaces of inner shell internally insulated with 4 inches of insulation.

F. Exhaust system designed by system manufacturer so that there will be minimum exhaust manifold back pressure and no excessive mechanical stresses on exhaust manifold due to weight, inertia, bending moments or thermal expansion. System shall permit no water to enter engine and shall totally enclose all gases and vent to the outside for complete operator and environmental safety.

G. System manufacturer shall warrant complete system against functional failure due to defects in material and workmanship for 15 years from date of delivery. System manufacturer shall be responsible for checking sizing, design and installation of system. If any component fails to perform its intended function of engine exhausting, for any reason, within 15 years of delivery, system supplier shall, at no expense to Owner, provide a replacement part or parts FOB jobsite.

PART 3 - EXECUTION

3.1 EMERGENCY GENERATOR ENGINE EXHAUST INSTALLATION

A. Install in strict accordance with manufacturer’s published installation instructions. Terminate as required by NFPA 211 or local jurisdiction.

3.2 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 23 51 00

SECTION 23 60 00 – WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Water Cooled Liquid Chiller

B. Related Sections include the following:

1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors.
2. Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems”.
3. Division 23 Section “HVAC Water Treatment”.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

1.4 REFERENCES

A. ANSI/ASHRAE 15: Safety Code for Mechanical Refrigeration

B. AHRI 550/590: Centrifugal, Rotary Screw and Reciprocation Water Chilling Packages

C. AHRI 560: Absorption Water Chilling Packages

D. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

E. NFPA 70: National Electric Code

F. NEMA ICS-6: Enclosures for Industrial Controls and Systems

G. UL: Underwriters Laboratories, applicable standards

H. ETL: Electrical Testing Laboratories, applicable standards

1.5 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's certified prints of equipment assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Operating weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Manufacturer Seismic Qualification Certification: Submit certification that water chillers, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

E. Source quality-control test reports.

1.6 WARRANTY

A. Special Warranty: Provide extended warranty or warranty service as specified in this section.

1.7 MANUFACTURER’S SUPERVISION/INSPECTION SERVICES

A. Water Chiller

1. Provide services of manufacturer's factory trained field engineer to supervise installation of unit and witness pressure testing, evacuation and charging. Manufacturer's field engineer shall also perform initial startup including proper coordination with Contractor on startup of cooling tower and associated condenser water and chilled water pumps.
2. When chiller is shipped in sections, manufacturer shall properly field charge assembled system.
3. Following test, startup, adjustment and balancing, manufacturer's engineer shall instruct Owner or his representative in proper care and operation of unit for a period of 2 days, continuous or intermittent at option of Owner.

4. Following test, startup, adjustment and balancing, manufacturer shall certify, in writing, that the equipment is installed in accordance with his requirements and is operating in accordance with the intent of the specifications.

1.8 QUALITY ASSURANCE

A. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

B. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Comply with NFPA 70.

D. Comply with UL 1995.

E. Rating temperatures and conditions, COP and EER of all equipment and components provided under this section shall meet the requirements of the State Energy Code or latest issue of ASHRAE Standard 90 or the latest issue of the Standards for Equipment of the National Energy Policy Act, whichever is more stringent.

1.9 COORDINATION

A. Centrifugal Water Chiller: Contractor for DIVISION 26, ELECTRICAL, will install chiller motor starter(s) and will provide power wiring from source to chiller motor starter(s) and motor(s). DIVISION 26, ELECTRICAL shall provide wiring from the chiller control panel to the chiller starter, and including wiring from flow switches to safeties.

B. Water Chiller Mechanical Room Refrigerant Monitor: Contractor for DIVISION 26, ELECTRICAL, will provide power source from emergency power system to monitor terminals. Ventilation control wiring and DDC alarm will be provided under Division 25. Provide all other required wiring under this section.

1.10 SOURCE QUALITY CONTROL

A. Water chillers shall receive factory performance test as specified. All tests to be witnessed by the Owner’s representative. Manufacturer shall provide minimum two weeks prior notice of test date.

B. Include test procedures and results of chiller performance tests in final book to the Owner.

1.11 DELIVERY OF EQUIPMENT

A. Equipment manufacturer shall prepare units for shipment. Units shall be fully cleaned and plastic wrapper prior to shipment. Provide instructions for assembly as required.

B. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

C. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 AIR COOLED LIQUID CHILLER (ROTARY SCREW)

A. Acceptable Manufacturers:

1. Trane
2. York / Johnson Controls, Inc.
3. Carrier
4. Daikin / McQuay

B. General

1. Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled screw compressor chiller(s) as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with flammability rating of "1", as defined by ANSI/ASHRAE Standard-34 Number Designation and Safety Classification of Refrigerants. Chiller shall include, but is not limited to: a complete system with not less than two independent refrigerant circuits, semi hermetic twin screw compressors, direct expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.
2. Chiller shall operate using refrigerant R-513A.

C. Cabinet

1. External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 500 hour, 5% salt spray test, yields minimum ASTM D1654 rating of "6".

D. Compressors and Motors

1. Compressors: Shall be direct drive, semi hermetic, rotary twin-screw type, including internal muffler, temperature actuated "off-cycle" heater, rain-tight terminal box, internal discharge check, discharge and suction shut-off service valves, and precision machined cast iron housing. Design working pressure of entire compressor, suction to discharge, shall be 450 PSIG (31 Bar). Compressor shall be UL listed.
2. Motors: Refrigerant suction gas cooled two-pole accessible hermetic compressor motor, full suction gas flow through 0.006-inch maximum mesh screen, with inherent internal thermal overload protection and external current overload on all three phases. Motor stator shall employ APT2000 type magnet wire.
3. Lubrication: External oil separators with no moving or fragile parts, 450 psig design working pressure, and UL listing. Refrigerant system differential pressure shall provide oil flow through service replaceable, 0.5 micron, full flow, cartridge type oil filter internal to compressor. Filter bypass, less restrictive media, or oil pump not acceptable.

4. Capacity Control: Compressors shall start at minimum load position. Capacity control range from 100% to 10% of chiller full load using continuous function slide valves, and without hot gas bypass. Step unloading unacceptable. Provide microprocessor controlled, output pressure regulating capacity control valve to command compressor capacity independent of control valve input pressure and balance compressor capacity with cooling load.

E. Refrigerant Circuit Components

1. Each independent refrigerant circuit shall include liquid line shutoff valve with charging port, low side pressure relief device, removable core filter-drier, solenoid valve, sight glass with moisture indicator, expansion valves, and flexible, closed-cell foam insulated suction line.

F. Heat Exchangers

1. Evaporator:

a. Direct expansion type with refrigerant inside high efficiency copper tubes, chilled liquid forced over the tubes by galvanized steel baffles. Independent refrigerant circuits per compressor.
b. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 350 psig refrigerant side design working pressure and 150 psig water side design working pressure.
c. Shell covered with 1-1/2 inch, flexible, closed-cell insulation, thermal conductivity of 0.26k (BTU/HR-$Ft^{2-°}$F)/in.) maximum. Water nozzles with grooves for mechanical couplings and insulated by Contractor after pipe installation.
d. Provide vent and drain fittings, and thermostatically controlled heaters to protect to -20°F ambient in off-cycle.
e. Flanged piping connections, raised face, 150 psig.

2. Air Cooled Condenser:

a. Coils: Internally enhanced, seamless copper tubes, mechanically expanded into aluminum alloy fins with full height collars. Subcooling coil an integral part of condenser. Design working pressure shall be 450 psig.
b. Fans: Shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into low noise, full airfoil cross section, providing vertical air discharge from extended orifices for efficiency and low sound. Each fan in its own compartment to prevent cross flow during fan cycling. Guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.
c. Fan Motors: High efficiency, direct drive, 6-pole, 3-phase, insulation class "F" current protected, Totally Enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

3. Provide auxiliary heat exchangers to increase overall unit efficiency: UL/cUL listed 450 psig design working pressure.

G. Controls and Valves

1. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

2. Control Circuit Transformer: Factory mounted with primary breaker having lockable, external handle, and 115V/1φ secondary.
3. Microprocessor Enclosure: Rain and dust tight NEMA 3R/12 (IP55) powder painted steel cabinet with hinged, latched, and gasket sealed door.
4. Microprocessor Control Center:

    a. Automatic control of compressor start/stop and load/unload, anti-coincidence and anti-recycle timers, automatic pump-down at start-up and shut-down, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, run signal contacts, and chiller operation from 0°F to 125°F ambient. Automatic reset to normal chiller operation after power failure.

    b. Setpoint Reset:

        1) Pulse Width Modulated (PWM) input to reset current unload setpoint downward via signal from external Energy Management System (EMS), maximum allowable reset programmable from microprocessor keypad.
        2) PWM input to reset the chilled liquid setpoint upward via signal from remote EMS, maximum allowable reset programmable from microprocessor keypad.

5. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real time clock (RTC) memory for minimum 5 years.
6. Forty character liquid crystal display, descriptions in English (or Spanish or French), numeric data in English (or Metric) units. Sealed keypad with sections for setpoints, display, entry, print, program, clock, and unit on/off switch.
7. Programmable Setpoints (within Manufacturer Limits): Display language; discharge pressure unload and cutout; low suction pressure cutout; low and high ambient cutouts; leaving chilled liquid temperature; setpoint, control range, and cutout; high motor current unload; anti-recycled time; lag compressor start; local or remove control; units of measure; compressor lead/lag; power failure restart (auto or manual), and maximum EMS-PWM reset temperature range.
8. Display Data: Chiller liquid return and leaving temperatures, ambient, lead compressor identification and lead/lag deplay, clock and schedule, (variable) out of range, remote input indication, chilled liquid reset setpoint, leaving liquid pull-down rate setpoint, leaving liquid error (deviation from setpoint), and history data for last six shutdown faults. Compressor suction, discharge, and oil pressures and temperatures, suction and discharge superheads, percent of full-load motor current, operating hours, starts, and anti-recycle timer status. Status messages for manual override, unit switch, off, compressor run, run permissive, remote controlled shutdown, no cooling load, daily/holiday shutdown anti-recycle/anti-coincident timer, high pressure low suction temperature limit.
9. System Safeties: Shall cause individual compressor systems to perform auto-reset shutdown; manual reset required after the third trip in 90 minutes. Includes: high discharge pressure or temperature, low suction pressure, high/low motor current, high pressure switch/high/low differential oil pressure, high oil temperature, and motor protector. Compressor motor protector shall protect against damage due to low or high input current, phase reversal (reverse rotation), current unbalance, phase loss, thermal overload of windings, and low voltage.
10. Unit Safeties: Shall be automatic reset and cause compressors to shut down if: high or low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.
11. Alarm Contacts: High or low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure or temperature, low suction pressure, low or high motor current, low or high differential oil pressure, and high oil temperature.

12. Furnish system integrator to communicate chillers and to provide complete integration to Building Management System. Provide listings of all available points to be communicated to the BMS with submittal.
13. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

H. Power Connection and Distribution

1. Power Panels:

    a. NEMA 3R/12 (P55) rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor and fan motor start contactors, current overloads, and factory wiring.
    b. Field power supply wiring connections shall be to a single power center on the chiller, shall be 3 phase of scheduled voltage, and shall connect to terminal blocks per each of the two motor control panels. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.
    c. Provide two electrically separate, adjacent motor control center cabinets, with independent doors and separated by a steel panel, for compressor and fan motor power distribution components.

2. Exposed compressor and fan motor power wiring shall be routed through liquid tight conduit.

I. Accessories and Options

1. Microprocessor controlled; factory installed Wye-Delta compressor motor starters for reduced compressor inrush start current. Machines equipped with single-point power connection and with Star-Delta compressor motor start shall also include factory provided circuit breakers in each motor control center.
2. Power Supply Connections:

    a. Single Point Terminal Block or Non-fused Disconnect Switch: Field provided branch circuit shall connect to single-point terminal block or non-fused disconnect with lockable external handle in compliance with NEC Article 440-14, with factory provided interconnecting wiring to (optional individual system circuit breakers, and) compressor motor start components in each of two motor control center cabinets.

3. Control Circuit Power Terminal Strip (115V, 1φ) located in the microprocessor panel to accept a field provided control power circuit with appropriate branch circuit protection in accordance with applicable local and national codes.
4. Flow Switch (field-mounted): Vapor proof SPDT, NEMA 4X switch (150 psig) -20° F to 250° F.
5. Low Temperature Process Brine: Leaving chilled liquid setpoint range 20° F to 55° F; optional to 15° F.
6. Building automatic System (EMS) Reset Interface: Chiller to accept 4 to 20mA, 0 to 10 VDC, or discrete contact closure input to reset the leaving chilled liquid temperature, or percent full load amps (current limit).
7. Remote Control Panel (Field-mounted): Auxiliary panel for remote user interface for functions normally made at the unit control center.

8. Sound Reduction (Factory-mounted):

    a. Low speed, reduced noise fans
    b. Acoustic Silencer Kit
    c. Compressor Sound Blankets

9. Vibration Isolation (Field-mounted): Neoprene Isolators.

PART 3 - EXECUTION

3.1 CHILLER INSTALLATION

A. Install chillers on concrete base.

B. Charge chiller with refrigerant if not factory charged.

C. Provide water piping and accessories for water cooled oil cooler.

D. Pipe discharge from relief valve and purge to exterior of building.

E. Install temperature sensor, chilled and condenser water flow and differential switches and other devices not specified or not furnished as factory installed.

F. Provide union/flanged piping connections and arrange piping risers to allow head removal for tube cleaning or replacement with minimal disturbance to piping connections. Provide drain and vent valves for evaporator and condenser.

G. Leave adequate pull space at the end of unit where access is required for tube pulling.

H. Connect wiring and electrically ground water chillers according to Division 26. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

I. Start Up Service:

1. Engage a factory authorized service representative to perform startup service.
2. Inspect field assembled components, equipment installations, and piping and electrical connections for proper assemblies, installations and connections.
3. Complete startup checks according to manufacturer's written instructions and perform the following:

    a. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
    b. Verify that pumps are installed and functional.
    c. Verify that thermometers and gages are installed.
    d. Operate water chiller for run-in period according to manufacturer's written instructions.
    e. Check bearing lubrication and oil levels.
    f. Verify that refrigerant pressure relief is properly vented.
    g. Verify proper motor rotation.

h. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
i. Verify and record performance of water chiller protection devices.
j. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

4. Prepare a written startup report that records results of tests and inspections.

END OF SECTION 23 60 00

SECTION 23 70 20 – COMMERCIAL ROOFTOP AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. Commercial rooftop air handling unit

B. Related Sections include the following:

1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors and variable frequency motor speed controllers.
2. Division 23 Section “Air Filtration” for air filters mounted in air handling units.
3. Division 23 Section “Vibration Isolation and Seismic Restraints For HVAC Systems”.

1.3 REFERENCES

A. AGA: Applicable publications

B. AMCA-210: Laboratory Methods of Testing Fans for Rating

C. AMCA-500: Test Method for Louvers, Dampers and Shutters

D. AHRI-410: Forced Circulation Air-cooling and Air-heating Coils

E. AHRI-430: Central Station Air Handling Units

F. ASHRAE 90.1: Energy Standard for Buildings, Except Low-Rise Residential Buildings

G. NBS: Applicable standards

H. NEC: National Electric Code

I. NFPA: Applicable standards

J. UL: Applicable standards

1.4 SUBMITTALS

A. Product Data: For each type of air-handling unit indicated, include the following:

1. Certified fan-performance curves with system operating conditions indicated. Submit multiple RPM fan curve, single RPM fan curve not acceptable.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.
8. Internal pressure drop calculation tabulating each component, including dirty filter allowance, include inlet and outlet openings.
9. Wiring diagrams: Power and control wiring as applicable.

B. Shop Drawings: Provide a detailed fabrication drawing for each air handling unit, drawn accurately to scale, clearly indicating installation of all components, accessories, and unit connections, when assembled as a complete unit. Include unit dimensions and operating weights. Shipping splits shall be indicated as applicable.

C. Manufacturer Seismic Qualification Certification: Submit certification that air-handling units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

1.5 WARRANTY

A. Special Warranty: Provide extended warranty and/or warranty service where specified elsewhere in this section.

1.6 MANUFACTURER'S SUPERVISION/INSPECTION SERVICES

A. Air Handling Units

1. The manufacturer shall be present during field installation or shall inspect completed installation of all air handling units and shall certify in writing that the installation is in accordance with their requirements and the units will function properly and operate in accordance with the intent of the specifications.
2. The manufacturer shall include the cost of furnishing the services of a factory trained representative to supervise the initial startup and testing of all air handling units.
3. Following test, startup, adjustment and balancing, the manufacturer shall also provide the services of a factory trained representative for instruction of the Owner's personnel in the operation and maintenance of the equipment.

B. Variable Frequency Motor Speed Controller for Air Handling Units

1. Provide the services of the manufacturer's engineer or authorized serviceman to check, start-up, test and adjust controller and to assist the TAB Contractor and BAS Contractor in setting up controls for the variable speed controller.
2. The manufacturer's engineer or authorized serviceman shall: Check the equipment for proper installation and for its conformance to the Specifications; run the system in all modes of operation to ascertain that the unit will function properly; test the system for line noise and

radio interference and furnish test report; make necessary adjustments to ensure trouble-free service.

3. After completion of the start-up procedure, the manufacturer shall certify in writing, that the equipment is installed in accordance with his requirements and is operating in accordance with the intent of the Specifications and shall instruct the Owner in proper operation and maintenance of the variable speed controller.

1.7 QUALITY ASSURANCE

A. Drawings indicate size, profiles, and dimensional requirements of air-handling units and are based on one manufacturer. Other manufacturer's dimensions and weights that deviate from the basis of design are acceptable provided that there is no impact to the general layout, structural design, and accessibility requirements indicated on the documents. Division 23 Contractor shall be fully responsible to coordinate all changes.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

D. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.

E. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Coordinate with Division 26 for the required unit power connections, including any internal wiring of lights and receptacles not factory wired.

1.9 DELIVERY OF EQUIPMENT

A. Equipment manufacturer shall prepare units for shipment. Identify each component and mating planes. Units shall be fully cleaned and completely dry, and plastic shrink wrapped for each shipping section. Provide instructions for assembly.

B. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.

C. Contractor shall inspect equipment on receipt and report any damage to the Owner in writing. Barring such written notification, Contractor shall be fully responsible for and shall repair at his own expense any damage to the equipment resulting from his receipt, unloading, storage if necessary, and installation of the equipment.

D. Equipment manufacturer shall provide a trained field technician to supervise assembly of air handling units in the field.

PART 2 - PRODUCTS

2.1 HEAT TRANSFER COIL FOR AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Water and Steam Coils: Manufacturer to be selected by and complete responsibility of air handling unit manufacturer.
2. Preheat Coil, Face and Bypass Type:

    a. The Wing Co.
    b. Aerofin
    c. Control Air Inc. Subsidiary of Aeronix

B. Extended surface type constructed of copper tubes with aluminum fins, unless otherwise specified. Coil headers of steel, copper or cast iron unless otherwise specified. Header and nipple designed and constructed to prevent electrolytic corrosion. Tubes staggered in direction of air flow. Fin spacing 10 fins per inch maximum for cooling coils unless indicated otherwise. Coil rating certified in accordance with AHRI 410.

C. Water Coils

1. Cooling Coils: 1/2-inch (DN 15) o.d. x 0.016-inch (0.41 mm) tube wall.
2. Heating Coils: 5/8-inch (DN 17) o.d. x 0.020-inch (0.51 mm) tube wall.
3. Coil headers of steel, copper or cast iron unless otherwise specified.
4. Coils for cooling service (chilled water) constructed of plate type fins with tubes mechanically or hydraulically expanded into fins to form a permanently tight metal to metal contact. Coils for heating or reheat service similarly constructed or may be constructed of helical fins wound to the tubes to provide a permanently tight metal to metal contact.
5. Serpentine type designed for 200 psi working pressure and 220° F Drainable with nontrapping circuits. Provide coil headers with drain and vent tappings.
6. Provide coils with supply and return connections on the same end of coil.

D. Maximum coil face velocities or minimum coil areas and minimum rows deep are noted on Drawings. Increase face area or rows as required to meet scheduled performance, not fins per inch.

E. Casings: Construct casings and tube sheet of type 304 stainless steel for cooling coils, galvanized sheet steel elsewhere, with intermediate tube supports for coils exceeding 48-inch tube length. Tube sheets and intermediate tube supports to have either extruded holes or ferruled holes.

F. Preheat Coil, Face and Bypass Type

1. Integral face and bypass coils shall have vertical tubes with supply and return connections at the bottom. Steam coil design shall be nonfreeze type with tube within tube, the outer tube having a wall thickness of not less than .035 inch. Fins shall be copper with a coating of solder to completely cover the fins and tube surface. Headers shall be fabricated of carbon steel, and

the coil casing shall be fabricated of 12 gauge galvanized steel. Coil tubes shall be free floating to allow for expansion and contraction, without the use of offset bends. Factory test at 200 psig steam and 1,000 psig hydrostatic pressure.

2. Built-in control dampers to be 16 gauge galvanized steel with aluminum hinges, stainless steel hinge pins, and stainless-steel interconnecting damper linkages. Damper operator electrically controlled with lever arm welded to a common shaft for permanent alignment. Bronze iolite bearings. Operator connected to damper linkage using threaded ball joint rod ends.
3. Proportioning of air shall be such that average temperature at any point in plane parallel to face of coil 3 feet downstream from leaving side will not vary more than 5° F from thermostat setting and pressure drop of air passing through coil shall not vary more than 5% regardless of position of internal dampers.
4. Enclose units in galvanized sheet steel casing with angle reinforcement.

2.2 HUMIDIFIER FOR AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Dri-Steem, Ultra-Sorb
2. Armstrong, Humidipack
3. Nortec

B. Packaged panel type assembly of steam dispersing tubes connected to a steam supply header/separator and, if required by manufacturer's design and construction, a condensate return header, all constructed of Type 304 stainless steel and contained within a galvanized metal casing. Tubes fitted with nonmetallic steam discharge tublets with steam orifices.

C. Select panel size, tube spacing and number of orifices for maximum absorption distance at scheduled face velocity. Absorption distance 18 inches maximum at 52° F DB and 90% RH supply air with panel face velocity up to 1500 ft. per minute. Air pressure loss not to exceed 0.26 inches w.g. at panel face velocity of 1500 ft. per minute.

D. Provide manufacturer's full modulating electric valve properly orificed, strainer and trap(s), all constructed of Type 304 stainless steel and shipped loose for field installation.

E. Include with submittal factory published/calculated absorption distance and air pressure drop for actual installed velocity at maximum and minimum flow conditions and design temperature conditions at 90% minimum duct relative humidity.

2.3 COMMERCIAL ROOFTOP AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. York
2. Trane
3. McQuay
4. Carrier

B. General:

1. Air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and accessories as specified herein. Suitable for operation at scheduled static pressure. Fan and coil performance AHRI certified whenever AHRI offers such certification.
2. Unit specifically designed for outdoor application. Weatherized indoor unit is not acceptable.
3. Manufacturer shall guarantee performance of cooling coil(s) such that no moisture carryover will occur on downstream components. Provide moisture eliminator at discharge of cooling coil if required to prevent moisture carryover.
4. Provide access sections of sufficient length between unit components to ensure proper performance and airflow across all surfaces as well as sufficient distance for maintenance and service access.
5. Air handling unit total static pressure indicated on the drawings is approximately only. Manufacturer shall be responsible to confirm internal pressure drop for each component of the unit, including intake/relief louvers and plenum "system effects", and combined with scheduled external static pressure, determine total fan pressure drop for the basis of fan selection. Include filter manufacturer's recommended dirty filter pressure drop in total pressure drop calculations.

C. Base and Frame:

1. Base assembly constructed of minimum 12 gauge galvanized steel channels to form a rigid equipment mounting structure. All major components supported from base.
2. Upper frame fabricated of heavy gauge galvanized steel bolted or welded, roll formed to provide structurally rigid, unitized assembly.
3. Unit base shall be suitable for mounting on full perimeter roof curb or steel dunnage as indicated on the drawings. When mounted on roof curb, base shall overhang roof curb for water runoff and have a fabricated recess with a continuous surface to seat on roof curb gasket, providing a positive air and watertight seal.
4. Provide lifting lugs integral to unit base. Entire base frame cleaned and finished with weatherized coating to match unit casing.

D. Casing:

1. Construct entire casing of unit of galvanized steel with double wall thermal barrier system. Unit casing to have solid inner walls constructed of minimum 20 gauge and solid outer walls constructed of minimum 18 gauge galvanized steel with galvanized steel support members to achieve maximum deflection of L/200 at scheduled operating pressure. Perforated inner wall will not be accepted.
2. Roof panels single or dual sloped for water runoff.
3. Exterior panels shall form a smooth, continuous surface, with no standing seams.
4. All panel-to-panel joints welded or caulked for air and water tightness. Units shipped in sections, shall be specifically designed for assembly with mating flanges with gasketing of entire perimeter. Align holes drilled in flanges, and provide all required bolts, nuts, washers and gaskets for air and watertight assembly. After assembly, provide additional caulk seal around full perimeter of outer seam.
5. Exterior screws to be zinc chromate plated or stainless steel.
6. Floor shall be 10 gauge galvanized steel, except stainless steel required under cooling coils and humidifiers.
7. Provide insulated double wall sloped drain pan under cooling coils and humidifier, to comply with ASHRAE 62. Fabricate drain pans from single sheet with welded corners. Fabricate full inner pan of stainless steel and outer pan of galvanized steel. Either provide stainless steel

moisture eliminator or extend drain pan sufficient distance downstream of cooling coil to collect all condensed moisture when units are operating at maximum catalogued face velocity across cooling coil. Extend drain connection(s) to exterior of unit casing.

8. Unit constructed such that there are no uninsulated thermal paths from inside of unit to outside.
9. Entire exterior of unit completely cleaned and finished with factory applied enamel which meets or exceeds Federal Specifications TTP636 outdoor exposure requirements. Standard color.

E. Insulation:

1. Insulate entire unit between inner and outer panels with 2-inch-thick polyurethane foam insulation conforming to NFPA 90A and NFPA 90B.
2. Thermal conductivity (k value): 0.18 at 75 deg. F.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C411.

F. Access Panels and Doors:

1. Provide access doors of same construction as unit casing, complete with hinges, latches, handles, and gaskets. Doors shall have minimum three stainless steel hinges and two compression latches and handles, fully gasketed and open against unit pressure to form a positive seal. Access doors shall be sized and located to allow periodic maintenance and inspections. Provide access doors for each access section.
2. Provide rain drain lips above each access door.
3. Provide access panels of same construction as unit casing to allow removal of components such as coil(s) and fans. Access panels shall be bolted and gasketed to be removable as well as air and watertight.

G. Fans, Motors and Drives:

1. Provide fan assembly consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support frame equipped with formed steel channel base for integral mounting of fan and motor.
2. Fan assemblies statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
3. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.

    a. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
    b. Performance Class: AMCA 99-2408, Class suitable for scheduled operating condition.
    c. Horizontal Flanged Split Housing: Bolted construction.
    d. Plug Fans: With steel cabinet. Fabricate without fan scroll and volute housing.

4. Plenum/Plug Fan Wheels:

    a. Plenum/plug fans shall be non-overloading, single width, single inlet (SWSI), direct drive, centrifugal airfoil "plug" type fan. Manufacturer's fan ratings shall be based on

tests performed in strict accordance with AMCA Standard 210-85. Fans must carry the seal authorized by AMCA, indicating that the ratings are certified by the organization and are a member in good standing with AMCA. Fans not meeting this criterion will not be accepted.

b. Fan housing shall be all aluminum wheel and hub. The airfoil blades shall be fabricated from heavy gauge extruded aluminum. The airfoil blades shall be continuously welded to the back plate and inlet shroud, leading edge of fan blade 100% welded to fan wheel top and bottom of airfoil blade. Inlet cones shall be configured so that wheel inlet efficiency and stall free performance is ensured.

5. Shafts: Turned, ground, and polished hot rolled solid steel with keyway. Ship with protective coating of lubricating oil. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
6. Provide self-aligning oil or grease lubricated pillow block type ball bearings with adaptor mount and two-piece, cast-iron housing. Minimum L-10 life of 50,000 hours. Provide suitable lubrication fittings.
7. Drives and guards: For belt driven fan, provide an adjustable drive sheave with adjustment limits plus or minus 12-1/2 percent and based on a service factor of 1.5 as applied to the motor nameplate rating. Provide at least two belts for drives of 1 hp and larger; matched belts for all multiple belt sets; oil resistant, nonsparking and nonstatic belts. For constant speed motors 20 hp and greater, and for motors with variable frequency motor speed control, provide fixed nonadjustable sheaves. Provide substantial, OSHA approved, drive guard secured to the equipment for each belt drive. Construct guard of galvanized expanded metal face, solid sides. Provide adequate openings in guard at drive sheave and driven sheave centers.
8. Motor(s) shall comply with requirements of Division 23 Section "Electrical Requirements for HVAC Equipment". Motors shall be factory wired to a nonfused disconnect switch mounted in NEMA 3R weatherproof enclosure on the side of the unit.
9. Fan Speed Control: Where scheduled, provide variable frequency motor speed controller as specified in Division 23 Section "Electrical Requirements for HVAC Equipment".
10. Include with submittals multiple RPM fan curve with operating point plotted on curve. Single RPM curve not acceptable. Equivalent fan selection shall not increase motor horsepower (wattage) and shall not increase noise level and tip speed by more than 10 percent or increase inlet or discharge air velocity by more than 20 percent.
11. Sound Performance: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

H. Vibration Isolation

1. Install entire fan, motor and drive assembly on a structural steel vibration isolator base and isolate by use of springs, internally mounted at factory, together with fan discharge flexible connection and thrust restraint springs.
2. Isolation devices shall comply with Division 23 "Vibration Isolation and Seismic Restraints for HVAC Systems".

I. Filter(s): Provide air filter(s) as scheduled, constructed as specified in Division 23 "Air Filtration.

J. Coil(s):

1. Construct coil(s) as specified elsewhere in this Section under “Heat Transfer Coil for Air Handling Unit”.
2. Provide cooling coil support racks constructed of stainless-steel structural members.
3. Where coils are stacked more than one high, provide individual coil support racks to allow easy removal of a lower coil without disturbing the upper coils. For stacked cooling coils, provide independent stainless steel support racks and intermediate stainless-steel drain pan with downspout for each upper coil.
4. Extend coil connections through unit casing to the exterior of unit. Seal casing penetrations airtight.

K. Piping Vestibule:

1. Provide a double wall insulated piping vestibule constructed same as unit casing, including full perimeter base and frame integral to unit. Pipe vestibule adequately sized to accommodate coil piping connections and valve accessories indicated on the drawings.
2. Provide hinged access door.

L. Economizer/Mixing Box

1. Designed and configured for outside air, return air, and relief/exhaust air. Outside air and exhaust air openings shall be on opposite sides of unit in order to minimize recirculation.
2. Provide outside air and exhaust air openings covered with rain hoods or storm proof louvers. Louver velocities not to exceed 500 fpm gross area on outside air intake and 1,000 fpm on exhaust discharge. Provide bird screens covering all openings. Air flow pressure drop through outside air intake and exhaust discharge when unit is operating at 100% full economizer, including dampers, shall not exceed 0.25 inch.
3. w.g. for the outside air intake, and 0.50-inch w.g for the exhaust discharge.
4. Construct economizer/mixing box with three sets of extruded aluminum, airfoil type dampers with compressible jamb seals, extruded vinyl blade edge seals, mounted on steel shafts supported in nylon bearings. Provide where scheduled, maximum and minimum outside air damper section with area of each damper proportional to its percentage of total airflow. Damper linkages shall be completely independent of each other suitable for mounting of damper control actuators provided by BAS Contractor.
5. Dampers low leakage type, maximum 10 cfm per square foot at 4-inch w.g. static pressure, tested according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating". Outside air and return air dampers shall be parallel flow type with blades positioned to direct airflow toward each other to facilitate mixing.
6. Provide additional baffles as required to prevent stratification of air streams.
7. Where indicated, provide factory fabricated air blender module.
8. Where indicate, provide airflow measurement for minimum outside air damper. Install airflow measuring device in strict accordance with the manufacturer’s published requirements to achieve accuracy listed below. The airflow measurement system shall operate with 24 VAC power supply and be capable of functioning accurately between minus 20 deg F and 158 deg F, shall transmit a 2-10 VDC linear signal representative of velocity and be factory calibrated to provide an accuracy of plus/minus 5 percent of actual flow down to 15 percent of the nominal flow. Assemble and calibrate airflow measuring system in the field based on actual conditions.

M. Lights and Receptacles:

1. Provide factory mounted weather resistant (enclosed and gasketed), light fixture in all sections. Fixture shall be complete with junction box, globe, aluminum globe guard, and bulb. Provide one (1) unit mounted jeweled indicator light switch with auto “off” timer located adjacent to fan section access door to serve all lights mounted in weatherproof enclosure.
2. Provide duplex GFI receptacle mounted adjacent to light switch mounted in weatherproof enclosure.

N. Roof Curb:

1. Roof curbs with vibration isolators and seismic restraints are specified in Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.

O. Smoke Dampers:

1. Provide smoke dampers internally installed in the supply air and return air connections.
2. Smoke damper and actuator assembly shall be UL listed and comply with the requirements of UL555S, class II at 250 deg F and so labeled. Certified by manufacturer for pressure drop not to exceed 0.25-inch w.g. at 2,000 fpm velocity based on AMCA 500.
3. Damper to be parallel blade galvanized steel airfoil type with electric actuator.

P. Diffuser Section: Provide diffuser plate constructed of heavy gauge perforated galvanized steel at discharge of fan section to provide uniform face velocity across downstream cooling coil or filter section.

PART 3 - EXECUTION

3.1 GENERAL

A. Review the drawings to determine whether the layout shown will affect proper performance of the equipment. Include any system effect factors in the fan static pressure drop calculations.

B. Assemble units shipped in sections. Install all equipment in accordance with manufacturer’s instructions.

3.2 INSTALLATION, ROOFTOP AIR HANDLING UNIT

A. Mount unit on roof curb.

B. Prior to setting unit on roof curb, verify that area within curb is clean and dry. Ensure that all roofing work, insulation, acoustical treatment of roof deck, curb, etc has been completed as applicable, when such requirements are shown on the drawings. Provide full perimeter gasket around top of roof curb.

C. Install unit on curbs and coordinate roof flashing and penetrations with roof construction specified in Division 07. Secure unit to upper curb rail, and secure base of curb to roof framing with structural fasteners.

D. For units shipped and assembled in sections, provide additional caulk seal at mating joints on the inside and outside of unit casing. Provide additional caulk seal at all removable panels on outside of unit casing.

E. Pipe condensate from drain pan and provide appropriately sized drain trap. Extend drainpipe to nearest roof drain. Cut discharge end of drainpipe at 45-degree angle.

3.3 FILTERS

A. Provide temporary filters for use during construction. Do no operate unit(s) until filters (temporary or permanent) are in place. Replace all temporary filters used during construction with specified filters before turning equipment over to Owner. Provide new filters as specified for air balancing work. Provide Owner with one additional set of filters.

B. Provide air filter draft gauge as specified in Division 23 Section “Air Filtration”. Mount draft gauge in accessible and visible location adjacent to filter module.

3.4 COILS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

B. Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins.

C. Keep drains and plugs accessible.

D. Ensure water coils are drainable with proper drain valves and air vents.

3.5 MANUFACTURER’S SUPERVISION/STARTUP SERVICE

A. Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer’s supervision and startup services and manufacturer’s written certification as specified in Part 1 of this section and shall make any corrections/modifications to the installation as required by the manufacturer.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete.
3. Verify units are completely cleaned and dry.
4. Briefly energize motor, verify proper rotation, and operation of motor, drive system, and fan wheel.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Comb coil fins bent or damaged during installation.

7. Verify clean filters have been installed.

3.6 CLEANING AND PROTECTION

A. Maintain protective covering on unit during construction until final duct and piping connections are made. Protect above unit from water damage. Provide protective sheeting on top of unit when installation work above unit is required. Unit access doors shall remain closed during construction.

B. Do not use air handling unit access sections for storage of construction equipment and materials not associated with the air handling unit.

C. Clean air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

END OF SECTION 23 70 20

SECTION 23 70 40 – INDUSTRIAL ROOFTOP AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. Industrial rooftop air handling unit

B. Related Sections include the following:

1. Division 23 Section “Electrical Requirements for HVAC Equipment” for motors and variable frequency motor speed controllers.
2. Division 23 Section “Air Filtration” for air filters mounted in air handling units.
3. Division 23 Section “Vibration Isolation and Seismic Restraints For HVAC Systems”.

1.3 REFERENCES

A. AGA: Applicable publications

B. AMCA-210: Laboratory Methods of Testing Fans for Rating

C. AMCA-500: Test Method for Louvers, Dampers and Shutters

D. AHRI-410: Forced Circulation Air-cooling and Air-heating Coils

E. AHRI-430: Central Station Air Handling Units

F. ASHRAE 90.1: Energy Standard for Buildings, Except Low-Rise Residential Buildings

G. NBS: Applicable standards

H. NEC: National Electric Code

I. NFPA: Applicable standards

J. UL: Applicable standards

1.4 SUBMITTALS

A. Product Data: For each type of air-handling unit indicated, include the following:

1. Certified fan-performance curves with system operating conditions indicated. Submit multiple RPM fan curve, single RPM fan curve not acceptable.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.
8. Internal pressure drop calculation tabulating each component, including dirty filter allowance, include inlet and outlet openings.
9. Wiring diagrams: Power and control wiring as applicable.

B. Shop Drawings: Provide a detailed fabrication drawing for each air handling unit, drawn accurately to scale, clearly indicating installation of all components, accessories, and unit connections, when assembled as a complete unit. Include unit dimensions and operating weights. Shipping splits shall be indicated as applicable.

C. Unit Casing Performance Certification: Submit calculations and confirmation that condensation will not occur on exterior of unit casing under normal unit operating conditions. Calculations shall be based on 105°F db/80°F wb ambient conditions.

D. Source quality control test reports.

E. Field quality control test reports.

F. Manufacturer Seismic Qualification Certification: Submit certification that air-handling units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

1.5 WARRANTY

A. Special Warranty: Provide extended warranty and/or warranty service where specified elsewhere in this section.

1.6 MANUFACTURER'S SUPERVISION/INSPECTION SERVICES

A. Air Handling Units

1. The manufacturer shall be present during field installation or shall inspect completed installation of all air handling units and shall certify in writing that the installation is in accordance with their requirements and the units will function properly and operate in accordance with the intent of the specifications.
2. The manufacturer shall include the cost of furnishing the services of a factory trained representative to supervise the initial startup and testing of all air handling units.
3. Following test, startup, adjustment and balancing, the manufacturer shall also provide the services of a factory trained representative for instruction of the Owner's personnel in the operation and maintenance of the equipment.

B. Variable Frequency Motor Speed Controller for Air Handling Units

1. Provide the services of the manufacturer's engineer or authorized serviceman to check, start-up, test and adjust controller and to assist the TAB Contractor and BAS Contractor in setting up controls for the variable speed controller.
2. The manufacturer's engineer or authorized serviceman shall: Check the equipment for proper installation and for its conformance to the Specifications; run the system in all modes of operation to ascertain that the unit will function properly; test the system for line noise and radio interference and furnish test report; make necessary adjustments to ensure trouble-free service.
3. After completion of the start-up procedure, the manufacturer shall certify in writing, that the equipment is installed in accordance with his requirements and is operating in accordance with the intent of the Specifications and shall instruct the Owner in proper operation and maintenance of the variable speed controller.

1.7 QUALITY ASSURANCE

A. Drawings indicate size, profiles, and dimensional requirements of air-handling units and are based on one manufacturer. Other manufacturer's dimensions and weights that deviate from the basis of design are acceptable provided that there is no impact to the general layout, structural design, and accessibility requirements indicated on the documents. Division 23 Contractor shall be fully responsible to coordinate all changes.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

D. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.

E. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Coordinate with Division 26 for the required unit power connections, including any internal wiring of lights and receptacles not factory wired.

1.9 SOURCE QUALITY CONTROL

A. All air handling units shall be factory leak tested and performance tested with their sections assembled as a complete unit. Prepare test procedures and include as part of submittal. Prepare test results for each unit and submit to Owner and Architect prior to shipment of units. All tests to be witnessed by Owner or designated representative. Manufacturer shall provide minimum two weeks prior notice of test date. Manufacturer shall include the cost of travel expenses to the factory for two Owner's representatives.

B. After delivery of air handling units to the jobsite, units shall be assembled as a complete unit and field leak tested. Procedures for field testing shall be the same as shop testing.

C. Include all test procedures and results in final book to the Owner.

1.10 DELIVERY OF EQUIPMENT

A. Equipment manufacturer shall prepare units for shipment. Identify each component and mating planes. Units shall be fully cleaned, and completely dry, and plastic shrink wrapped for each shipping section. Provide instructions for assembly.

B. Installing contractor shall schedule delivery with the equipment manufacturer and shall receive, unload, store if necessary, and install equipment in accordance with manufacturer's instructions.

C. Contractor shall inspect equipment on receipt and report any damage to the Owner in writing. Barring such written notification, Contractor shall be fully responsible for and shall repair at his own expense any damage to the equipment resulting from his receipt, unloading, storage if necessary, and installation of the equipment.

D. Equipment manufacturer shall provide a trained field technician to supervise assembly of air handling units in the field.

PART 2 - PRODUCTS

2.1 HEAT TRANSFER COIL FOR AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Water and Steam Coils: Manufacturer to be selected by and complete responsibility of air handling unit manufacturer.
2. Preheat Coil, Face, and Bypass Type:

    a. The Wing Co.
    b. Aerofin
    c. Control Air Inc. Subsidiary of Aeronix

B. Extended surface type constructed of copper tubes with aluminum fins, unless otherwise specified. Coil headers of steel, copper or cast iron unless otherwise specified. Header and nipple designed and constructed to prevent electrolytic corrosion. Tubes staggered in direction of air flow. Fin spacing 10 fins per inch maximum for cooling coils unless indicated otherwise. Coil rating certified in accordance with AHRI 410.

C. Water Coils

1. Tubes: 5/8-inch (DN 17) diameter with 0.035 inch (0.89 mm) thick wall minimum.
2. Fins: 0.010-inch fins minimum.
3. Coil headers nonferrous barrels with HPT connections. Tubes brazed to headers.

4. Coils for cooling service (chilled water) constructed of plate type fins with tubes mechanically or hydraulically expanded into fins to form a permanently tight metal to metal contact. Coils for heating or reheat service similarly constructed or may be constructed of helical fins wound to the tubes to provide a permanently tight metal to metal contact.
5. Serpentine type designed for 200 psi working pressure and 220° F. Drainable with nontrapping circuits. Provide coil headers with drain and vent tappings.
6. Provide coils with supply and return connections on the same end of coil.

D. Maximum coil face velocities or minimum coil areas and minimum rows deep are noted on Drawings. Increase face area or rows as required to meet scheduled performance, not fins per inch.

E. Casings: Construct casings and tube sheet of type 304 stainless steel for cooling coils, galvanized sheet steel elsewhere, with intermediate tube supports for coils exceeding 48-inch tube length. Tube sheets and intermediate tube supports to have either extruded holes or ferruled holes.

F. Preheat Coil, Face and Bypass Type

1. Integral face and bypass coils shall have vertical tubes with supply and return connections at the bottom. Steam coil design shall be nonfreeze type with tube within tube, the outer tube having a wall thickness of not less than .035 inch. Fins shall be copper with a coating of solder to completely cover the fins and tube surface. Headers shall be fabricated of carbon steel, and the coil casing shall be fabricated of 12 gauge galvanized steel. Coil tubes shall be free floating to allow for expansion and contraction, without the use of offset bends. Factory test at 200 psig steam and 1,000 psig hydrostatic pressure.
2. Built-in control dampers to be 16 gauge galvanized steel with aluminum hinges, stainless steel hinge pins, and stainless-steel interconnecting damper linkages. Damper operator electrically controlled with lever arm welded to a common shaft for permanent alignment. Bronze iolite bearings. Operator connected to damper linkage using threaded ball joint rod ends.
3. Proportioning of air shall be such that average temperature at any point in plane parallel to face of coil 3 feet downstream from leaving side will not vary more than 5° F from thermostat setting and pressure drop of air passing through coil shall not vary more than 5% regardless of position of internal dampers.
4. Enclose units in galvanized sheet steel casing with angle reinforcement.

G. Corrosion Resistant Construction: Construct coils of copper fins. Coat coils with a baked phenolic coating, Heresite P-413 or equal, applied to entire coil and casing in a multistep (four dip minimum) process, with each coat baked for maximum corrosion resistance. Coils shall be dipped - spray coating not acceptable.

2.2 HUMIDIFIER FOR AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Dri-Steem, Ultra-Sorb
2. Armstrong, Humidipack
3. Nortec

B. Packaged panel type assembly of steam dispersing tubes connected to a steam supply header/separator and, if required by manufacturer's design and construction, a condensate return

header, all constructed of Type 304 stainless steel and contained within a galvanized metal casing. Tubes fitted with nonmetallic steam discharge tublets with steam orifices.

C. Select panel size, tube spacing and number of orifices for maximum absorption distance at scheduled face velocity. Absorption distance 18 inches maximum at 52° F DB and 90% RH supply air with panel face velocity up to 1500 ft. per minute. Air pressure loss not to exceed 0.26 inches w.g. at panel face velocity of 1500 ft. per minute.

D. Provide manufacturer's full modulating electric valve properly orificed, strainer and trap(s), all constructed of Type 304 stainless steel and shipped loose for field installation.

E. Include with submittal factory published/calculated absorption distance and air pressure drop for actual installed velocity at maximum and minimum flow conditions and design temperature conditions at 90% minimum duct relative humidity.

2.3 INDUSTRIAL ROOFTOP AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Alliance
2. York Custom
3. Trane Custom

B. General:

1. Provide factory engineered, fabricated and assembled air handling unit(s), complete with all components specified herein, scheduled or indicated on drawings, and of the size and capacity shown on the performance schedules(s). Each unit shall include all components installed at the factory and shall be suitable for operation at scheduled static pressure. Field fabrication of units and their components will not be accepted. All units shall be inspected, and factory performance tested prior to shipment.
2. Unit specifically designed for outdoor construction. Weatherized indoor unit will not be accepted.
3. Fan and coil performance AHRI certified whenever AHRI offers such certification.
4. All ferrous construction, inside and outside, of casings and casing accessories shall be of corrosion resistant construction.
5. Seal both sides of all pipe and conduit casing and safing penetrations air and moisture tight with FDA approved sealant.
6. Provide access sections of sufficient length between unit components to ensure proper performance and airflow across all surfaces as well as sufficient distance for maintenance and service access.
7. Air handling unit total static pressure drop indicated on the drawings is approximate only. It includes all external losses and scheduled losses for unit coils and filters, but it does not include internal characteristics and plenum losses. Manufacturer shall be responsible for internal characteristic pressure drop for casing and plenum “system effect” factor on fan operation and actual wet coil pressure drop, and adjust total static pressure drop and fan selection accordingly. Account for manufacturer’s recommended dirty filter allowance in calculation.

C. Base and Floor Construction:

1. The unit floor shall be constructed of minimum 10 gauge galvanized steel welded to a 6 inch 8.2 lb/ft structural full perimeter channel base with intermediate floor support framing. Tubular of roll formed sheet metal is not acceptable.
2. Maximum live load floor deflection shall not exceed L/360 and shall be suitably braced to prevent “oil-canning”.
3. Immediately beneath the floor, there shall be minimum 2 inch thick, polyurethane foam. The insulation shall be enclosed with 20 gauge galvanized steel sheet on the underside of the channel base. Additional cross members shall be provided to support the internal components.
4. Where sections of floor join together, the joints shall be welded and caulked.
5. Drain Pans: In cooling coil and humidifier sections, the floor shall be recessed and constructed as a continuously welded positively sloping 12 gauge 304 stainless steel drain pan with a minimum depth of 4 inches at the drain. The drain pan shall be insulated with 2 inch polyurethane foam and 20 gauge galvanized steel cover sheet.
6. Unit base shall be suitable for mounting on full perimeter roof curb or steel dunnage as indicated on the drawings. When mounted on roof curb, base shall overhang roof curb for water runoff and have a fabricated recess with a continuous surface to seat on roof curb gasket, providing a positive air and watertight seal.
7. The unit base shall be provided with integral lifting lugs, minimum four per shipping section. The unit base shall be prime coated with an epoxy mastic and finished with rust inhibiting enamel to match unit casing.

D. Casing Construction:

1. Walls and roof shall be constructed of galvanized steel. Carbon steel shall not be used in the panel support framing system. Outer wall and roof panels shall be constructed of minimum 16 gauge G90 galvanized steel sheet. Exterior walls shall be flush with no external standing flanges. The inner wall shall be minimum 20 gauge solid galvanized steel except in the cooling coil and humidifier sections, where inner skin shall be solid 20 gauge 304 stainless steel. Inner casing walls shall be flush with no standing flange seams. Perforated inner wall will not be accepted.
2. Maximum wall or roof deflection shall not exceed L/240 at 125% of maximum fan shutoff static pressure. Maximum leakage shall not exceed 0.5 percent of unit capacity at 125% design static pressure.
3. Roof shall be single or dual sloped at a minimum of ½ inch per foot to provide water runoff.
4. Insulation: The insulation shall be 4-inch-thick polyurethane foam panel and shall be full
5. 4 inches thick throughout the unit height and width. Insulation shall have minimum R- value of 22.7 or maximum u-value of 0.045 and comply with NFPA-90A requirements.
6. All internal seams shall be welded and caulked with mold resistant FDA approved sealant.
7. Panel outer wall shall be roll formed inward turned double flange. Inner wall fastened to
8. flange face. Slip-in inner wall will not be accepted.
9. Panel outer wall shall be roll formed inward turned double flange. Inner wall fastened to
10. Provide full length perimeter angles located inside units at shipping splits to allow for field bolting of modular sections. Unit manufacturer to provide necessary hardware, tape sealer and caulk required to field join and seal the modular sections. All exterior panel to panel joints welded or caulked for water and airtightness.
11. Exterior casing screws cadmium plated or stainless steel and shall have cup washers with neoprene grommets to prevent damage to paint finish and to form a weathertight seal.
12. Entire exterior unit housing completely cleaned and to receive one coat of air dried chemical resistant epoxy over recommended primer coat. Standard color.

E. Access Panels and Doors:

1. Access doors shall be provided as indicated on the contract drawings to provide adequate access to each unit component. Doors shall be insulated solid double wall panel construction same as unit casing with full length stainless steel piano hinges. Each door shall be provided with a 12-inch x 12-inch double pane viewing port (deadlite), centerline mounted 60 inches above bottom of unit structural base. Doors shall be minimum 24 inches by 60 inches (or maximum allowable size if unit is less than 60 inches high) and shall open against the section's operating pressure. Doors smaller than 24 inches wide shall be permitted only where specifically noted on drawings. Provide doors with two (2) Ventlok latches, Model 310 Alloy operable from either side of door. Door opening shall be fully gasketed with extruded Santoprene fitted into retainer slots in the door panel and frame. Door frames shall be aluminum with the exterior side of the door flush with the unit.
2. All access doors shall be provided with thermal break construction.
3. Access doors shall have been tested in an independent laboratory in accordance with ASTM E 283-84 (Rate of air Leakage through Exterior Windows, Curtain Walls and Doors). A normal 24 inch W by 60 inches H door assembly must withstand 25 inches of water column test chamber pressure. Air infiltration shall not exceed 0.41 cfm per linear foot of panel frame opening at 11-inch water column.
4. Provide for each access door, instrument test hole (Ventlock Model 699-2) with screw cap and gasket, located below view window.
5. Provide rain drip lips above each access door.
6. Provide access panels of same construction as unit casing to allow removal of components such as coil(s) and fans. Access panels shall be bolted and gasketed to be removable as well as air and watertight.

F. Lights and Receptacles

1. Each accessible section shall be provided with factory mounted weather resistant (enclosed and gasketed) light with impact resistant housing and wire guard. Lights shall be wired to a switch with an indicating light, located on the outside of the unit near the fan section access door. The switch shall have an auto off timer and be mounted in weatherproof enclosure.
2. Provide duplex GFI receptacle outside fan section access door mounted on unit suitable for use outdoors.
3. All wiring in rigid conduit. Wire all lights, switches, and receptacles to a single point, 120V junction box mounted on the exterior of the unit.

G. Intake Plenum Module/Mixing Box Module

1. The intake plenum module shall be designed and fabricated in accordance with the general unit construction.
2. Provide outside air openings covered with rain hoods or storm proof louvers. Louver velocities not to exceed 500 fpm gross area on outside air intake. Provide bird screens covering all openings. Air flow pressure drop through outside air intake, including dampers, shall not exceed 0.25-inch w.g.
3. Provide industrial type ultra-low leakage, maximum 6 cfm per square foot at 4-inch W.G. static pressure, airfoil, bladed dampers at the inlet opening(s). Frames shall be constructed of extruded aluminum hat channel with hat mounting flanges on both sides of the damper frame. Blades shall be airfoil type extruded aluminum with integral structural reinforcing tube running full length of each blade. Blade edge seal shall be extruded vinyl double- edge design.

Bearings shall be non-corrosive two-piece molded synthetic. Linkage shall be concealed in the frame.

4. When air streams are 90° to each other and unit is not provided with an air blender, dampers to be parallel blade type with blades positioned to direct air toward each other. Where air streams are 180° to each other and/or when unit has an air blender module and/or if single unit intake plenum, dampers to be of opposed blade type with blades positioned across the short air opening dimension.
5. Provide an access door of double wall insulated construction with features similar to those described for access section module of this section.

H. Filter Module

1. The combination filter module shall be designed and fabricated in accordance with the general unit construction.
2. Provide filters as scheduled, constructed as specified in Division 23 Section “Air Filtration”.
3. Provide upstream access for filter changeout. Both prefilters and final filters shall be face-load mounted and properly sealed to prevent air bypass. Reinforce filter holding frame to provide rigid support frame suitable for unit operating pressure.
4. Each filter bank shall be furnished with a Dwyer magnehelic gauge to measure the filter pressure drop, with two static pressure tips and vent valves. The gauge shall be factory-mounted on the exterior of the unit.

I. Access Section Module

1. The access section module shall be designed and fabricated in accordance with the general unit construction.
2. Access section module shall provide access upstream or downstream of other system module components for maintenance or inspection. The access section doors shall be 24 inches wide permitting adequate entrance to the module. The doors shall be as previously specified.

J. Preheat Coil Module: The preheat coil module shall be designed and fabricated in accordance with the general unit construction. The module cabinetry shall completely encompass the heat transfer surface, headers and return bends. Externally mounted coils, header covers, or header extensions are not acceptable. One removable coil access panel shall be provided allowing coil removal from the header connection side. Coil connections shall be extended through the unit casing wall and properly sealed by the unit manufacturer. Coil module shall be provided with an individual coil support rack, where the coils are stacked more than one high, to allow easy removal of a lower coil without disturbing the upper coil(s). Locate coil in center of AHU so as not to impede airflow through cooling coil.

K. Integral Face and Bypass Coils:

1. Construct coils as specified in this section under Preheat Coil, Face, and Bypass Type.
2. Construct preheat module with a minimum of 3'-0" clearance between downstream edge of dampers and face of downstream coil.
3. Locate coil in center of AHU so as not to impede air flow thru cooling coil. Position coil so that condensate pipe is located minimum 18 inches above housekeeping pad to allow for proper trapping.

L. Cooling Coil Module:

1. The cooling coil module shall be designed and fabricated in accordance with the general unit construction. The module cabinetry shall completely encompass the heat transfer surface, headers and return bends. Externally mounted coils, header covers, or header extensions are not acceptable. One removable coil access panel shall be provided allowing coil removal from the header connection side. Coil connections shall be extended through the unit casing wall and properly sealed by the unit manufacturer.
2. Cooling coil modules shall be provided with an individual coil support rack, where the coils are stacked more than one high to allow for easy removal of a lower coil without disturbing the upper coil(s). Where individual coil support racks are utilized, provide an intermediate drain pan with a trough and downspout at each end. Coil support racks shall be constructed of stainless-steel structural members. Intermediate drain pans, troughs, and downspouts shall be constructed of 304 stainless steel. A continuously welded, positively sloping 12 gauge 304 stainless steel drain pan with a minimum depth of 4 inches deep at the drain, constructed in compliance with ASHRAE 62, shall be provided below the coils, and shall completely encompass the coil headers and return bends and shall be an integral part of the module base. The condensate drain pan shall be double wall construction with not less than 2 inches -3#/ft^3 density fiberglass insulation. Extend drain pan minimum 18 inch downstream of leaving face of coil.

M. Cooling Coils: Construct coils as specified in this section under Heat Transfer Coils. Provide MISTOP, INC. moisture eliminator mounted on leaving air face of cooling coil(s). Where unit has two banks of coils in series, provide eliminator for downstream coil only.

N. Humidifier Module

1. Humidifier module shall be designed and fabricated in accordance with general unit construction, casing and floor shall be constructed as specified for cooling coil module.
2. Length of humidifier section downstream of humidifier not less than 1 ft. greater than humidifier manufacturers absorption distance, 3'-0" minimum.
3. Coil connections shall be extended through unit casing wall and properly sealed by the unit manufacturer.

O. Humidifier: Provide panel type humidifier as specified elsewhere in this section.

P. Fan Module (Fan Array)

1. General:

a. The array shall consist of multiple, direct driven, arrangement 4, plenum fans constructed per AMCA requirements for the duty specified, (Class I, II, or III).
b. All fans shall be selected to deliver design air flow at the specified operating Total Static Pressure (TSP) at the specified motor speed and as scheduled.
c. The Array shall be selected to operate at a system Total Static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan speed.
d. The fan array shall consist of multiple fan and motor "cubes", spaced in the plenum cross section to provide a uniform air flow and velocity profiles across the entire plenum cross section and components contained therein.
e. The manufacturer shall provide a complete spare fan array fan/motor assembly for emergency replacement, one for each type of assembly provided on the project.

f. Each fan shall be provided with a back draft damper to prevent bypass in the event of a failure.
g. Each array shall be provided with one inlet airflow blank-off plate to be used in case of a motor failure. Plate to include handles and latches for quick installation.
h. Redundancy Criteria: Unit shall be able to deliver a minimum of 100 percent total capacity in the event of any single fan motor or VFD failure.

2. Construction:

a. Each fan/motor "cube" shall include 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel motor support plate and structure.
b. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance.
c. All motors shall be standard pedestal mounted type, TEAO, T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere.
d. All motors shall include isolated bearings or shaft grounding. Bearings shall be fully enclosed and not require any grease maintenance.
e. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

3. Electrical:

a. Provide a complete electrical and control system required to run the fan array system including all equipment, material, electrical enclosure, electrical components and electrical labor. Single point power connection.
b. Electrical installation shall be in accordance with NEC, UL 508A and local codes. Motors shall be labeled with UL rating.
c. Each motor shall be provided with individual thermal overload protection. All motor circuit protectors shall be located in main enclosure.
d. Safety shutdown shall be hard wired. All other control and monitoring shall utilize Ethernet/IP interface with the BAS.
e. Provide control wiring and components required for complete operation of the fan array system. Control functions shall include the following:

1) Auto or manual mode
2) CFM control mode
3) BAS control mode
4) Auto start/stop
5) Manual start/stop
6) Life Safety shutdown
7) Smoke shutdown
8) System alarms
9) VFD alarms

4. Variable Frequency Drives:

a. Provide one (1) variable frequency drive for each individual fan.
b. The VFDs shall be properly matched to each fan. Provide short circuit protection for each drive through means of using fuses with fuse blocks or circuit breakers.

c. The VFDs shall be mounted in a remote-control cabinet for connection to single point power. Enclosure shall have main disconnect.

5. Motors:

a. Provide premium efficiency motors.
b. Each fan cube shall be individually wired to a control panel containing motor circuit protectors and single VFD or multiple VFDs as specified for the total connected HP for all fan motors contained in the fan array.
c. Wire sizing shall be determined and installed in accordance with applicable NEC standards.
d. Each VFD/Motor shall have a dedicated means of locking out and tagging out the power supply.
e. Each motor shall be provided with a shaft grounding ring to prevent Electrical Discharge Machining (EDM) damage to the motor bearings.

6. Airflow Measurement:

a. Each fan assembly shall be supplied with a complete flow measuring system, which indicates airflow in Cubic Feet per Minute.
b. The flow measuring system shall consist of a flow measuring station with four static pressure taps and four total pressure tubes located at the throat of the fan inlet cone.
c. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels.
d. A surface mounted indicator, located in the mechanical corridor, shall provide digital CFM readout, and/or a 4-20 ma output control signal for use in the BAS as specified elsewhere. The DDC controller will measure the pressure in the flow measuring station and calculate the airflow based upon the size data provided by the AHU Manufacturer.

7. Fan Speed Control:

a. For each fan array, provide fan speed control to accept digital start/stop and analog speed input from the facility Building Automation System (BAS). Provide outputs to allow the BAS to monitor VFD trouble, VFD status and airflow.
b. The variable frequency drive shall convert line voltage +/- 10%, three phase, 60 hertz (+/- 2 H_z.) utility power to adjustable voltage/frequency, three phase, A-C power continuous motor control from 10% to 105% of base speed. The variable frequency drive (VFD) shall produce an adjustable A-C voltage/frequency output of complete motor speed control using transistorized sinc coded Pulse Width Modulated technology and an input power factor near unity over the entire speed range.
c. The VFD shall not produce excessive or objectionable motor acoustical noise.
d. The VFD shall be self-contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0 and 40C.
e. The VFD shall be 95% efficient at 100% rated output power, 60 H_z.
f. The VFD shall be UL listed.
g. The VFD shall have a hand/off/auto operator switch, drive switch with run or stop command and panel mounted digital display capable of indicating unit status, frequency, and fault diagnostics.
h. The VFD controller shall have a current limit provided at 100% of the motor FLA. If the current continues to rise the VFD will shut down on over current. The VFD shall

indicate through the digital display if over current, over-voltage, overheating, ground fault or short circuit occurs.

8. Unit Sound Power:

   a. Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

Q. Discharge Plenum Module:

1. The discharge plenum module shall be designed and fabricated in accordance with the general unit construction. Provide discharge openings fabricated from a minimum of 16 gauge ASTM galvanized steel to connect the external system ductwork to the discharge plenum module. The access section doors shall be minimum 24 inches wide and constructed as previously specified. Where shown on the drawings, provide smoke damper in discharge collar, size as shown on drawings.

R. Vibration Isolation

1. Install entire fan, motor and drive assembly on a structural steel vibration isolator base and isolate by use of springs, internally mounted at factory, together with fan discharge flexible connection and thrust restraint springs.
2. Isolation devices shall comply with Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.

S. Smoke Dampers:

1. Smoke damper and actuator assembly shall be UL listed and comply with the requirements of UL 555S, class II at 250^{o} F and so labeled. Certified by manufacturer for pressure drop not to exceed 0.25-inch water gauge at duct velocity of 2,000 feet per minute based on AMCA 500 wind tunnel test for 24 inch x 24 inch damper section.
2. Smoke damper to be extruded aluminum parallel blade airfoil type.
3. Electric actuator(s).

T. Piping Vestibule:

1. Provide a double wall insulated piping vestibule constructed same as unit casing, including full perimeter base and frame integral to unit. Pipe vestibule adequately sized to accommodate coil piping connections and valve accessories indicated on the drawings.
2. Provide hinged access door.

U. Roof Curb:

1. Roof curbs with vibration isolators and seismic restraints are specified in Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.

V. Factory Testing:

1. Vibration Testing: Each unit shall be factory-run tested with unit fully assembled. Fan vibration readings shall be taken in accordance with ANSI S2.19 grade G6.3. Maximum fan vibration measured on fan bearings shall not exceed 0.16 inch per second.

2. Leakage Testing: Each unit shall be fully factory assembled and leakage tested as follows:

   a. Unit shall be tested in accordance with SMACNA "Leakage Test Manual". Close- off plates shall be attached to the division between the positive and negative sections (if applicable). The unit shall be either pressurized or evacuated, as applicable, to the design value and leakage measured.
   b. Measure unit leakage rate at the test static pressure. The total leakage shall be divided by the rated flow to acquire the leakage percentage. The operating static pressure shall be defined as the maximum pressure (positive or negative) to which a section will be subjected to under normal operating conditions. The test static pressure is defined as the operating static pressure multiplied by the previously specified service factor. The maximum test static pressure shall not exceed 1.1 times the fan shutoff static pressure.
   c. The unit shall be pressurized (evacuated) with an auxiliary fan. A pitot tube shall be used to measure the airflow in the attaching ductwork. Unit leakage rate shall not exceed 1/2 of 1% of unit capacity at 1.25 times the operating static pressure.

3. Performance Testing: Each unit shall have a factory witnessed performance test of a design capacity and pressure in general accordance with procedures outlined in AMCA Standard 210.
4. Provide Owner with minimum two-week prior notice of test date.

W. Manufacturer's Supervisor/Startup Services: Provide as specified in Part 1 of this section.

PART 3 - EXECUTION

3.1 GENERAL

A. Review the drawings to determine whether the layout shown will affect proper performance of the equipment. Include any system effect factors in the fan static pressure drop calculations.

B. Assemble units shipped in sections. Install all equipment in accordance with manufacturer’s instructions.

3.2 INSTALLATION, ROOFTOP AIR HANDLING UNIT

A. Mount unit on roof curb.

B. Prior to setting unit on roof curb, verify that area within curb is clean and dry. Ensure that all roofing work, insulation, acoustical treatment of roof deck, curb, etc has been completed as applicable, when such requirements are shown on the drawings. Provide full perimeter gasket around top of roof curb.

C. Install unit on curbs and coordinate roof flashing and penetrations with roof construction specified in Division 07. Secure unit to upper curb rail, and secure base of curb to roof framing with structural fasteners.

D. For units shipped and assembled in sections, provide additional caulk seal at mating joints on the inside and outside of unit casing. Provide additional caulk seal at all removable panels on outside of unit casing.

E. Pipe condensate from drain pan and provide appropriately sized drain trap. Extend drainpipe to nearest roof drain. Cut discharge end of drainpipe at 45 degree angle.

3.3 FILTERS

A. Provide temporary filters for use during construction. Do no operate unit(s) until filters (temporary or permanent) are in place. Replace all temporary filters used during construction with specified filters before turning equipment over to Owner. Provide new filters as specified for air balancing work. Provide Owner with one additional set of filters.

B. Provide air filter draft gauge as specified in Division 23 Section “Air Filtration”. Mount draft gauge in accessible and visible location adjacent to filter module.

3.4 COILS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

B. Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins.

C. Keep drains and plugs accessible.

D. Ensure water coils are drainable with proper drain valves and air vents.

3.5 FIELD QUALITY CONTROL

A. After delivery of air handling units to the jobsite, units shall be assembled as a complete unit and field leak tested. Procedures for field leak testing shall be the same as factory testing.

B. Field leak testing shall be witnessed by Owner or Owner’s designated representative.

C. Include all test procedures and results in final book to the Owner.

3.6 MANUFACTURER’S SUPERVISION/STARTUP SERVICE

A. Contractor shall be fully responsible for properly making arrangements for and coordinating with the manufacturer to provide the specified manufacturer’s supervision and startup services and manufacturer’s written certification as specified in Part 1 of this section and shall make any corrections/modifications to the installation as required by the manufacturer.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete.

3. Verify units are completely cleaned and dry.
4. Briefly energize motor, verify proper rotation, and operation of motor, drive system, and fan wheel.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Comb coil fins bent or damaged during installation.
7. Verify clean filters have been installed.

3.7 CLEANING AND PROTECTION

A. Maintain protective covering on unit during construction until final duct and piping connections are made. Protect above unit from water damage. Provide protective sheeting on top of unit when installation work above unit is required. Unit access doors shall remain closed during construction.

B. Do not use air handling unit access sections for storage of construction equipment and materials not associated with the air handling unit.

C. Clean air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

END OF SECTION 23 70 40

SECTION 23 80 00 - HEAT TRANSFER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Unit Heaters

B. Related Sections:

1. Air Coils for Air Handling Units are specified in Division 23 “Air Handling Units”.
2. Reheat coils in air volume control boxes are specified with air volume control boxes in Division 23 “Ductwork and Ductwork Accessories”.
3. Split system direct expansion fan coil units are specified in Division 23 “Unitary Air Conditioning”.
4. Heat Exchangers and Heat Transfer Package are specified in Division 23 “Heat Exchangers”.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Details of custom-fabricated enclosures indicating dimensions.
2. Location and arrangement of access panels to service piping valves and specialties.
3. Enclosure joints, corner pieces, access doors, and other accessories.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Color Samples for Initial Selection: For units with factory-applied color finishes.

D. Operation and Maintenance Data: For equipment include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of equipment and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 ELECTRIC CABINET UNIT HEATER

A. Acceptable Manufacturers:

1. Berko Electric
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.
5. QMark Electric Heating; a division of Marley Engineered Products.
6. Trane.

B. Unit arrangement as indicated. Electric finned tube heating element, double inlet centrifugal fans and motor, built-in thermal cutout switch, integral disconnect switch and temperature controls, bonderized 16 gauge steel casing and front panel finished in baked enamel, standard color as selected by Architect. Submit color chart.

C. Fans and direct driven motor mounted on common shaft and removable as a unit.

D. Unit shall be UL listed.

PART 3 - EXECUTION

3.1 UNIT HEATER INSTALLATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

F. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 80 00

SECTION 23 81 00 – UNITARY AIR CONDITIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Ductless split system air conditioning.

B. Related Sections include:

1. Refrigerant piping systems are specified in Division 23 “Refrigerant Piping Systems”.
2. Cooling towers for water-cooled heat pump system are specified in Division 23 “Cooling Towers”.

1.3 SUBMITTALS

A. Product Data: Include manufacturer’s technical data for each manufactured piece of equipment, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that equipment, accessories, and components will withstand seismic forces in accordance with Division 23 Section “Vibration Isolation and Seismic Restraints for HVAC Systems.”

D. Manufacturer Wind Loading Qualification Certification: Submit certification that equipment will withstand wind forces identified in Division 23 “Vibration Isolation and Seismic Restraints for HVAC Systems”.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
2. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

B. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

C. UL Compliance: Comply with UL 1995.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components that fail in materials or workmanship within specified warranty period.

1.6 MANUFACTURER'S SUPERVISION AND INSPECTION SERVICES

A. Refrigerant Piping System: Provide the services of the equipment manufacturer, or their authorized representative, to design and supervise the installation, cleaning and testing of the field installed refrigerant piping system. At the completion of the installation, the equipment manufacturer shall certify in writing that the installation was made in accordance with their design and recommendations and shall provide record fabrication drawing schematics showing all pipe sizes and specialties of complete refrigeration piping system.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNIT

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Sanyo
2. Mitsubishi
3. Enviromaster International
4. Daikin

B. Type: Provide ductless air conditioning systems complete with packaged wall mounted room unit, remote air cooled condensing unit (CU), temperature controls, filters, factory installed condensate pump, and other system components as specified or scheduled, all assembled and tested at factory prior to shipment.

C. Wall Mounted Room Unit

1. Cabinet and Chassis: Constructed of 20-gauge galvanneal steel and designed for easy installation and service access. Cabinet to have powder coat matte finish. Suitable wall mounting through setscrew mounting holes. Discharge grilles constructed of high temperature Noryl. Inlet grille to be steel.
2. Refrigeration System: Split between indoor and outdoor sections. Both factory piped and sealed with an operating charge. Connection of the indoor and outdoor sections shall not require brazing, dehydration or charging.
3. Evaporator Section: Copper-tube, aluminum-fin evaporator coil and thermal expansion valve. Provide condensate drain pan constructed of galvanized steel with anti-corrosion coating.

D. Air Cooled Condensing Unit (CU): Hermetic compressor with overloads, manual reset high pressure switch, spring isolation, crankcase heater. Include filter drier, refrigerant line sight glass and moisture indicator. Condenser coil constructed of copper tubes and aluminum fins with direct drive propeller type fan. Capable of operation to -20° F. ambient air. Provide 24V control interconnection to evaporator unit.

E. Air Distribution System: Direct drive fan assembly equipped with multiple, double-inlet blowers, self-aligning sleeve bearings and lifetime lubrication. Fan motor permanent-split, high efficiency type, equipped with two speeds for airflow modulation. Dehumidification shall utilize the lower fan speed.

F. Air Filters: Permanent washable electrostatic type. Easily removable from front of unit and not require system shutdown for service.

G. Controls: Factory assembled, wired into unit and tested prior to shipment. Consisting of an On/Off switch, adjustable temperature thermostat, high/low fan speed selector switch and indicator lights for fan speed and operational mode. Easily accessible from front of unit and protected by an impact resistant cover. Provide 24V remote thermostat with controls and relays.

PART 3 - EXECUTION

3.1 SPLIT SYSTEM AIR CONDITIONING UNIT INSTALLATION

A. Install units level and plumb. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

B. Install roof-mounting compressor-condenser components on equipment support rails or curbs specified elsewhere in Division 23. Anchor units to supports with removable, cadmium-plated fasteners.

C. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

E. Use qualified mechanics and thoroughly check equipment at site for leaks and loose connections in accordance with manufacturer's instructions.

F. Install piping adjacent to unit to allow service and maintenance.

G. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

H. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Provide manufacturer’s certification of installation in accordance with requirements of Part 1 of this Section.

B. Contractor shall be fully responsible for properly making arrangement for and coordinating with manufacturer to provide specified manufacturer’s supervision and inspection services, and shall make any corrections or modifications to installation as required by the manufacturer.

C. Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 01 Section “Demonstration and Training.”

END OF SECTION 23 81 00

SECTION 23 84 13 - HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gas Fired Humidifier

B. Related Sections:

1. Humidifiers for Air Handling Units are specified in Division 23 “Air Handling Units.”

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.5 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PANEL TYPE HUMIDIFIER

A. Acceptable Manufacturers:

1. DRI-STEEM Humidifier Company
2. Armstrong International, Inc.
3. Nortec Industries, Inc.

B. Packaged panel assembly of steam dispersing tubes connected to a steam supply header/separator and, if required by manufacturer's design and construction, a condensate return header, all constructed of Type 304 stainless steel and contained within a galvanized metal casing. Tubes fitted with nonmetallic steam discharge tublets with steam orifices.

C. Provide insulated dispersion tube. Insulation shall be suitable for use in wet/hot humidifier applications.

D. Select panel size, tube spacing and number of orifices for maximum absorption distance at scheduled face velocity. Absorption distance 18 inches maximum at 52^{o} DB and 90% RH supply air with panel face velocity up to 1500 ft. per minute. Air pressure loss not to exceed 0.26 inches w.g. at panel face velocity of 1500 ft. per minute.

E. Include with submittal factory published/calculated absorption distance and air pressure drop for actual installed velocity at maximum and minimum flow conditions and design temperature conditions at 90% minimum duct relative humidity.

F. Accessories:

1. Duct-mounted, high-limit humidistat.
2. Airflow switch for preventing humidifier operation without airflow.

2.2 GAS-FIRED STEAM GENERATOR

A. Acceptable Manufacturers:

1. Dri Steem
2. Armstrong
3. Nortec

B. General: Factory tested packaged, gas-fired steam generator assembly consisting of burner section, humidifier tank, heat exchanger, integral drain cooler, control panel weatherproof enclosure and panel type humidifier suitable for use with softened water.

C. Burner Section: Forced draft burner section to provide full modulation through variable speed burners. Burner section suitable for use with natural gas and shall be AGA certified. Gas assembly shall consist of gas valve(s), explosion proof premix combustion air blower(s), microprocessor-controlled ignition, safety switches/sensors and sight glass. Provide louvered burner enclosure.

D. Humidifier Tank: Tank and cover to be constructed of fully-welded stainless steel. Tank cover easily removable and gasketed for leaktight enclosure. All tank surfaces insulated minimum 1 inch insulation. Provide remote-mounted float chamber with low water safety shutdown. Water quality to be maintained through either disposable ionic bed cartridges or Teflon coated stainless steel probes with skimmer, both with flushing cycle.

E. Heat Exchanger: Provide easily removable stainless steel heat exchanger. Heat exchanger elements mounted vertically to minimize sealing.

F. Control Panel: Provide unit mounted control panel with user interface capable of performing the following operations:

1. Fully modulating steam production using signal from ATC system 4-20 mA.
2. Real time draining and flushing.
3. Aquastat freeze protection.
4. Adjustable blowdown.
5. Automatic "no load" shutdown and drain after 72 hour period with no call for humidity (with automatic restart).
6. Over temperature sensing lockout.
7. Fully modulating makeup control.

G. Weatherproof Enclosure: Provide watertight, factory assembled enclosure with supplemental heating and access door(s). Enclosure/generator assembly shall be factory assembled, tested and shipped as a single piece.

H. Dispersion: Provide panel type humidifier as specified hereinbefore, except without control valve, inlet strainer and steam trap(s). Provide steam piping from generator to humidifier trap and drain as required.

I. Include with submittal factory published/calculated absorption distance with air pressure drop for actual installed velocity and design temperature conditions at 90% minimum duct relative humidity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine duct layout at location of humidifier, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Install humidifiers with required clearance for service and maintenance.

C. Seal humidifier manifold duct or plenum penetrations with flange.

D. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

E. Install gas-fired steam generators according to NFPA 54.

F. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

G. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

H. Install piping from safety relief valves to nearest floor drain.

I. Connect gas piping full size to steam-generator, gas-train inlet with union.

J. Connect breeching full size to steam-generator outlet. Venting materials are specified in Division 23 Section "Ductwork and Ductwork Accessories”.

K. Combustion-air inlets should be a minimum of 14-inches above the roof to prevent splashed rain from entering intake.

L. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

M. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 84 13

SECTION 25 09 00 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Division 23 for general provisions, installation requirements and additional HVAC equipment control information.

C. All electrical work shall be in accordance with Division 26 Specification Sections.

D. Related Sections include the following:

1. Refer to Division 1 Section “TESTING, ADJUSTING, AND BALANCING FOR HVAC” for additional work related to system testing and balancing.
2. Refer to Division 1 Section “COMMISSIONING” for work associated with HVAC system commissioning.
3. Refer to Division 23 Section "Meters for HVAC” for steam and water flow measuring devices that relates to this Section.
4. Refer to Division 25 Section “Sequence of Operations for HVAC Controls” for requirements that relates to this Section.
5. Refer to Division 23 Section “Laboratory Airflow Control System” for interface requirements related to this Section.

1.2 SUMMARY

A. This Section includes all labor, materials, equipment, and service necessary for a complete and operating control system for all HVAC equipment including control of units not supplied with factory-wired controls and installation and wiring of loose controls shipped with equipment.

B. All new HVAC equipment to be provided with Direct Digital Controls (DDC) monitored/controlled thru the new Building Automation System (BAS), except the following:

1. Unit Heaters (UH) and Split System Units (SS) serving utility spaces (Mechanical and Electrical Rooms) shall be controlled by wall mounted thermostats.

C. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation System (BAS), utilizing a high-speed peer to peer network of interoperable Direct Digital Controls (DDC), Graphical User Interface (GUI) with color graphic displays, and electronic interfaces and actuation devices, as shown on the drawings and as described herein.

D. The new BAS system shall be fully compatible with the existing campus control system. All new controls shall be fully accessible through the existing operator’s terminals. Division 25 contractor is responsible for determining compatibility prior to submitting bid.

E. Southern Nevada Health District presently has an existing Automated Logic Building Automation System as part of past projects. The intent of this specification is to extend and interoperate with this system and to provide a peer-to-peer, networked control system for the control work that is part of this project. All components, software and operation shall be interoperable with the existing building automation system. The installed system will interface directly with the existing system. The existing software and database will be modified to accept the new equipment being installed under this project to maintain integrity for centralized scheduling, trending, programming and alarming. PC Desktop icons that "link" to a separate system are not acceptable. Any costs associated with connecting to the existing energy management system, including licensed software, programming, training etc., shall be part of the controls contractor's bid. The contractor must demonstrate their ability to perform the integration to the existing systems prior to submittal acceptance. All systems as described in the sequence of operation will be shown via dynamic graphics with all pertinent system alarms for proper operation and maintenance. The use of separate PC workstations, gateways, metalinks, replacement of existing controllers and control devices, and additional software graphic packages to accomplish this integration will not be accepted.

F. The BAS Local Area Network (LAN) shall be an Ethernet network supporting BACnet, Modbus, Java, XML, HTTP, and 100% CORBA IIOP for maximum flexibility for integration of building data and providing support for multiple Network Server Controllers (NSC), user workstations and host computer system.

G. Provide surge and over-voltage protection of all electronic controllers serving HVAC equipment. This shall include protection of all controllers provided with equipment where this protection is not factory installed.

1.3 DEFINITIONS

A. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.

B. BACnet/IP: Defines and allows using a reserved User Datagram Protocol (UDP) socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.

C. BAS: Building Automation System (Synonymous with BMS)

D. BMS: Building Management System (Synonymous with BAS)

E. Control Contractor: Contractor for this section

F. DDC: Direct digital control

G. I/O: Input/output

H. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

I. MS/TP: Master slave/token passing

J. Network or Supervisory Controller: Digital controller, which supports a family of programmable

application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

K. NIST: National Institute of Standards and Technology

L. PC: Personal computer

M. PID: Proportional plus integral plus derivative

N. OWS: Operator Work Station

O. RTD: Resistance temperature detector

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 60 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 60 dynamic points with current data within 4 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or work station within two seconds.
5. Alarm Response Time: Annunciate alarm at work station within 45 seconds. Multiple work stations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values or update changes and outputs at least once per second.
8. Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
9. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within minimum tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F
    b. Water Flow: Plus or minus 5 percent of full scale
    c. Water Pressure: Plus or minus 2 percent of full scale
    d. Temperature: Plus or minus 0.5 deg F
    e. Temperature Differential: Plus or minus 0.25 deg F
    f. Relative Humidity: Plus or minus1 percent
    g. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale
    h. Airflow (Measuring Stations): Plus or minus 2 percent of full scale
    i. Airflow (Terminal): Plus or minus 10 percent of full scale
    j. Air Pressure (Space): Plus or minus 0.001-inch wg
    k. Air Pressure (Ducts): Plus or minus 0.1-inch wg
    l. Carbon Monoxide: Plus or minus 5 percent of reading

m. Carbon Dioxide: Plus or minus 50 ppm
n. Electrical: Plus or minus 5 percent of reading

B. All validateable sensors used in facilities that measure critical parameters shall be provided with 3 point factory calibration certification. All sensors shall be NIST traceable.

1.5 SUBMITTALS

A. The Controls contractor shall provide a complete set of DDC Drawings as part of the submittal process; these shop drawings shall show all logic, set points, and control schedules. A complete points list with range and scale for electrical and engineering units shall be provided as part of the submittal as well.

B. During the submittal process, full point names must be submitted. All point names must adhere to Owner's established point naming conventions for both points and panels. Naming convention list will be provided by Owner upon request.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator work station equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices. Contractor's detailed installation drawings will not be accepted in lieu of schematic flow diagrams.
3. Wiring Diagrams: Power, signal, and control wiring. All wiring diagrams shall reference BAS point names.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. All data sheets shall indicate accessories and options included.
9. DDC System Hardware:

a. Wiring diagrams for control units with termination numbers. All wiring diagrams shall reference BAS point names
b. Schematic diagrams and floor plans for field sensors and control hardware.

c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator work station and control unit locations.

10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
11. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Written description of sequence of operation including schematic diagram.
    c. Points list.

12. Floor plan layout drawings indicating locations of all DDC panels. DDC panels located above ceilings shall be specifically identified.

E. Data Communications Protocol Certificates: Certify that each proposed DDC controller complies with ASHRAE 135.

F. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Device address list.
3. Printout of software application and graphic screens.
4. Software license required by and installed for DDC work stations and control systems.

G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

H. Qualification Data: For Installer and manufacturer.

I. Field quality-control test reports.

J. Graphics User Interface Submittal: Submit graphics package (including all graphic screens and user interface modes) for review by Engineer and approval by Owner.

K. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Index sheet, listing contents in alphabetical order.
3. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams.
4. Description of Sequence of Operations.
5. As-built interconnection wiring diagrams.
6. Operator's manuals.
7. Trunk cable schematic showing all remote electronic panel locations, and all trunk data wiring runs.
8. All commissioning documentation specified herein.
9. Copies of all graphic screens.
10. Keyboard illustrations and step-by-step procedures indexed for each operator function.

11. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
12. Calibration records and list of set points.
13. All new graphics shall be based on existing graphics (if available) and shall be reviewed by the Engineer and approved by the Owner prior to acceptance.

L. Project Record Drawings of as-built versions of submittal shop drawings provided in electronic PDF format. This shall include Product Data, Sequence of Operations and schematic flow diagrams.

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire system for a period of one year after acceptance. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices. Provide cost for second year.

B. The on-line support services shall allow the system supplier to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

C. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the system supplier shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

1.7 QUALITY ASSURANCE

A. Installer Qualifications

1. Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
2. The system shall be installed, commissioned, and serviced by manufacturer employed, factory trained personnel.
3. Installer of control system shall have a branch office within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system controllers.

D. Manufacturer Qualification: Manufacturer shall certify in writing that all products and devices being installed for the project are not being phased out and will not be antiquated within a period of ten (10) years from project completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. Controller Firmware: Update to latest version of firmware at project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate location of control panels, dampers, valves, and devices such that clearance can be maintained for proper access to all components.

C. Coordinate location of space differential pressure sensors, gas sensors, duct mounted temperature and humidity sensors, flow sensors with airflow and instrumentation diagrams and piping and instrumentation diagrams and Division 23 before installation.

D. Coordinate equipment and wiring with Division 26 requirements to achieve compatibility of communication interfaces, drives, motor starters and annunciation devices.

E. Coordinate equipment with Division 28 to achieve compatibility with equipment that interfaces with Fire Alarm system.

F. Coordinate and assist Testing, Adjusting and Balancing (TAB) Contractor with proper set up and operation of HVAC Systems.

G. The minimum quantity of DDC/ATC panels are located on the contract documents. Provide additional panels as required. All panel locations must be approved by the Owner and Architect and coordinated with all trades prior to installation. If approval and/or coordination are not completed, then panels shall be relocated at no cost to owner.

H. Do not locate DDC panels above ceilings unless specifically reviewed by the Engineer and approved by the Owner. Panels shall be located in mechanical rooms or in equipment systems rooms.

I. Automatic temperature control valves and thermowells furnished by Control Contractor shall be installed by Division 23 Contractor under the supervision of Control Contractor.

J. All automatic control dampers shall be furnished by Control Contractor and shall be installed by Contractor for Section 23 30 00 under supervision of Control Contractor except where dampers are specified to be provided by unit manufacturer.

K. Combination fire/smoke and smoke dampers in ducts with electric motors will be provided by Contractor for Section 23 30 00. Division 26 contractor shall wire electric motors.

L. Smoke detectors in ducts and at air handling units shall be wired into the Fire Alarm System by Division 28. Required power for those smoke detectors shall also be provided by Division 28. Provide wiring from smoke detectors/interface modules to respective air handling unit(s) and fan(s) for shutdown in the event of smoke conditions. Contractor for Section 23 30 00 will install

detectors in ductwork where shown or where required.

M. Furnish Contractor for Section 01 91 00 approved temperature control technical data and shop drawings, information relating to changes or revisions in work, and all other information required for proper balancing, adjusting and commissioning of systems.

N. Furnish duct mounted airflow measuring stations and static probes to Contractor for Section 23 30 00 for installation.

O. Through-penetration fire-stop systems at penetrations through floors or fire or smoke rated walls and partitions will be provided by Division 07. Control Contractor shall be responsible to coordinate quantity and locations of all penetrations.

P. Provide all power wiring and devices required for electric/electronic motors.

Q. Provide air volume (constant or variable) box controls. Coordinate with box manufacturer to either field install DDC controllers or ship controller to box manufacturer for installation in the factory. Furnish hydronic control valve for field installation and provide all additional wiring and tubing as required for a complete installation.

R. All deviations from specifications shall be documented separately. Obtain approval for deviations prior to fabrication or installation. Include all costs, including delays to other trades, to remedy deviations in fabrication, installation or other issues. All issues shall be reviewed.

S. All mechanical equipment sent with loose controls shall be mounted and wired by Division 25.

T. Control Contractor shall provide all conduit and accessories, etc. required for power and control wiring to his devices.

U. Control Contractor shall include time in his bid required to meet with specialty equipment manufacturers and program their equipment to fully interface with the BAS.

V. Control Contractor shall interlock fans or pumps through hard wiring where indicated on contract documents; software interlocks shall not be acceptable.

W. Provide communication cards or ports to interface with equipment such as variable frequency drives, chillers, boilers, packaged equipment, etc. as required by the contract documents. Coordinate communication protocol with equipment manufacturer.

X. All critical control and monitoring (start/stop, fault, status, etc.) must be through hard-wired points to the DDC controller. Use of communication cards is strictly limited to monitoring purposes and shall not be used for critical control.

Y. Control contractor shall coordinate with EMS (Equipment Monitoring System for communication of monitoring of critical and validated systems.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Existing control system provided by Automated Logic Corporation.

B. Provide a microprocessor-based direct digital control (DDC) system consisting of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems and to perform functions as specified.

C. DDC system shall be web based.

1. Web-Based Access to DDC System:

a. DDC system software shall be based on server thin-client architecture, designed around open standards of web technology. DDC system server shall be accessed using a web browser over DDC network, using Owner's LAN, and remotely over Internet. The web browser shall be able to access graphics and trends; to configure points and controllers; and to edit programming. Web access shall be password protected.

2. Web-Compatible Access to DDC System:

a. Workstation and server shall perform overall system supervision and configuration, graphical user interface, report generation, and alarm annunciation.

b. DDC system shall support web browser access to building data. Operator using a standard web browser shall be able to access control graphics and change adjustable set points. Web access shall be password protected.

D. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator work station permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

E. The control system shall be set up and configured in such a way that the communications between panels is eliminated or kept to an absolute minimum. Communication of any data required to operate the system in the event of a network outage is prohibited to be communicated across the communications network or through a communications card; all points must be directly wired to the associated DDC panel.

F. Provide all materials and field work necessary for a complete system.

G. Provide an electric actuator for each damper and valve to be controlled, unless one is specified elsewhere.

H. Unless specified otherwise, provide fully modulating components.

I. Unless specified otherwise, provide proportional/integral/inverse derivative components for variable air volume controls, proportional/integral components for air handling unit discharge control, and fully proportional/integral components elsewhere.

J. Floating control or motors that respond to incremental "pulse" signals or do not fail to the specified position shall not be acceptable.

K. Provide all electrical wiring, communication cabling, relays or other devices for interlocking of equipment as described in Sequence of Operations or as shown on drawings.

L. DDC system shall be capable of operating in environmental conditions of 30 deg F to 120 F and 10% RH to 90% RH noncondensing. Sensors and final control elements shall be capable of operating in environment in which they are installed. Instruments and actuators not available with integral enclosures shall be protected with NEMA type enclosures specific to their location.

M. Graphic User Interface:

1. New global graphics to provide a user friendly interface to the new detail graphics. Provide an overall riser diagram page which will allow instant access to new floor plan graphic pages, individual air handling units and central plants. An individual floor plan graphic will be provided for each floor of the building. The floor plan will show air handling zone layout and provide a link to the associated air handler graphic within each zone. Each space temperature available on the DDC system shall be interactively displayed on the floor plan. Provide sub-area graphics as required to fit all temperatures.
2. All graphics shall be full screen, viewable on a wide screen at 1920x1080 resolution.
3. All graphic screens shall be reviewed by Engineer and approved by Owner prior to system acceptance. Revise graphics as indicated in review comments.

N. Provide all I/O shown on drawings or required by sequences of operation.

O. Provide electronic communication with all systems as indicated on control drawings and specified in Divisions 22, 23 and 25. Provide all hardware and software as required for full integration.

P. DDC System Data Storage:

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.

2.2 DDC CONTROLLER INTEGRATION TO EXISTING BAS NETWORK

A. Prior to physically connecting the new DDC Controllers to the existing system, the BAS contractor shall print a predefined report listing any points that are failed, in alarm, or overridden in the system. Once the integration is complete, verify through the same reports that no additional existing points are failed, in alarm, or overridden.

B. Once the new DDC controllers are commissioned, the BAS contractor shall assist the Owner's rep to make the physical connection to the existing network. The DDC system shall be connected to the existing BAS server for full database management. All new controls shall be fully accessible through the existing site-wide operator's terminals and the database server.

C. It shall be possible to access any new DDC panel through the network. Such access shall include full read-write capability from an operational as well as programming standpoint. Total system information shall be available to the database server at all new or existing operators' workstations.

D. Once the tie-in is complete, the BAS contractor shall confirm communication with the server.

E. Upload all data to the server.

F. Verify there are no new failed existing points on the system. If so, take corrective action to resolve discrepancies.

G. Create graphics that represent the new systems, including but not limited to AHU layouts, navigation, screens, and room graphics.

H. Map all alarmable points into the existing remote notification software installed on the server.

2.3 ETHERNET COMMUNICATIONS AND EQUIPMENT (BAS Provide network)

A. The DDC Controllers shall communicate via TCP/IP over Ethernet. The BAS contractor shall furnish and install cables, switches, signal repeaters, and operator workstation/servers to insure a fully functional Ethernet network. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and tenant data and communication networks.

1. The BAS contractor shall design the network to accommodate all the DDC Controllers and PC's provided for the BAS system. The appropriate quantity of switches and signal repeaters shall be provided to meet the network requirements; the locations shall be coordinated with the project team. The BAS contractor shall provide 120VAC to each piece of network equipment. E.g. hubs, routers, switches, or signal repeaters.
2. The BAS contractor shall coordinate: node names, IP addresses, access privileges, and system configuration with the owner prior to startup.
3. Provide modular 8-pin, Category 6 information outlets at all DDC controllers. The cable shall be terminated inside the field panel at the information outlet. A patch cable shall be provided to connect the field panel to the information outlet.
4. Ethernet cable shall be furnished and installed to connect the operator workstation/server to each of the DDC controllers. Installation shall comply with:

    a. Use plenum-certified Ethernet cable when run through a plenum.
    b. Ethernet cable shall only be buried in an insulated electrical tunnel. Ethernet wiring is not certified for direct burial.
    c. Manufacturer shall be responsible for system requirements of design and operation.

5. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance.

2.4 BAS TO COMMUNICATE TCP/IP OVER ETHERNET (Owner's Backbone)

A. The owner's representative shall furnish and install cables, switches, and signal repeaters to connect the new project to the existing workstations/server.

B. The BAS Contractor shall provide the second-tier network.

C. The BAS contractor shall coordinate: node names, IP addresses, access privileges, and system configuration with the owner prior to startup.

D. The owner's representative shall provide a modular 8-pin, Category 6 information outlet at all

DDC controllers and shall terminate the cable inside the field panel at the information outlet. A patch cable shall be provided by the BAS contractor to connect the field panel to the information outlet.

E. Owner will provide all hardware and operating systems and SQL server database licenses for the BAS servers and clients. BAS software will be required to operate on virtual servers and the BAS Contractor shall provide all necessary labor to work with the Owner on installation and implementation of all software packages specified.

F. The BAS Contractor shall provide all software, temporary server, Ethernet network, and computer hardware as necessary for startup and commissioning until the owner provided equipment is in place and ready for BAS software.

2.5 NETWORK COMMUNICATION PROTOCOL

A. Network Communication protocol used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.6 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through multiple means, including, but not limited to, the following:

1. Desktop and portable / laptop workstation with hardwired or wireless connection through LAN port or router.
2. Mobile device and application with secured wireless connection through LAN router or cellular data service.
3. Remote connection through web access.

B. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent to DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm. DDC system shall notify recipients by any or all means, including email, text message and prerecorded voicemail to phones.

C. DDC system shall be capable of accommodating up to five simultaneous operators.

2.7 DDC EQUIPMENT

A. Operator Work Station: One PC-based computer(s) with minimum configuration as follows:

1. Motherboard: With minimum of 4 integrated USB 3.0 ports, Network Interface Card (NIC), integrated audio, bios, and hardware monitoring.
2. Processor Speed Minimum: 4 GHz.
3. RAM Capacity: 8 GB.
4. Video Card: Resolution: 1920x1200With 128 MB RAM
5. Monitor: Non-reflective Minimum 19 inch flat panel LCD and shall support a display resolution of 1920 x 1200 pixels. Separate controls shall be provided for color, contrast and brightness.
6. Solid State Drive (SSD): 1 TB.
7. Mouse: Three button, optical.
8. Operating System: Microsoft Windows Latest Available Operating System
9. Printer: Black-and-white, laser-jet type as follows:

    a. Print Head: 1200 x 1200 dpi resolution.
    b. Paper Handling: Minimum of 250 sheet trays.
    c. Print Speed: Minimum of 120 characters per second.

10. Application Software:

    a. I/O capability from operator station.
    b. System security for each operator via software password and access levels.
    c. Automatic system diagnostics; monitor system and report failures.
    d. Database creation and support.
    e. Automatic and manual database save and restore.
    f. Custom graphics generation and graphics library of HVAC equipment and symbols.
    g. Alarm processing, messages, and reactions.
    h. Trend logs retrievable in spreadsheets and database programs.
    i. Alarm and event processing.
    j. Object and property status and control.
    k. Automatic restart of field equipment on restoration of power.
    l. Data collection, reports, and logs. Include standard reports for the following:

        1) Current values of all objects.
        2) Current alarm summary.
        3) Disabled objects.
        4) Alarm lockout objects.
        5) Logs.

    m. Custom report development.
    n. Utility and weather reports.
    o. Work station application editors for controllers and schedules.
    p. Maintenance management.

11. Custom Application Software:

    a. English language oriented.
    b. Full-screen character editor/programming environment.

c. Allow development of independently executing program modules with debugging/simulation capability.
d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

B. Portable Workstation / Laptop: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With two integrated USB 3.0 ports, 10/100 NIC, integrated audio, bios, and hardware monitoring.
2. Processor Speed Minimum: 4 GHz.
3. RAM Capacity: 8 GB.
4. Hard-Disk Drive: 500 GB .
5. Display: LED Color display with 1920 x 1080 pixel resolution

C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator work station or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Application Programs:

a. Include control programs capable of performing functions as described in Sequence of Operations.
b. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
c. Remote communications.
d. Maintenance management.
e. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator work station or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. Local Control Units: Modular, comprising processor board with electronically programmable,

nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator work station or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications
    b. Discrete/digital, analog, and pulse I/O
    c. Monitoring, controlling, or addressing data points

3. Local operator interface provides for download from or upload to operator work station or diagnostic terminal unit.

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0-10VDC), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
5. Analog Outputs: Provide modulating signal, low-voltage (0-10VDC) or current (4 to 20 mA).
6. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V
2. Maximum response time of 10 nanoseconds
3. Minimum transverse-mode noise attenuation of 65 dB
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz

2.8 DDC CONTROLLERS

A. General

1. DDC controllers shall be capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
2. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and uninterruptible power source.
3. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.

4. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Controller shall have service communication port for connection to diagnostic terminal unit.

B. Each DDC controller shall be provided for control of each of the following types of equipment. DDC controllers shall reside on a peer to peer network.

1. DDC controllers shall be a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
2. Each primary networked DDC controller shall house a minimum of 32 MB RAM and 8 MB Flash ROM to support its own operating system, databases, and stand-alone software functions. Include spare processing memory for each controller. Network controllers, programmable application controllers and application specific controllers shall have at least 50 percent free memory. The following functions shall be provided for each DDC controller:

a. Control Processes
b. Energy Management Applications
c. Mathematical Modeling, Equipment Learning, Part Load Curve Updating Functions to support advanced algorithms for energy reduction.

1) Provide capabilities for mathematical modeling of VAV air delivery systems to optimize static pressure setpoints and reduce fan energy while maintaining cooling and ventilation constraints in each of the areas served by the VAV system.
2) Provide capabilities for equipment learning such that load and part load curves are built for equipment controlled to optimize equipment selection at given loads.

d. It shall be possible for the controller to determine equipment degradation from internal plotting of load curves to schedule maintenance.
e. Alarm Management Applications including custom alarm messages for each level alarm for each point in the system.
f. Historical/Trend data for points specified.
g. Maintenance support applications.
h. Custom Processes.
i. Operator I/O

j. Remote Communications

3. DDC controllers shall provide a communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
4. DDC controllers shall be provided with digital input and output LED status indication for visual confirmation of point conditions.
5. DDC Controllers shall be provided with communication ports for the control and monitoring of application specific controllers to coordinate control of major mechanical equipment with downstream terminal equipment.
6. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication to alert facility personnel of failure.
7. Surge and Transient Protection: Provide isolation at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587.
8. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

    a. Upon restoration of normal power, the DDC controller shall automatically resume full operation, incorporating time delays to prevent surges, without manual intervention.
    b. Should DDC controller memory be lost for any reason, the user shall have the capability of reloading the DDC controller via the local communication port, via telephone line dial-in or from a network work station PC.

9. Controllers shall be provided with the capability to communicate TCP/IP directly over Ethernet, without the use of an external network interface card. Devices must:

    a. Auto-sense 10/100 Mbps networks.
    b. Receive an IP Address from a Dynamic Host configuration Protocol (DHCP) Server or be configured with a Fixed IP Address. (Owner shall provide IP addresses and relevant network information for each DDC controller provided under this specification.)
    c. Resolve Name to IP Address for devices using a Domain Name Service (DNS) Server on the Ethernet network.
    d. Allow access using Telnet.

C. Network Controllers shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.

1. Controller shall have enough memory to support its operating system, database, and programming requirements. Controllers that perform scheduling shall have a realtime clock. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.

2. Network controllers shall communicate with other devices through TCP/IP directly over ethernet. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers. Controller shall be equipped with a service communications port for connection to a laptop.
3. Controller shall be equipped with diagnostic LEDs for indication of power, communication, and processor.

D. Each Application Specific Controller (ASC) shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multitasking, real-time digital control processor. Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device. Application specific controllers shall communicate with other application-specific controllers and devices on network. Controller shall be equipped with diagnostic LEDs for indication of power, communication and processor. Controller shall use nonvolatile memory and maintain all BIOS and programming in event of power loss.

2.9 CONTROL PANELS

A. Provide panels of unitized cabinet type for each system.

B. Enclosure: Fabricate panels from16 gauge steel or aluminum with baked enamel finish, with hinged key lock door and UL listing as NEMA 1. All panel locks shall be keyed alike.

C. Configure layout of devices and wiring within control panels to isolate voltages greater than 50 volts to enable maintenance in accordance with NFPA 70E with minimal arc flash personnel protective equipment. Include a barrier between line voltage and low voltage electrical and electronic products.

D. Mount all relays, clocks, switches, transmitters and controllers within cabinet. Mount temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet face.

E. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face. Nameplates shall be white with black center core and shall have at least ¼-inch high lettering.

F. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

G. Terminate field cable and wire using heavy duty terminal blocks. Include spare terminals, equal to not less than 10% of used terminals. Label each end of cable, wire and tubing in enclosure.

H. Where required, include temperature controlled ventilation fans with filtered louver to maintain inside of enclosure below maximum operating temperature.

2.10 FIELD HARDWARE PANELS (FHP)

A. Provide field hardware panel whenever interface equipment will not fit into Control Panels. Field hardware panels shall also be used to house devices where voltages above 50V are present for arc flash service requirements. Devices such as transducers (current to pressure, pressure to current), relays, contactors, and other devices shall be labeled for quick identification.

B. Provide power from the same source as DDC panels.

C. Provide plastic engraved nameplates for instruments and controls inside cabinet and on cabinet face.

2.11 HMI FOR MONITORING SPACE CONDITIONS

A. Acceptable Manufacturer:

1. ELO I-Series, or approved equivalent

B. Provide minimum 19 inch display with touchscreen interface with minimum 1600 x 900 resolution, 16:9 aspect ratio.

C. Integral Intel i3 Core processor, 3.10 GHz, 128 GB storage and 8 GB RAM.

D. Connectivity:

1. (1) USB 3.0 port
2. (4) Micro USB 2.0 ports
3. (1) LAN RJ45
4. WiFi 802.11 capable, 2.4 GHz & 5 GHz
5. Bluetooth 5.0 capable

E. Voltage: 100-240 VAC, 50-60Hz

F. Provide graphical floor plan which the user can select specific rooms or zones from.

1. HMI shall indicate all critical space parameters (temperature, humidity and differential pressure) overlaid on a floor plan graphic.
2. User shall be able to zoom in on specific floors or zones through the touch screen.
3. Each HMI shall be capable of displaying multiple floors.
4. Zones shall be color-coded to coincide with space conditions; green for normal and red for alarm with the parameter that is out of tolerance clearly identified.
5. HMI shall display real time data from the Building Automation System with customized graphics specific to the HMI.

G. HMI shall be for monitoring only.

H. Review graphics with Owner and Engineer.

2.12 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Wire: Twisted, shielded-pair cable.
2. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by

temperature stratification or where ducts are smaller than 9 sq. ft.

3. Averaging Elements in AHU/Ducts: Minimum 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
4. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
5. Room Sensor Cover Construction: Manufacturer's standard locking covers.
6. Outside-Air Sensors: Watertight inlet fitting, with sunshield.
7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Wire: Twisted, shielded-pair cable.
2. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
3. Averaging Elements in Ducts: Minimum 8 feet in length; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
4. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
5. Room Sensor Cover Construction: Manufacturer's standard locking covers.
6. Outside-Air Sensors: Watertight inlet fitting with sunshield.
7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. RTD’s and Transmitters for High Accuracy Applications:

1. Acceptable Manufacturers”

    a. Vaisala (basis): Model HMT 120 and 130 or HMD 60

        1) Space / wall mounted: Model HMT 120/130
        2) Ducted mounted in limited access area: Model HMT 120/130 with remote probe, duct mount kit and probe cable. Transmitter mounted in nearby accessible area.
        3) Duct mounted in fully accessible ceiling space or walkable ceiling area: HMD 60

    b. Rotronic
    c. General Eastern
    d. Setra

2. Three-point traceable calibration with NIST Certificate
3. Wire: Twisted, shielded-pair cable
4. Insertion elements in ducts: Single point, 6 inches long; use where affected by temperature stratification or where ducts are smaller than 9 sq. ft. Remote probe option with 20 meter cable.
5. Measurements Range: minus 4 to plus 131 deg F
6. Accuracy: +/-0.18 deg F at 59-77 deg F

E. Humidity Sensors Bulk polymer sensor or Humicap® element.

1. Acceptable Manufacturers:

    a. ROTRONIC Instrument Corp.
    b. Vaisala
    c. General Eastern

2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed
    b. Color: Standard.

4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
5. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

F. Humidity Sensors for High Accuracy Applications**:**

1. Acceptable Manufacturers”

    a. Vaisala (basis): Model HMT 120 and 130
    b. Rotronic
    c. General Eastern
    d. Setra

2. Three-point traceable calibration with NIST Certificate
3. Room Sensor Range: 0 to 100 percent relative humidity
4. Room sensor cover construction: manufacturer’s standard locking covers

    a. Color: standard

5. Duct Sensor: 0 to 100 percent relative humidity range with element guard, mounting plate and remote interchangeable probe with 20 m cable.
6. Outside Air Sensor: 0 to 100 percent relative humidity rang with mounting enclosure, suitable for operation at outdoor temperatures of minus 40 to plus 140 deg F
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
8. Accuracy: +/-1.5% RH at 0-90% RH Stability: +/-0.5% per year in typical HVAC applications.

G. Space Pressure Transmitters/Transducers:

1. Space Pressure Transmitters/Transducers for Laboratories:

    a. Acceptable Manufacturers:

        1) Ashcroft
        2) Setra

3) Vaisala

b. Differential-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
c. Range: ± 0. 25 inch wg.
d. Accuracy: 0.25% of natural span, including nonlinearity, hysteresis, deadband, nonrepeatability.
e. Span Range: Calibrated span can be down ranged to 40 percent of natural span.
f. Transducer Response Time: 0. 25 seconds to range from 10% to 90%.
g. Temperature Affect: <0.00015 in. wg +0.03% per degree F.
h. Mounting Position Affect: None.
i. Stability: Auto zeroing accuracies within 0.17 of calibrated span frequency every 1 to 24 hours on 1 hour intervals.
j. Temperature Limit: 0 to 150 deg F.
k. Humidity Limit: 0-90 percent RH.
l. Display: LED indicating lights.
m. Outputs: 4-20 mA or 0-10 VDC.
n. Power Supply: 24 VAC/120 VAC.
o. Tubing: ¼" stainless steel between probe and transmitter.

H. Differential-Pressure Transmitter:

1. Duct/Plenum and/or Unit Mounted Midrange Differential Pressure Transmitter:

a. Acceptable Manufacturers:

1) AutoTran
2) Setra
3) Schneider Electric
4) Siemens
5) Johnson Controls, Inc.

b. Range: 0.1 to 3.0 inch wg.
c. Temperature Limits: -40 to 185 deg F.
d. Humidity Limits: 0-100 percent RH.
e. Accuracy: plus or minus 1 percent
f. Stability: 5 year stability.
g. Outputs: 4-20 mA.
h. Duct Mounting: Construct with multiple static pressure sensors located along exterior surface of cylindrical probe, of extruded aluminum and complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.13 CONDENSATE PAN WATER LEVEL DETECTOR

A. UL 508 listed condensate overflow switch designed for installation in auxiliary discharge pipe or drain pan. 24VAC supply voltage with magnetic, solid-state relay for alarm output. Provide with mounting adapter and 48” wiring lead. Kele Model SS2AP.

2.14 SPACE WATER LEVEL DETECTION SWITCH

A. Acceptable Manufacturers:

1. Kele, Inc. Model WD-1B

B. Water detector shall have gold-plated probes and microchip technology

1. Power Requirements: 11-27 VAC/VDC (50/60 Hz).
2. Operating Temperature: 32° to 158° F.
3. Enclosure: Cast aluminum, weatherproof with adjustable legs
4. Alarm Output: SPDT contacts rated, 1A @ 24 VAC/VDC, 1/2 @ 120 VAC

2.15 AREA LEAK DETECTION SYSTEM

A. Acceptable Manufacturers

1. Liebert
2. APC

B. Leak Detection Cable: Flexible thermally bonded and plenum rated cable in 50’-0” lengths with mating connections on each end to support up to 5,000 feet cable length. Cable shall be able to sense presence of water anywhere along its length and send an analog signal back to the monitoring panel indicating location of leak.

C. Monitoring Panel: Lockable NEMA 1 panel with 4-line, 20-character LCD screen and soft keys mounted on cover for alarm indication and navigation. Panel shall be capable of monitoring up to 10,000 feet of leak detection cable in two separate zones up to 5,000 feet each. Points along the cable shall be mapped so that leak locations can be pinpointed in terms of distance from the panel in feet. Panel shall have the following characteristics:

1. Audible and visual alarms
2. Adjustable sensitivity for leak indication
3. Historical logs accessible from LCD screen
4. Battery backup
5. Capability for connection to the Building Automation System
6. Password protection
7. Integral power transformer
8. Two, 4-wire cable inputs for use with leak detection cable
9. Two analog (4-20 mA) leak detection alarm outputs

10. Two digital (24 VAC, 1 A) leak detection alarm outputs
11. Two digital (24 VAC, 1A) fault alarm outputs

D. Ambient Conditions: 32 - 104°F, 0 – 95% RH non-condensing.

E. System shall operate on 115 VAC power

2.16 INDOOR AIR QUALITY ROOM SENSORS

A. Acceptable Manufacturers:

1. Honeywell International Inc.
2. Siemens
3. JCI
4. Schneider

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

2.17 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on weekday, Saturday, and Sunday.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

a. Time of day
b. Actual room temperature
c. Programmed temperature
d. Programmed time
e. Duration of timed override
f. Day of week
g. System mode indications include "heating," "off," "fan auto," and "fan on"

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F

maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

E. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

F. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

G. Electric, Low-Limit Duct Thermostat (Low Temperature Limit Thermostat): Two sets of contacts, snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any incremental segment of capillary length is equal to or below set point.

1. Capillary Length: Minimum 20 feet
2. Quantity: One thermostat for every 20 sq. ft. of coil surface

H. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.18 HUMIDISTATS

A. Acceptable Manufacturers:

1. Vaisala
2. ROTRONIC Instrument Corp.

B. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.19 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Electrical Requirements for HVAC Equipment."

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Acceptable Manufacturers:

a. Belimo Aircontrols (USA), Inc.
b. Johnson Controls, Inc.
c. Schneider Electric
d. Siemens
e. Honeywell

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

a. Parallel-Blade Damper: 7 inch-lb/sq. ft. of damper.
b. Opposed-Blade Damper: 5 inch-lb/sq. ft. of damper.
c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.
13. All actuators shall have visual indication of damper or valve position.

2.20 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system valves shall have the following characteristics:

1. NPS 2 and Smaller:

    a. Globe Valve: Class 125 bronze body, bronze trim, stainless steel rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Replaceable plugs and stainless-steel or brass seats. Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    b. Ball Valve: Class 125 bronze body with full-port, stainless steel ball and stem; TFE seats and packing; and 600-psig minimum CWP rating and blowout-proof stem. Threaded ends.

2. NPS 2-1/2 and Larger:

    a. Globe Valve: Class 125 iron body, bronze trim, stainless steel rising stem, plug-type disc, flanged ends, and renewable seat and disc. Replaceable plugs and stainless-steel or brass seats. Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    b. Butterfly Valve: 150 psig WOG, bubbletight shutoff, 250°F continuous: Butterfly type with one piece semisteel body (split body design not acceptable), threaded lugs (same number of lugs as connecting flange), extended neck to suit insulation thickness, bronze disc, bronze bearings, stainless steel shaft and continuous retained EPDM resilient seat to provide end or isolation service without use of downstream flanges.

3. Sizing:

    a. Two Position: Line size; ball or butterfly valve.
    b. Two-Way Modulating: 3-psig maximum pressure drop at design flow rate; globe or ball valve.
    c. Three-Way Modulating: Line size; globe, ball or butterfly valve.
    d. Valves which are sized 6 inch and larger shall be butterfly type.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating equal to pump dead head (zero flow) pressure for two-way valves and 100 percent of pressure differential across valve for three-way valves.
6. One third and two thirds of total capacity is design and actual split will be the ratio of each valve’s Cv to the total Cv.

C. Pressure Independent Control Valve (Modulating Service) Without Meter

1. Acceptable Manufacturers

    a. Belimo
    b. Siemens
    c. JCI
    d. Schneider

2. General: Pressure independent assembly that maintains flow regardless of pressure variations in the system. Device uses a differential pressure regulator and includes visual position indication. Field adjustable flow by means of a percentage of rated valve flow.
3. Valve Differential Pressure: minimum 2 psi differential

4. Body:

   a. ½” – 2”: De-zincificated hot-pressed brass or forged brass, nickel plated
   b. Greater than 2”: Cast iron

5. Seat: Brass or PTFE
6. Seals: EPDM 281 or Viton
7. Valve characteristic: Equal Percentage or Linear
8. Stem and Ball: Stainless steel
9. Body pressure rating: 360 psi
10. Close off pressure: minimum 100 psi
11. Fluid Temperature: 14°F to 250°F
12. Fluid: Water up to 50% glycol
13. Flow Control Tolerance: 5%
14. Connections: NPT (1/2” to 2”) or ANSI 125 flange (2-1/2” and larger)

2.21 DAMPERS

A. Acceptable Manufacturers:

   1. Ruskin
   2. Air Balance Inc.
   3. Greenheck

B. Dampers: AMCA-rated, airfoil design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel or extruded aluminum with maximum blade width of 6 inches and length of 48 inches. Dampers installed in stainless steel ductwork shall be completely constructed of stainless steel.

   1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   2. Operating Temperature Range: From minus 40 to plus 200 deg F.
   3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

C. Provide parallel type blades for mixing applications and opposed blade dampers for all other reasons.

D. Damper End Switches: Non-mercury damper position switch; clamp on shaft type, roller ball and mechanical switch. Kele Model T5-475 or equal.

2.22 AIR FLOW MEASURING STATION (PITOT TUBE)

A. Acceptable Manufacturers: Company manufacturing air flow measuring station shall have a

minimum of five years' experience producing products specified.

1. Air Monitor Corporation: Multipoint, self-averaging pitot tube airflow measurement technology.
2. Cam-Far (Cambridge)
3. Deltec

B. Duct Airflow Station:

1. Furnish unit containing total and static pressure sensing manifolds, internal piping and external pressure transmission ports with flexible tubing and quick-connect fittings.
2. Fabricate of galvanized steel with flanges, size for duct in which mounted. Maximum pressure loss through station of 0.08 inches water gauge at 1500 fpm. Sound level within the duct shall not be amplified nor shall additional sound be generated by air measuring station.
3. Station shall have accuracy of 2% from 960 fpm to 4000 fpm and contain minimum of one total pressure sensor per 36 square inches of station area.
4. Identify by model number, size, area and specified air flow capacity.

C. Fan Inlet Airflow Station:

1. Furnish fan inlet airflow traverse probes (bellmouth); multipoint, self averaging pitot tube technology or thermal dispersion airflow measurement technology.
2. Piezometer ring shall not be acceptable.
3. Assembly shall produce minimum accuracy of 3% of actual flow without significantly impacting fan performance or contributing to fan generated noise.
4. Multipoint Self Averaging Pitot Tube Airflow Measurement Technology.

    a. For fan inlets 20 inches or less, provide copper tubing and larger fan inlets shall be 316 stainless steel.
    b. The traverse probes shall not require the application of any calibration factors.

D. Duct Airflow Probe:

1. Traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds.
2. Traverse probe shall be extruded aluminum construction furnished with mounting plate, gasket, and signal fittings suitable for HVAC duct installation.
3. Probes shall be AMCA certified and capable of measuring the airflow rates within an accuracy of plus or minus 2 percent without the use of correction factors.
4. The maximum allowable pressure drop caused by the probes shall not exceed 0.025 inch at 2000 FPM.
5. Transmitter supplied shall be selected such that the measured differential pressure measurement is in the upper 50% of the range of the device.

E. For measuring airflow, furnish a portable meter consisting of dual-scale, diaphragm actuated, differential pressure gauge mounted in an anodized carrying case. Gauge to read in feet per minute and inches water column. Portable metal shall be complete with eight feet of preconnected 1/4 inch o.d. plastic tubing (for both total and static pressure signals, carrying handle and a built-in rear storage chamber for storing tubing when not in use.

2.23 METERING

A. Provide interface hardware and/or software to interface with the utilities indicated on the drawings and in Division 23 section “Meters for HVAC”.

B. Coordinate electric metering requirements with Division 26 contractor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and operator work station.

B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. General

1. Install software in control units and operator work station(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
2. Connect and configure equipment and software to achieve sequence of operation specified.
3. Furnish automatic control dampers to Division 23 Section "Duct and Duct Accessories" for installation.
4. Install damper motors on outside of duct in tempered areas, not in locations exposed directly to outdoor temperatures.
5. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
6. Coordinate location of hydronic instrument wells, valves, and other accessories installed by Division 23 Section "Hydronic Piping Systems."

B. Thermostats and Temperature Sensors

1. Verify location of thermostats and/or temperature sensors where shown on drawings and room interior elevations. Coordinate location with other wall mounted devices.
2. Install space thermostats and/or temperature sensors 48 inches above finished floor.
3. Provide insulation pads for thermostats and/or temperature sensors mounted on exterior walls and columns.
4. Install averaging elements in ducts and plenums in serpentine, crossing or zigzag pattern across the area of duct or plenum in order to sense true average temperature. Secure averaging elements in such a manner as to prevent vibration from causing element fatigue.
5. Secure duct mounted sensors to ductwork in a vibration free area.
6. Furnish thermal wells for sensors to be installed in piping. Furnish extension necks where installed in insulated piping. Material for wells shall be compatible with material of piping where installed.

C. Humidistats and Humidity Sensors

1. Verify location of humidistats and/or humidity sensors where shown on drawings and room interior elevations. Coordinate location with other wall mounted devices.
2. Install space humidistats and/or humidity sensors 48 inches above finished floor.
3. Secure duct mounted sensors to ductwork in a vibration free area.

D. Low Temperature Limit Thermostats

1. Install sensing element serpentined across coil to provide full coil sensing.
2. Setpoint shall be adjustable. Initial setting at 35 deg F. Wired to stop fan and alarm DDC system.
3. Provide a low temperature limit thermostat for every 20 square feet of coil area.
4. Install on entering side of cooling coil unless otherwise shown elsewhere on the drawings.

E. Control Valves

1. Tag each valve with brass or aluminum tag with corresponding number on control drawings. Tag shall identify valve number and be attached to valve with non-ferrous metal chain.

F. Control Dampers

1. Verify size and locations of control dampers with Division 23 Contractor prior to fabrication. Locations of dampers shall be reviewed to ensure that maximum velocity rating is not exceeded.

G. Airflow Measuring Stations

1. Verify size and locations of duct mounted airflow stations with Division 23 Contractor prior to fabrication. Locations of airflow stations shall be reviewed to insure adequate straight run distances are provided and turbulence will not affect accuracy of transmitter.

H. Control Panels

1. Mount control panels adjacent to associated equipment either on walls or freestanding on steel supports. Mounting on ductwork or air handling units will not be permitted. Panels shall be free from vibration.
2. Panels shall be securely mounted with vertical and lateral bracing.
3. Install wiring diagrams for each control panel inside hinged door.

I. Current Switches

1. Shall be installed such that core is securely in place.
2. Shall be adjusted such that calibration trip point will detect drive belts slipping, breaking, or pump coupling shear.

J. Metering

1. Provide interface hardware and/or software to interface with the utilities indicated on the drawings and in Division 23 section “Meters for HVAC”.
2. Coordinate electric metering requirements with Division 26 contractor.

K. Graphics and User Interface

1. Coordinate with owner and engineer specific points that require trending, historical logs and graphical display. Review length of time that each point shall be capable of trending.

3.3 SENSOR TUBING INSTALLATION

A. Locate clear of all hot surfaces which are in excess of 125 deg F. Do not install in ducts or outside air intake ducts or plenums.

B. Number-code or label sensor tubing for future identification and service of control system.

C. Provide hard fittings at all bends.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Provide signal and power wiring to all panels and devices furnished under the contract and signal and safety device wiring to all equipment controlled under this contract.

B. Provide all interlock wiring between equipment being sequenced as required to accomplish the sequence of operations, which shall include, but not be limited to, supply and return air fans, exhaust fans, coil circulating pumps, chilled and condenser water pumps, cooling tower fans and chiller control panels, flow switches, etc.

C. Mount and wire all loose control components provided with packaged equipment.

D. Provide all required power wiring and conduit for all panels furnished by the contractor for the project. All panels shall be circuited to the type of panel indicated below and utilize 20-amp single pole spare circuit breaker in panelboard. Refer to electrical documents to ascertain exact location of nearest panelboards. Multiple panels may use same circuit within the electrical limitations. Indicate panelboard name and circuit number for each panel on shop drawings.

1. Network / Supervisory Panels: House UPS Panel
2. DDC Panels Serving Equipment on Emergency Power: House UPS Panel
3. DDC Panels Serving Equipment on Normal Power: Normal Branch
4. Operator Workstation / BAS Server: House UPS Panel
5. Connect all normal power DDC/ATC panels to the nearest normal 208/120V power panelboard within the electrical circuit zone.
6. Connect all emergency power DDC/ATC panels to the nearest 208/120V emergency panel that is fed by the same automatic transfer switch (emergency branch) that supplies emergency power to the respective HVAC equipment.
7. Connect no more than five (5) DDC/ATC panels to a dedicated 20A, 120V branch circuit. Utilize 20A single pole spare circuit breakers within each panelboard.

E. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

F. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Install signal and communication cable according to Division 26 Section “Communications Horizontal Cabling.”

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in conduit.
3. All BSL3 Laboratory control cabling shall be installed in conduit.
4. All cabling associated with life safety systems shall be installed in conduit.
5. Install concealed cable in conduit. All cabling shall be plenum rated.
6. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
7. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
8. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
9. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

H. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

I. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth,

and other applicable considerations.

4. Check temperature instruments and material and length of sensing elements.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.7 TESTING, ADJUSTING AND BALANCING

A. Testing, adjusting and balancing of air and water systems will be provided under Division 01 “Testing, Adjusting and Balancing of HVAC Systems”.

B. Cooperate with testing, adjusting and balancing Contractor in coordination and scheduling of testing, balancing and adjusting work, as well as determining appropriate set point adjustments required for proper system operation.

C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.

D. BAS Contractor shall set up and calibrate the mass flow control devices to the design contract values. BAS Contractor shall adjust the AVCB control so that final setup does not deviate more than plus or minus 5 percent from the design value.

E. BAS Contractor shall index the system configuration as requested by the TAB Contractor.

F. BAS Contractor shall obtain static pressure readings from TAB Contractor at the various points in the system for programming and tuning final set point conditions.

3.8 COMMISSIONING

A. Commissioning will be provided as specified in Division 01 Section “Commissioning”. All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section “Commissioning”.

B. Ensure participation of major equipment manufacturers or their representatives.

C. Equipment and systems/subsystems installed under this section are expected to be in full

compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

3.9 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Provide minimum (8) hours of training. Refer to Division 01 Section "Demonstration and Training."

B. Upon completion of all work, tests and commissioning, operate systems for a period of 48 hours without adjustment to demonstrate to owner to definitively determine whether the system as a whole is in first class working condition.

C. Before installation is accepted, provide certification to Owner and Architect that control system and equipment have been inspected and found to be properly installed and functioning satisfactorily.

END OF SECTION 25 09 00

SECTION 25 09 33 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes requirements for system operation for HVAC equipment.

B. Related Sections

1. Division 25 09 00 "Instrumentation and Controls for HVAC"

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS

A. AHU-2 (typical for AHU-3, Laboratory Areas)

1. General

a. Unit is 100% outside air and has a preheat coil, supply air smoke dampers, chilled water-cooling coil, variable frequency drive fan, and humidifier. Unit runs continuously.
b. Preheat coil valve shall fully open whenever outside air temperature falls below 45^{o} F or whenever face damper is opened to any position.

2. Startup and Shutdown

a. When unit is indexed to start, outside air and smoke dampers shall open. When dampers open, end switches shall energize fan. Interlocked exhaust fans EF-1,2 shall be energized. (EF-3,4,5 for AHU-3.)
b. Whenever fan is deenergized, outside air dampers close, smoke dampers close, and humidifier valve closes, and preheat coil remain under control.
c. Whenever dampers close, there shall be a time delay to allow for fan spindown.

3. Occupied

a. Temperature: Supply air temperature sensor through DDC system shall modulate unit

cooling coil valve to maintain 52° F. On a fall in temperature, after cooling coil valve is closed preheat coil valve shall be modulated open to maintain supply air temperature. Preheat coil low limit discharge air temperature sensor shall prevent discharge air from falling below its setting (initially set at 50° F).

b. Humidity: Supply air Humidity sensor through DDC system shall modulate humidifier valve to maintain 40% relative humidity. A supply air humidity sensor shall override and prevent supply air humidity from rising above its setpoint of 60% relative humidity. Whenever fan is deenergized, humidifier shall be off.

c. Pressure: A static pressure sensor located 2/3 down supply duct shall, through the DDC System shall, modulate variable frequency drive to maintain duct static pressure and maintain minimum supply fan cfm. A discharge high limit static pressure sensor shall override supply duct static control and prevent over pressuring of system. Supply air and exhaust air cfm's shall be measured and exhaust fan variable frequency drive shall be controlled to maintain constant cfm differential.

4. Unoccupied

a. System shall operate at reduced air volume based on a minimum air volumes set at VAV boxes. VAV boxes shall remain under control and shall be indexed to minimum position.

5. Safety Controls

a. Smoke detectors in supply and exhaust air ducts shall operate interface modules and deenergize fans.

b. Low temperature limit thermostat shall deenergize fans and alarm DDC system.

c. Preheat and cooling coil pumps shall be energized whenever outside air temperature falls below 35ºF.

B. AHU-1 (Office Areas)

1. General

a. Unit has supply and return air smoke dampers, a chilled water cooling coil, variable frequency drive fan, and humidifier. Unit runs continuously.

2. Startup and Fan Shutdown

a. When unit is indexed to start, smoke dampers shall open and end switches shall energize supply and return fans.

b. Whenever fan is deenergized, outside air dampers close, smoke dampers close, humidifier valve closes, and dampers remain under control.

c. For DDC systems having economizer and start/stop requirements, provide slow opening signal to (maximum) outside air dampers to prevent nuisance shutdowns.

d. Whenever dampers close, there shall be a time delay to allow for fan spindown.

3. Warm-up/Cool down Cycle: Cycle shall be initiated prior to occupancy in order to warm up/cool down building by occupied time. Supply and return fans shall start up. Outside air and exhaust dampers shall remain closed and return air damper shall be open during warm-up. Also during warm-up, the supply fan shall be limited to the capacity of the return fan and

the fan differential shall be zero. Outside air and relief dampers shall open and return air damper shall close during cooldown if return air temperature is higher than outside air temperature. Variable air volume boxes shall remain under control. The supply air temperature shall be increased for warm-up to 65°F (reprogrammable) and the cooling coil valve shall remain closed. The supply air temperature shall remain 55°F (reprogrammable) for cool down and the preheat valve shall remain closed. Outside air temperature and building temperatures shall be measured in order to determine warm-up/cool down time.

4. Occupied Control

   a. A signal from DDC controller shall index system to occupied mode
   b. Temperature

      1) A supply air sensor through DDC system shall on a rise in temperature first modulate reheat coil valves closed, then modulate outdoor air damper open and return air damper closed, and finally modulate cooling coil valve to maintain setpoint. System shall go to minimum outside air when outside air temperature is above 65° F reprogrammable.

   c. Humidity: Return air Humidity sensor through DDC system shall modulate humidifier valve to maintain 50% relative humidity. A supply air humidity sensor shall override and prevent supply air humidity from rising above its setpoint. Whenever fan is deenergized, humidifier valve shall be closed.
   d. Pressure:

      1) A static pressure sensor in return plenum shall modulate open relief air damper to maintain its setting.
      2) A static pressure sensor located 2/3 down supply duct shall, through DDC System, modulate variable frequency drive to maintain duct static pressure. A discharge high limit static pressure sensor shall override supply duct static control and prevent over pressuring of system. Supply air and return air cfm's shall be measured and return fan variable frequency drive shall be controlled to maintain constant cfm differential.

5. Unoccupied

   a. VAV boxes shall remain under control.

6. Safety Controls

   a. Smoke detectors in supply and return air ducts shall through interface modules deenergize fans.
   b. Low temperature limit thermostat shall deenergize fans.

C. Duct Mounted Reheat Coil Control: Provide temperature sensor and 2-way or 3-way control valve, as scheduled, to modulate valve in response to programmable room temperature set point.

D. Air Volume Control Box Schemes

1. All Control Schemes: Control Contractor shall coordinate with box manufacturer and provide all necessary materials and field work to connect control components factory

supplied as part of various variable air volume control box schemes in order for them to operate as described.

2. Control Scheme

    a. VAV Boxes: Provide a space sensor which shall on a fall in temperature modulate box cfm to its scheduled minimum. On a continued fall after the box has reached scheduled minimum flow the reheat valve shall be modulated to maintain space temperature.

E. Chiller Control

1. Initial Start: On a rise in outside air temperature to 60°F (reprogrammable), the chiller shall be energized. The starting of the chiller shall open chilled water and condenser water valves for that chiller and then energize the pumps.

2. Operation

    a. The differential pressure transmitter(s) shall modulate the variable volume chilled water pumps to maintain the programmed set point.
    b. The chiller flow shall be measured and when the operating chiller flow begins to fall near its minimum, the system bypass valve shall be modulated open to maintain chiller programmed minimum flow.

3. Electronic Communication:

    a. Provide electronic connection (BacNet, ModBus, Gateway or Direct Port) from chiller panel(s) to the DDC panel.
    b. Coordinate the mapping of points with Owner for meeting operator needs.

F. Boiler Control

1. Boiler manufacturer is providing all boiler, pump and valve controls.
2. Provide electronic connection (BacNet, Mod Bus, Gateway or Direct Port) for boiler panels to DDC panel.
3. Coordinate mapping of points with Owner for meeting operator needs.

    a. A supply water sensor, through the DDC system monitor shall control the three way control valve to maintain the hot water supply temperature.
    b. Provide output signal to enable the selected or lead boiler. In the event the supply water temperature falls, a second boiler shall be enabled. On a rise in return water temperature, a boiler (for multiple boiler systems) shall be disabled. However, one boiler shall be enabled at all times.

G. Unit Heater Controls: Wall mounted electric thermostat cycles unit motor to maintain thermostat setpoint.

H. Hood Safety Alarm

1. Provide a pressure sensor in exhaust duct above each hood, which shall, through a pressure

switch, light two (in parallel) red pilot lights and sound an alarm bell when pressure falls below setpoint. Provide a key operated switch to silence bell, lights shall remain lit. When pressure is corrected, bell shall silence (if not already silenced) and lights shall go out.

2. Provide required recessed back box to house lights, bell, pressure switch and override switch.
3. Pressure switch shall be "photohelic" type with a range of 0.0 to 1.0 inch w.g. Also, switch shall have tamperproof setpoint adjustment.
4. Lights shall be red pilot light assembly complete with lamps and 3-inch bell. Lights and bell shall operate with 120V AC.

END OF SECTION 25 09 33

SECTION 26 05 00 - COMMON MATERIALS AND METHODS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section is intended to describe the basic materials and installation methods for electrical work; it applies in general to all Sections under DIVISION 26. All materials and equipment specified and/or shown on Drawings are new unless noted otherwise.

B. All new materials, equipment and systems shall be listed and labeled by a licensed nationally recognized testing laboratory as defined by OSHA and used for the specific purpose, environment or application for which it was tested and approved. No field modifications and/or noncompliant installation whatsoever shall be made to any materials, equipment and systems that would violate the listing and labeling.

C. This section includes the following:

1. Electrical equipment coordination and installation
2. Sleeves for raceways and cables
3. Sleeve seals
4. Grout
5. Common electrical installation requirements

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. EPDM: Ethylene-propylene-diene terpolymer rubber.

G. NBR: Acrylonitrile-butadiene rubber.

1.4 REFERENCES

A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:

1. National Electrical Code, NFPA 70 (NEC)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturer's Association (NEMA)
4. National Electrical Contractors Association (NECA
5. The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
6. Applicable NFPA Codes and Standards

B. Conflicts

1. Nothing stated or shown in Specifications or on Drawings is intended to conflict with the above standards and regulations. Should Contractor find any apparent conflict, it shall be his responsibility to notify Architect before any of the work in question is performed or material purchased.

1.5 SUBMITTALS

A. Provide Product List of factory fabricated items, in accordance with Section 016000 "Product Requirements", including name of proposed manufacturer, for all products specified in various sections of Division 26.

B. Provide submittals in accordance with Section 013300 "Submittal Procedures" in sufficient detail to verify full compliance with the requirements of the Contract Documents.

C. Product Data: Provide for each type of factory-fabricated product indicated.

D. Submit testing reports.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Comply with warranty and contract closeout requirements specified in Division 01, GENERAL REQUIREMENTS.

B. Provide Special Warranties and/or warranty service in accordance with Section 016000 "Product Requirements" where specified in the various sections of Division 26.

C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 26.

D. Upon completion of work and tests, and at a time mutually agreed to by Contractor, Architect and Owner, operate all systems installed, in all parts, at Contractor's expense for sufficient length of time to demonstrate the mode of operation and definitely determine whether systems as a whole are in first class working condition. Defects and malfunctions that may develop during this period of operation shall be immediately corrected by Contractor at his own expense, and systems placed in first class working condition before being finally turned over to Owner.

E. Include information for all products specified in the operation and maintenance manual.

F. Provide electrical certificate(s) from electrical inspection agency - see Article titled "Inspections".

G. Provide manufacturer's certification and warranty of system operation - see Article titled "Tests".

1.7 QUALITY ASSURANCE

A. The specifications for certain products and alternative materials may appear in more than one section of Division 26. Work of Division 26 shall be coordinated for all sections of Division 26 to assure that where two or more items of any given product are furnished under Division 26 that they are of the same manufacturer and type and that alternative materials is consistent throughout the work of Division 26.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle all material and equipment in accordance with manufacturer’s instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.

B. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.

C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 PHASE ARRANGEMENT

A. Exercise great care in maintaining a uniform and consistent arrangement of phase conductors on all systems. Throughout the entire wiring systems, each phase conductor must always be in the same physical position with respect to the other phase wires at equipment terminals.

B. Identify phase wires by color coded conductors. Refer to Section 26 05 53.

1.10 INSPECTIONS

A. Before starting any Work under this Contract, file for inspection with the agency approved by the AHJ. Upon completion of the work, furnish electrical certificates from said agency for all electrical equipment and systems installed or furnished and installed as part of the work.

B. Electrical equipment or systems that are modified in the field shall be reinspected. Furnish a new electrical certificate covering such modifications.

1.11 GENERAL COORDINATION.

A. The electrical systems are indicated on the Electrical Drawings. Certain pertinent information and details required by the electrical work appear on the Architectural, Structural, Mechanical, Civil, Fire Protection, and Security Drawings. Become familiar with all drawings and incorporate all pertinent requirements

B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the Electrical work. Do not scale the drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.

C. Coordinate scheduling, sequencing, movement and positioning of large equipment into the building during construction.

D. Coordinate installation of identification devices with completion of covering and painting of surfaces where identification devices are to be applied.

E. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

G. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

H. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.12 ELECTRICAL WORK ASSOCIATED WITH OTHER DIVISIONS

A. WORK NOT REQUIRED BY DIVISION 26

1. Unless otherwise noted or specified, setting of mechanical equipment and associated safety and control devices will be done by Division 22 and 23 Contractors.
2. Control devices provided under Division 22 or 23 will include, but are not necessarily limited to the following:

    a. Limit Switches: Aquastats, thermostats, air, gas and water pressure
    b. Sensing Devices: Air, gas and water flow and their presence in atmosphere
    c. Flow Switches: Air, medical gas, water
    d. Valve Operators: Electric or air motors or pistons

3. Magnetic motor starters and their associated auxiliary contacts (other than Motor Control Center), pushbutton stations, selector switches, pilot lights and control switches that are integral with factory prewired packaged equipment.
4. Unless otherwise noted or specified, setting of mechanical equipment and associated safety and control devices will be done by Division 22 and 23 Contractors.
5. Automatic Temperature Control System including all necessary power wiring.
6. Motors for mechanical equipment.
7. Cooling Tower sump heaters, control panel and float switch.
8. Control wiring of remote control devices for laboratory exhaust hood systems.
9. Furnishing only of electric heaters as follows: unit heaters, cabinet unit heaters, baseboard heaters, duct heaters, radiant heaters and other heaters. Installation and wiring by electrical contractor.
10. Field wiring, other than power wiring, for electrical accessories furnished as an integral part of equipment furnished under Division 22 and 23.
11. Integral fused disconnect switch, circuit breaker or motor circuit breaker in control panels for Division 22 equipment, unless otherwise indicated.
12. Furnishing, installing and wiring of pilot switches, relays and other control devices required for the proper sequence, electrical or pneumatic control of the apparatus furnished under Division 22 and 23, and not specified or shown on Drawings as being furnished under Automatic Temperature Control System or under Division 26 of the Specifications.
13. Packaged room air conditioning units.
14. Variable frequency drives (VFD) furnished by Division 23 that are either integral with factory prewired packaged equipment or installed separately.
15. Passive communication cabling, terminations and devices are provided by Division 27.
16. Furnishing and installing heat trace cable and electric heaters in mechanical equipment, including control wiring.
17. Furnishing and installing humidifiers including control wiring.

B. WORK REQUIRED BY DIVISION 26

1. Provide all labor, materials, equipment, components and tools for required wiring and connections to control devices and instruments, as specified herein.
2. Provide all recording, indicating devices, contactors, time switches, photoelectric devices and lighting dimming equipment, as specified.
3. Install, completely wire and connect all systems specified herein in accordance with details on drawings and manufacturer’s instructions.

4. Install and adjust all mechanical and electrical interlocks. Repair or replace faulty equipment.
5. Install, wire and connect electric heater non-integral thermostats.
6. Provide magnetic and manual motor starters for equipment furnished by others except where starters and controllers are furnished as an integral part of prewired packaged equipment.
7. Provide power wiring to starters and from starters to motor including all connections. Wire capacitors, VFD and associated filter when they are provided by Division 23. Exception: When motors, starters, controllers, etc., are furnished as an integral part of any equipment furnished under Division 23, only power wiring to power terminals on said equipment shall be included herein.
8. Provide Motor Control Centers and/or Motor Starters including integral pushbuttons, pilot light, control switches, auxiliary contacts and the like, required for proper sequence and control function specified under Division 23.
9. Provide and wire all manual motor switches as required and specified.
10. Provide motor and circuit disconnect safety switches, both fusible and nonfusible types, as shown or as required by the NEC. Integral disconnect switches for power roof ventilators will be included under Division 23 and in equipment control panels under Division 22.
11. Provide branch circuits to ATC air compressor motor starters and associated air dryer. Branch circuits to ATC panels and other associated ATC equipment will be included under Division 25.
12. Provide power wiring for cooling tower sump heaters and float controls.
13. Provide branch circuits for pipe tracing electric heating cable, strip type space heaters, humidifiers and snow melting systems furnished and installed by Divisions 22 and 23.
14. Provide 120V circuits including conduit and wiring, to a junction box at air handling units. Make necessary connections to plenum luminaires, switches with pilot lights, receptacles and other 120V equipment.
15. Installation of electric unit heaters, cabinet unit heaters, baseboard heaters, and duct heaters including their power and control wiring.
16. Provide all interlock and control wiring shown or referred to on the Electrical and Mechanical Drawings including remote control devices for laboratory exhaust hood systems.
17. Provide grounded convenience outlet, or grounded junction box for solid connection when required, for each electric water cooler. Locate properly so connection is not visible.
18. Installation of variable frequency drives (VFD). Exception: When furnished as an integral part of prewired packaged equipment. Provide power wiring to VFD and from VFD to motor including all connections. Obtain manufacturer's installation instructions and wiring diagrams from Division 22 and 23.

C. Plumbing, Gas and Fire Protection System Controls

1. All plumbing system control equipment and devices will be provided under Division 22, with the exception of Motor Control Centers and any devices so indicated or specified otherwise under Division 26.
2. The following controls will be furnished and installed by Division 22 Contractor and wired and connected by Division Contractor indicated:

    a. Aquastats, float and pressure switches integral with a given system equipment piping - Division 22 or Equipment Supplier; individual devices installed at construction site -Division 26.

b. Pressure switches, flow and OS&Y indicating valve switches for fire protection – Division 26. When these devices are installed concealed above ceiling construction, provide local space mounted condition pilot lights as indicated.
c. Control transformers for Plumbing and Fire Protection System if integral with equipment Division 21 or 22, respectively; otherwise - Division 26.
d. Medical Gas alarm panels and remote devices – Division 22.

3. Coordinate all plumbing, gas and fire protection control equipment, devices, location of and test with the respective sections of Division 23.

D. Automatic Temperature Controls (ATC)

1. All temperature control equipment and devices will be provided under Division 25, with the exception of starters contained in Motor Control Centers (M.C.C.'s) and any devices indicated or specified otherwise under Division 26.
2. The following controls will be furnished and installed by Division 23, and as noted herein, wired and connected by Division Contractor indicated.

a. Line Voltage Thermostats – Division 25
b. Aquastats, Freezestats, Firestats – Division 25
c. Air Flow Switches, Float and Pressure Switches – Division 25
d. Pneumatic Electric (P.E.) and Electric Pneumatic (E.P.) Switches – Division 25
e. Duct Mounted Smoke Detectors - Furnished and wired to Fire Alarm System - Division 28. Installed and wired to dampers, fan controls and other mechanical devices – Division 25
f. Initiating Alarm Contacts for Supervisory (Surveillance) Alarm Wiring - Division 28
g. Control Transformers for HVAC Control Equipment - Division 25; exception control transformers in Motor Control Centers provided under Division 26.
h. Selector Switches for indexing spare chilled and condenser water pumps to primary pump service - provided by Division 25, wired by Division 26

3. Coordinate all temperature control equipment device locations and test with the respective Division 23 Contractor.

E. Air Volume Control Box Wiring

1. Unless otherwise noted in the Panelboard Schedule, connect no more than ten (10) air volume control boxes on a 20A, 120V branch circuit.
2. Connect all air volume control boxes to the nearest normal 208/120V power panelboard within the respective electrical circuit zone, unless the air handler that serves the air volume control box is on emergency power and/or indicated in the air volume control box schedule shown on the mechanical drawings. Air volume control boxes requiring emergency power shall be connected to the nearest 208/120V emergency panel that is fed by the same automatic transfer switch (emergency branch) that supplies power to the respective air handler.
3. Refer to Mechanical Drawings for quantity and locations of air volume control boxes.

F. Smoke and Combination Fire/Smoke Damper Wiring

1. Unless otherwise noted in the Panelboard Schedule, connect no more than ten (10) smoke and/or combination fire/smoke dampers on a 20A, 120V dedicated branch circuit.
2. Connect all smoke and/or combination fire/smoke dampers to the nearest normal 208/120V power panelboard within the respective electrical circuit zone, unless the air handler that serves the smoke and/or combination fire/smoke damper is on emergency power. Smoke and/or combination fire/smoke dampers requiring emergency power shall be connected to the nearest 208/120V emergency panelboard that is fed by the same automatic transfer switch (emergency branch) that supplies power to the respective air handler. Circuits shall be arranged as follows:

    a. Dampers located in riser shafts shall be circuited vertically to other dampers served by the same air handler.
    b. Dampers located in areas, other than riser shafts shall be circuited horizontally to the nearest panel board (as described above) within the respective electrical circuit zone. Coordinate circuiting arrangement with Division 23 contractor, prior to commencement of work, to limit the quantity of control relays associated with each fan.

3. Refer to mechanical drawings for quantity and locations of smoke and/or combination fire/smoke dampers.

G. Elevator Equipment Wiring

1. Provide circuit breakers, safety switches, power feeders, lighting feeders, control circuits, including connections to controller and elevator machine. Also provide pit lights, switches, receptacles, car light emergency circuit to controller and suitable communications connections to cab.
2. Elevator Contractor will provide Shop Drawings of all equipment to be installed for elevator systems. Investigate and determine exact locations for conduit, switches, etc., before installing same and comply with Elevator Contractor requirements for details of installation and materials to be provided.
3. Selector switch modules with control relays and contactors, to permit selective operation of elevators during periods when power source is from emergency supply, will be provided by Elevator Contractor. Provide an auxiliary contact on elevator automatic transfer switches to close on a transfer to emergency power. Provide two #14 in ¾-inch conduit from elevator automatic transfer switch to each elevator controller.
4. Refer to Specification Sections titled “Elevators” and “Fire Alarm System” for Fire Service Operator, for required response of elevator during an alarm condition of building fire alarm system.
5. Branch circuits for pit and car lights and controls shall be supplied from an emergency power source.
6. Each elevator disconnect switch (circuit breakers or safety switches) shall have provisions to be locked in the open position.
7. Heat detectors in the elevator machine room and at the top of the hoistway shall be as specified in Specification Section titled “Fire Alarm System” for shutdown of power to the elevator drive via shunt trip circuit breaker prior to release of water from the sprinkler system. Provide all wiring, conduit and equipment to connect fire alarm interface module to shunt trip circuit breaker to accomplish this operation.
8. Each elevator disconnect switch (circuit breakers or safety switches) shall be equipped with an auxiliary one (1) N.O./one (1) N.C. contact, rated ten (10) amps at 120/240 VAC.

H. Cooler and Freezer Wiring

1. Coolers and freezers will be supplied and installed by others, prewired complete with luminaires, light switch, door heater tape, all connected to a central terminal box. Provide required branch circuit wiring. Provide all conduit, wire and circuits required to operate refrigeration equipment, defrost heater, blower coil, alarm.
2. Arrange to have equipment supplier cut and seal all openings in coolers and freezers required to accommodate electrical system installation. Verify all locations with supplier.
3. Exposed conduit installed on surface inside coolers and freezers shall be installed parallel to room lines. Do not install exposed conduit if it can be avoided.
4. Where conduit enters refrigerated areas, install fiber nipple from box outside refrigerated area to surface mounted box inside area. Provide ground conductor through nipple. After conductors are installed, plug both ends of fiber nipple with oakum to prevent leakage and condensation.
5. Install required wiring and branch circuits when possible for blower fans, defrost heaters, lighting through top of cooler and freezer from surface mounted box in space above. Confirm characteristics of each electrical component before installing wiring and circuit protective devices, and provide as required.

I. Overhead Door Wiring

1. Install controller, push-buttons, limit switches, safety bars and key-operated stations for each overhead door. Provide branch circuit and control wiring, and circuit disconnect as required for each door.
2. Locate key-operated control station on the exterior of the building or where directed. Seal conduit after conductor installation.
3. Confirm all locations and electrical characteristics with supplier prior to installing electrical work.

J. Power Door Wiring

1. Perform the following work for power operated and power held doors furnished under other divisions of this specification.
2. Provide branch circuit/feeder and disconnect switches or devices at each location as shown or as required. Key switches if required will be furnished by others; install and connect.
3. Investigate and determine exact requirements for each power operated and held door specified or shown, for location of conduits, switches, controllers, etc., and type of connections. Coordinate all this data before making installation and provide as required to comply with manufacturer's requirements, details of installation and materials supplied. Wire and coordinate electric lock circuits for doors where required and/or indicated.
4. Certain doors to room(s) containing emergency engine generator(s) shall open automatically during operation of emergency engine generator and also open by operation of a local manual switch. Provide coordination and interwiring between the power door controller and engine generator control circuit relay contacts, for "open" and "close" response.

K. Electric Door Lock and Monitor Wiring

1. Perform the following work for the electric door lock and monitor systems specified and furnished under another section of this specification and as indicated.

2. Provide 120 Volt branch circuits required for each system specified, to a low voltage transformer and controller by others, as shown or required. Install and wire all electric door locks, contact devices, control switches and control devices for a complete operable system.
3. In addition to the local interior door systems, the following exterior doors with lock release system shall be equipped with a relay interwired with door security system circuit (specified by Division 28).
4. Investigate and determine exact requirements for each door lock system specified, for location of conduit, switches, wiring, etc., and type of connection, before installing any work and comply with manufacturer's requirements for details of installation and materials used.

L. Parking Lot Gate Wiring

1. Provide the following work for parking lot gate(s) and control unit(s) furnished under another section of these specifications.
2. Provide branch circuit wiring, control wiring and disconnect switches as shown and/or as required.
3. Provide required control wiring, conduit and connections between control unit enclosures and electrically operated gates.
4. Provide wiring, conduit and connections required for card readers and/or inductive loop detection for operation of complete gate system. Also, provide wiring, conduit and connections from control unit to central security office for remote operation and/or detection of illegal entry or malfunction of system.
5. Parking gate system manufacturer will provide Shop Drawings of all equipment and wiring to be installed; all work shall comply with manufacturer's requirements and details of installation and materials used.
6. Where shown and/or required, provide conduit and wiring for voice intercommunicating system or CCTV between gate and central security office.

M. Prefabricated Clean Room Partitions

1. Provide all electrical devices including but not limited to light switches, receptacles, telecommunication outlets, multi-outlet raceways and similar branch wiring devices located within the clean rooms where noted on the drawings. All devices shall be recessed mounted within clean room partitions.
2. Provide faceplates for all devices.
3. Provide all branch circuit wiring to electrical devices where noted on the drawings.
4. Low voltage cabling for support of access control, security and telecommunications devices shall be provided by Division 27 and Division 28 contractors.
5. Clean room partitions will incorporate a minimum of two (2) 2-inch by 3-inch full height vertical cable pathways located at each end of each panel which are UL listed for open cabling up to 120VAC. These vertical pathways shall be used for the installation of line and low voltage cabling to support devices shown on the drawings. Where branch circuit device voltage exceeds 120VAC, provide metallic conduit within vertical pathways to outlet box for line voltage cabling. Outlet boxes shall be shallow type suitable for recessed installation within clean room vertical pathway.
6. Provide pathways to low voltage devices including but not limited to access control, security and telecommunications devices as required to support low voltage cabling from

point of origin to clean room partition. Cabling shall be extended into clean room partition via integral vertical cable pathways without additional raceways to wiring device.

7. Do not install exposed conduit on clean room partitions. All cabling and conduit shall be concealed within clean room partition vertical pathways.
8. All cable and conduit penetrations, outlet boxes and wiring device faceplates shall be sealed by Division 26. Refer to Division 7 specifications for sealant requirements.

1.13 EQUIPMENT LOCATIONS

A. Locations are subject to changes in order to avoid obstacles in building construction. Verify all dimensions and conditions at site. Check layout for sizes and clearances, so that the apparatus and material may be installed and operated satisfactorily in space provided. Install equipment and raceways to preserve headroom and to keep openings and passageways clear.

B. Install equipment, boxes and outlets in accessible locations. Obtain final locations of all outlets and equipment from details on drawings and from Architect. Examine drawings of other trades and avoid interferences with their work.

C. In case of conflict in location of flush outlets, architectural details shall take precedence.

D. Install conduit to avoid mechanical and/or structural obstructions, minimizing crossovers.

E. Install all exposed conduits parallel or perpendicular to building lines.

F. Provide minimum of 6 inches clearance between electrical work and flues, steam pipes and other heat sources.

G. Mounting heights of outlets and equipment shall be as indicated on "Mounting Height" Schedule, or as specified herein.

H. Verify all door swings before installing switch boxes. In case of conflict between drawings, Architectural details shall take precedence.

I. Architect reserves the right to change, without additional cost, location of any luminaire, wall switch, receptacle or power outlet, provided such changed location is not more than 10 feet, and is ordered changed before said work is completely "roughed in".

J. Locations of electrical equipment and connections to all other equipment are approximately correct, and are subject to such modifications as are required at time of installation, in order to meet field conditions or the dimensions of equipment actually being supplied.

K. No changes are to be made in the original design without written approval by Architect.

1.14 SEISMIC REQUIREMENTS

A. Seismic Design

1. All new electrical systems (equipment, busway, cable tray, and raceways) shall be provided with seismic restraints in accordance with the requirements of the applicable building code

and site specific seismic design parameters and Division 26 Section “Vibration Isolation and Seismic Restraints for Electrical Systems”.

2. Refer to Structural Drawings and Division 01 for seismic criteria to be used for this project.
3. Use a Component Importance Factor, I_p, of 1.5 for all life safety systems required to function during and after an earthquake; including, but not limited to:

    a. Emergency equipment, including all generators, transfer switches, transformers, panelboards, raceways and lighting.
    b. All electrical equipment for mechanical, plumbing or fire protection systems that support the operation of or are connected to emergency power equipment.
    c. All electrical equipment for all equipment using combustible or toxic energy sources.
    d. Equipment buried underground is excluded, but entry of electrical and telecommunication services through the foundation wall is included.

4. Use a Component Importance Factor, I_p, of 1.5 for all electrical components for the systems that contain hazardous material, including, but not limited to:

    a. Isolation room exhaust
    b. Biohazard exhaust

5. Use a Component Importance Factor, I_p, of 1.5 for all systems and components needed for continued operation of the facility or whose failure could impair the continued operation of the building.
6. Except as noted otherwise herein, use an Importance Factor, I_p, of 1.0 for all other components.
7. It is the entire responsibility of the equipment manufacturer to design their equipment so that the strength and anchorage of the components of the equipment exceeds the force level used to restrain and anchor equipment itself to the supporting structure. Factory manufactured and/or field or shop fabricated equipment shall be designed to safely accept and resist, at its points of anchorage or suspension without failure or permanent displacement of the equipment, earthquake generated external forces required by the code.
8. The preparation and submittal of product data and shop drawings to the Architect for review shall constitute a representation by the manufacturer, contractor and vendor that all components comply with the above requirements.
9. The functional and physical interrelationship of components and their effect on each other shall be installed so that failure of an essential or nonessential architectural, mechanical, electrical component shall not cause the failure of nearby essential architectural, mechanical, or electrical components.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

    a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches thickness shall be 0.052 inch.
    b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

C. Coordinate sleeve selection and application with selection and application of fire stopping specified in Division 07 Section “Penetration Firestopping”

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Advance Products & Systems, Inc. (Inner Lynx)
    b. Calpico, Inc. (Pipe Linx)
    c. Metraflex Co.
    d. Pipeline Seal and Insulator, Inc. (Link Seal)
    e. O-Z/Gedney

B. Description: Modular Sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 CONDUIT SEALS

A. All active and spare underground power and communication conduits greater than 1-1/4 inches, leaving manholes and entering building foundation walls and floor slabs shall be provided with an inflatable bladder as manufactured by Tyco-Raychem, Product No. RDSS. Refer to manufacturer’s recommendations for bladder size and installation methods.

B. All active and spare underground power and communication conduits 1 1/4 inch or less, leaving below grade enclosures and entering building foundation walls and floor slabs shall be sealed with an approved waterproof sealant.

2.5 FIRE-RATED CABLE PATHWAYS

A. All telecommunications cable bundles shall utilize an enclosed fire-rated pathway device wherever said cables penetrate rated walls. The fire-rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

    a. STI, Inc., EZ-Path (Basis of Design)
    b. Hilti-Speed Sleeve
    c. 3M

B. Cable pathways shall have an orange finish color and dimensions as required based on the installation.

C. Provide three (3) cable pathways into each IDF, MDF and server room at the location of the cable tray penetration into each room. Provide "radius control module" on each end of cable pathway to provide a 1 inch minimum bend radius suitable for copper and fiber optic cables.

D. Multiple cable pathways shall be installed in rated partitions utilizing manufacturer's recommended wall plate.

E. Cable pathways shall meet or exceed rating of partition where pathway is installed. Refer to architectural drawings for rating of partitions.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. General

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such

a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

5. Right of Way: Give to piping systems installed at a required slope.
6. Furnish, deliver, erect, connect and finish in every detail, all materials, equipment and accessories required for the Work. Select and arrange to fit properly into the building spaces.
7. Perform all work in accordance with the drawings, specifications, including manufacturer's installation instructions, all applicable codes and NECA's Standard of Installation guidelines.
8. Include in the Work and in the bid proposal minor details not shown or specified, but manifestly necessary for the proper installation and operation of the various systems, as if specified or shown.
9. Position and install all material and equipment to permit proper access and in such a manner that maintenance, adjustment, calibration, inspection, repair and replacement of the material and equipment can be accomplished with minimum effort and cost.
10. Perform the installation, wiring, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturers' instructions and recommendations. Such instructions and recommendations are hereby made a part of these Specifications.
11. If any departures from Contract Documents are deemed necessary, submit details of such departures and the reasons there for to Architect for approval.
12. Pull and junction boxes shall be located and sized by the electrical contractor in accordance with NEC, EIA/TIA, utility company requirements and/or owner standards, unless otherwise noted on the drawings.

B. Layout and Coordination

1. Lay out all work from approved building and property lines and benchmarks. Verify and be responsible for the correctness of all measurements in connection with work. Any change made in major overall dimensions as shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to the use of equipment of a manufacturer other than that used as the basis of design shall not cause any interference with other work.
2. Examine the drawings of other trades and initiate cooperation and coordination of the Work with the work of other trades to ensure that the Work can be installed properly as designed and planned without interference with other work or delay. Furnish all necessary templates, patterns, measurements, etc., for installing work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required by the Work may not be shown due to the small scale of the drawings; provide such offsets, bends or other items as required to meet structural or finish conditions.
4. Coordinate and be responsible for the required clearances of the Work in shafts, chases, double partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review space requirements that exceed those shown.
5. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.

6. Install conduit, fittings, etc., to provide not less than 1/2 inch between their finished covering and the structure or adjacent work of any kind.
7. Electrical equipment shall not interfere in any way with other material or equipment and shall be provided with adequate working space; see the National Electrical Code working space requirements.
8. Make reasonable modifications in the layout of the Work, as directed, to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
9. Cooperate fully with the Contractor for General Construction in regards to location of electrical equipment and work progress schedules. Notify him of all flush panelboard locations so that wall of proper thickness is provided.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the Work is to be installed in relation to the work of other trades. Issue such drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades, detail and submit such deviation or conflicts to the Architect for review.
11. Locate wall switches at strike side of doors and at height indicated on "Mounting Height" schedule. Review all door swings with Contractor for General Construction prior to rough-in.
12. Locate receptacles at heights indicated in "Mounting Height" schedule. Mount receptacles vertically, ground pole at top. In special areas such as kitchens, laboratories, utility areas, coordinate locations with counters, benches and casework.
13. All devices and wiring are to be concealed where possible. Where specifically shown or where approved by the Architect, install exposed outlet boxes and branch circuit wiring in finished areas in formed metallic surface raceway systems using suitable factory fabricated fittings and devices as specified herein.
14. If work is installed before coordinating with all other trades and Owner's work, or so as to cause interference with the work of other trades, or so as not to provide proper access for maintenance or repair, make necessary changes in work to correct the condition at no cost to the Owner.

C. Excavation, Trenching, Backfilling

1. Mass excavation to required basic construction elevations will be performed under Division 31, EARTHWORK.
2. Provide all other excavation, trenching and backfilling including shoring, sheeting, pumping, grading, barricading and other related work necessary for installation of electrical work.
3. Perform work in accordance with the requirements of Division 31, EARTHWORK.

D. Cutting and Patching

1. Except where specified otherwise in Division 26, provide cutting, patching and refinishing work in accord with the requirements of Division 01, GENERAL REQUIREMENTS.
2. Horizontal chases shall not be cut into existing walls or partitions without approval of Architect.

E. Painting

1. Except where specified otherwise in Division 26, general painting will be provided under Division 09, FINISHES.
2. Touch up or paint out damage done to items having a factory applied finish, and which are installed under Division 26, utilizing materials and methods specified in Division 09. FINISHES.

F. Foundations

1. Provide concrete foundations required for the work specified under Division 26, unless specifically noted otherwise. Be responsible for preparing foundation drawings and setting foundation anchor bolts in time so as not to delay the work. Concrete foundations shall be of the types detailed or as specified.
2. Reinforce concrete foundations to suit the loads placed on them; foundations shall be in strict accordance with the equipment manufacturers' recommendations. Concrete materials and methods shall be as specified in Division 03, CONCRETE.
3. Unless otherwise indicated, concrete equipment pads shall be provided under all switchgear, switchboards, transformers, transfer switches, motor control centers, substations, etc., and shall extend a minimum 4 inches above the finished floor, at least 4 inches beyond the equipment base in all directions, shall have the top edges and vertical corners chamfered and shall have the same surface finish as the adjacent and surrounding floor.
4. Securely anchor concrete foundations to the floor slab with steel dowels. When so indicated or where required, concrete foundations or concrete footings for structural steel supports for equipment too heavy to be placed in the floor slab shall be extended not less than 12 inches below the underside of the floor slab, except where bearing rock is encountered at a lesser depth. In such cases, after inspection and approval, concrete foundations may be set on bearing rock.
5. Furnish and set, with proper templates, anchor bolts leveling steel rails and inserts required for the proper attachment of the equipment to the concrete foundations. Anchor bolts shall be of the size and number required by the equipment or as recommended by the equipment manufacturer and shall be in accordance with the requirements detailed or specified. Anchor bolts shall also be compatible with vibration isolation requirements specified for the equipment.
6. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve shall be the same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, completely fill the annular space between the anchor bolt and the inside of the pipe sleeve for the full length of the pipe sleeve with Embeco, or equivalent, nonshrink cement grout.
7. Grout any openings between the top of the concrete foundation and the base of the equipment using nonshrink cement grout.
8. Piles, pile caps and foundation beams for exterior underground duct banks and for equipment foundations will be furnished under the General Construction Divisions of the Specifications.

G. Access Doors and Panels

1. Coordinate requirements for access panels and doors for electrical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
2. Furnish access panels required under Division 26 for installation under the General Construction Sections.
3. Furnish access panels for access to concealed junction/pull boxes, cabinets, terminal boxes and other equipment where other means of access is not available. Access panels shall be adequate in size for the service requirements, and shall not have a clear opening of less than 16 inches x 16 inches. Final size and location of access panels shall be subject to approval of the Architect. Cooperate with other trades so that the equipment will be accessible through the access panels.

H. Sleeves, Fire-stops and Waterseals

1. Provide each raceway or cable passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe with smooth edges, securely and neatly cemented in place. Provide each raceway or cable passing through a wood or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.
2. Set floor sleeves flush with floor surface in finished areas; 1 inch above the finished floor in kitchens, cafeterias and similar service areas, mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Wall and partition sleeves shall be flush with each surface unless otherwise indicated or specified.
3. Sleeves shall be 2 pipe sizes larger than the conduit or cable size unless otherwise required by the sealing method selected by the Contractor for Division 07, THERMAL AND MOISTURE PROTECTION. Coordinate with the Contractor for that section to determine requirements for sleeves, clearances, etc. Remove sleeve if required by UL listing for system selected.
4. Place sleeves in concrete floor or wall forms before concrete is poured. Sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.
5. Insure proper location and alignment of all sleeves for electrical work before and during concrete placement.
6. Where sleeves penetrate exterior walls, fill and seal ends around conduits and/or cables with duct sealant compound equal to Solorite KN-1146, or Link Seal. Install seals in accordance with the manufacturer's recommendations to provide airtightness above ground and hydrostatic sealing below grade. Caulking or other type mastic is not acceptable.
7. Provide fire-stop systems in accordance with Division 07, THERMAL AND MOISTURE PROTECTION.

I. Flashing and Counterflashing:

1. For conduit penetrating built-up roofing membranes, provide a flashing fitting located approximately 1 foot above the roof and extend the conduit to the required height. Flashing fitting shall be J. R. Smith 1750 or equivalent. For sizes when manufactured fittings are not available, the flashing fitting shall consist of a drilled and threaded standard cast iron or malleable iron cap, galvanized, one size larger than conduit and screwed to form a

counterflashing or rainguard. Extend conduit through the cap and provide with a coupling for extension. Flashing under the Roofing Section will terminate at the flashing fitting. Apply two coats of asphalt base emulsion to the entire fitting and for a minimum of 6 inches up the conduit extension, to provide a completely weathertight installation.

3.2 PROTECTION OF WORK

A. Protect all conduit, fittings, panelboards, switchgear, transformers and other equipment before and during installation and keep clean.

B. Protect factory finished equipment, luminaires, panels, switchgear and devices with approved temporary protective material where these items are subject to accidental damage or abuse. Electrical equipment and switchgear shall be stored indoors or otherwise securely protected and kept free of condensation by adequate electric heat. Contractor shall remove all temporary protective material at the conclusion of the Work or as directed.

C. The Contractor shall assume full responsibility for the cost of repairing or replacing any damaged Work or material caused by employees working under this Division.

3.3 TESTS

A. Test equipment, including switchgear, motor starters, motors, panelboards and all other equipment to verify that items are free from unintended grounds, short circuits, and open circuits and that equipment will operate as specified. Test feeders for insulation resistance; for load balance of the final installation, and for overall operation of systems. Furnish labor and material required for making such tests and make corrections necessary to balance the load and to obtain proper operation.

B. Measure secondary voltages after energizing transformers and adjust transformer taps to provide rated voltages listed on drawings and/or specifications. After building is in use, measure these voltages during a period of "normal load" and "light load". Report results to Architect, who will advise Contractor whether or not further adjustment of voltages is required. Make changes as directed.

C. Test all wiring systems up to 600 volts, for insulation resistance with a megger in accordance with the NEC. Determine values with switchboards, panelboards, fuseholders, switches, receptacles and overcurrent devices in place.

D. Determine ampere rating of thermal overload relays in motor starters and compare with equipment nameplate and actual current measurement of the motor. If overload relays are found to be incorrect, provide proper size. Provide proper motor rotation.

E. Arrange for each system to be fully tested and adjusted by manufacturer or his authorized representative. Each element of each system shall be individually operated to insure that it will function as intended. Furnish all labor and material required to correct all defects.

F. Submit to the Architect a letter from manufacturer (or authorized representative) of each system, attesting to the fact that all necessary tests and adjustments have been made and that the entire system is functioning properly in every respect.

G. This article shall not be construed as deleting other tests specifically outlined in other sections of this Specification.

3.4 WORKMANSHIP

A. Electrical equipment shall be installed in a neat and workmanlike manner in accordance with latest and best practices of the trade.

B. Only mechanics skilled in this type of Work shall be employed and utilized by Contractor for this Division in the execution of this Work.

3.5 REFINISHING

A. All surfaces of boxes, cabinets and equipment shall have suitable lacquer, enamel or plated finishes. Touch up any finishes marred during construction. Supports and other metal work not furnished with a protective coating, shall be given two coats of approved paint after completion of the work.

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07, THERMAL AND MOISTURE PROTECTION.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07, THERMAL AND MOISTURE PROTECTION.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 INNERDUCT INSTALLATION

A. General

1. Provide innerduct for each fiber riser backbone cable as specified on the drawings.
2. All unused flexible non-metallic conduits shall be capped.
3. Innerduct quantity and diameter shall be as noted on the drawings.

B. Flexible Textile Fabric

1. Provide textile innerduct in conduit and wire ways and place textile innerduct within and under cable trays using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
2. Make a 2” incision approximately 18” from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape thus allowing the pull tape ends to retract back into the cells.
3. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.
4. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.

5. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
6. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.

    a. Design and install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
    b. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.
    c. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:

        1) Plenum areas: Plenum-rated plastic or stainless steel
        2) Non-plenum areas: Conventional flame-retardant nylon ties
        3) Underground locations: Conventional plastic cable ties.

3.9 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07, THERMAL AND MOISTURE PROTECTION.

B. Install all fire-rated cable pathways in accordance with manufacturer's recommendations.

3.10 CONTINUITY OF EXISTING SERVICES

A. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for same, coordinate with Architect, Owner and other sections, and obtain prior written clearance from Owner. Provide and place notices in affected areas, and on luminaires or equipment, etc., which will be temporarily out of use. Remove notices when interruption has been completed.

B. When Owner requires that work involving shutdown and interruption of existing facilities be performed on an overtime basis, Contractor shall pay all overtime costs.

3.11 DEMOLITION

A. Disconnect and cap existing DIVISION 26 services to demolished areas of existing and new building(s) as required. Cap services at points where directed by Contractor for Division 2, EXISTING CONDITIONS. Contractor for Division 2 will remove abandoned DIVISION 26 services between capped services and demolished areas.

3.12 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

A. Make all necessary alterations to existing DIVISION 26 systems to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether

indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.

B. Make all necessary alterations to existing DIVISION 26 systems to permit the installation of new DIVISION 23 equipment, i.e. ductwork and piping, to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.

C. Where equipment, ductwork and piping is removed or disconnected under DIVISION 26, perform the work in such a manner that no damage is done to the structure or remaining portions of the systems.

D. Remove exposed conduit, hangers and supports made obsolete due to this modification.

E. Where existing concealed conduit is not to be reused, abandon same in place unless otherwise indicated or specified.

F. Unless otherwise specified, all materials and equipment removed or disconnected by Contractor which are not to be reused shall become the property of Contractor and be removed from premises.

G. Where excavation for new electrical work disturbs support of any existing underground services, materials, equipment and structures, provide new and suitable concrete and steel supports as required. Review supports and supporting methods with Architect before beginning work.

H. Where items in above mentioned schedule have electrical services and are "removed" or "removed and reset" by the Contractor for another Division, the Contractor for DIVISION 26 shall disconnect electrical services from items at their present locations and if item is to be "reset", provide new electrical connections as indicated at new locations.

I. Where items in above mentioned schedule have electrical services and are "removed" or "removed and reset" by the Contractor for another Division, the Contractor for DIVISION 26 shall disconnect electrical services from items at their present locations and if item is to be "reset", provide new electrical connections as indicated at new locations.

J. Where items in above mentioned schedule are to be "removed" or "removed and reset" by the Contractor for DIVISION 26 and where any other items of electrical equipment, sterilizing equipment, etc., are not to be reused in their present locations, the Contractor for DIVISION 26 shall disconnect and remove the items and all associated supports, brackets, hangers, etc. Where equipment removed by the Contractor for DIVISION 26 is to be relocated and reused, the Contractor for DIVISION 26 shall store and protect equipment after removal, reinstall equipment in new locations and make all necessary electrical connections thereto.

K. Where hospital sterilizing, service room and pantry equipment removed by the Contractor for DIVISION 26 is not to be reused, place same in storage on premises where directed by Owner.

3.13 COMMISSIONING

A. Commissioning will be provided as specified in Division 01 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 01 Section "Commissioning".

B. Ensure participation of major equipment manufacturers or their representatives.

C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

END OF SECTION 26 05 00

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related sections include the following:

1. Division 26 Section “Common Material and Methods for Electrical”
2. Division 26 Section “Identification for Electrical Systems”

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. NETA: International Electrical Testing Association.

D. NRTL: Nationally Recognized Testing Laboratory.

E. Homerun: The circuit conductors between the branch circuit outlet and/or device and the panel board over current protective device.

F. VFD: Variable Frequency Drive or Variable Frequency motor Speed Controller (VFD)

G. Wet Location: The interior of enclosures or raceways installed underground or outside of a building’s waterproofing shall be considered to be a wet location.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Coordinate wall and floor penetrations with appropriate UL listed fire stopping systems.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. 600V Insulated Building Wire

a. Alpha Wire Corp.
b. General Cable Technologies Corporation
c. Anixter
d. Southwire Company
e. Encore Wire Corporation
f. The Okonite Company

2. 600V Insulated Metallic Clad Cable: Metal-Clad, Type MC.

a. AFC Cable Systems Inc.
b. Aetna Insulated Wire
c. Southwire Company
d. Kaf Tech Inc.

3. Fire-Resistive Cable Systems (FHIT)

a. Pentair/Pyroteuax System 1850 MI
b. RSCC Wire and Cable, LLC/VITALink

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Types THW-2, THHN-2-THWN-2, XHHW-2, UF, USE and SO.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC.

E. Multiconductor Cable Sheathing: Aluminum or steel.

F. Fire-Resistive Cable Systems (FHIT): Comply with UL 2196, 2-hour fire-resistance copper 600 Volt mineral-insulated, metal-sheath cable, Type MI.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC
4. 3M Company
5. Ideal Industries, Inc.
6. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, unless otherwise indicated.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in metal raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in metal raceway; Metal-clad cable, Type MC.

D. Feeders Concealed in Concrete and below Slabs-on-Grade: Type THHN-2 THWN-2, single conductors in raceway.

E. Feeders in Wet Locations (See Definition in Article 1.3): Type THHN-2-THWN-2, single conductors in metal raceway; Metal-clad cable, Type MC.

F. Normal Power and Lighting Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in metal raceway; Metal-clad cable, Type MC.

G. Branch Circuits in Wet Locations (See definition in Article 1.3): Type THHN-2-THWN-2, single conductors in metal raceway; Metal-clad cable, Type MC.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-2-THWN-2, in raceway.

J. Class 2 Control Circuits: Type THHN-2-THWN-2, in raceway.

K. VFD Output Circuits: Type THHN-2-THWN-2, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Division 26, Section “Raceways and Boxes for Electrical Systems” prior to pulling conductors and cables through raceways.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

H. Where specifically shown or where approved by the Architect, install exposed branch circuit wiring in finished areas in formed metallic surface raceway systems using suitable factory fabricated fittings and devices as specified herein.

I. Multi-wire branch circuits will not be allowed. A separate neutral conductor shall be provided for each branch circuit.

J. The continuity of a neutral conductor shall not be dependent upon device and luminaire connections, where removal of such device would interrupt the continuity of circuit.

K. All conductors of a parallel feeder shall be of the same length.

L. Lace or clip groups of conductors at lighting and distribution panels, pull boxes and wireways.

M. Where permitted install armored and/or metal-clad cable per requirements of NEC and support at each junction box. Support only from building structure. Provide an additional three feet of cable at each luminaire and support excess cable only from structure; do not lay on ceiling tiles or attach to any other support systems.

N. Protect metal-clad cable from physical damage where necessary by conduit, pipe, guard strips or other approved means.

O. Where groups of metal-clad cables extend from collector troughs, pull boxes or the like, secure and assemble them in an orderly manner on vertical cable tray or channel ladders.

P. MC cable shall be secured in place at intervals not exceeding 4-1/2 feet and within 12 inches of every outlet box, junction box, cabinet, or fitting.

Q. Not more than 4 metal-clad cables shall be grouped or bundled together throughout the installation.

R. MC cable shall not be used for branch circuit homeruns. Collect branch circuit MC cables in junction boxes located in nearest accessible ceiling spaces and extend branch circuit homeruns in metal raceway to panelboards.

S. Insulated conductors and cables installed in underground enclosures or raceways shall be listed for use in wet locations and shall comply with NEC Article 310.10(C). Any connections or splices in an underground installation shall be approved for wet locations.

T. Wireways and junction boxes shall <u>not</u> be used for routing and/or splicing of branch circuit, power and control wiring in excess of thirty current carrying conductors.

U. Do not install conduits and cables in the cell of the metal deck above bar joists or other structural member.

V. For branch circuits a maximum of six current carrying conductors shall be permitted to be installed in a raceway.

W. The smallest size conductors permitted are:

1. Lighting and Power Branch Circuits - No. 12 AWG

2. Control Circuits - No. 14 AWG
3. Luminaires (Pig Tails) - No. 16 AWG
4. Fire Alarm System - No. 14 AWG
5. Branch circuits rated 20 amperes, 120 volts and longer than 100 circuit feet from panelboard shall be #10 AWG.
6. Branch circuits rated 20 amperes, 277 volts and longer than 150 circuit feet from panelboard shall be #10 AWG.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color code conductors and cables according to Division 26, Section “Identification for Electrical Systems.”

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26, Section “Common Materials and Methods for Electrical”

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 26, Section "Common Materials and Methods for Electrical" and Division 7, Section "Firestopping."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Test all conductors and cables to verify that no short circuits or accidental grounds exist.

2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, per inspection and test procedures Section 7.3.2 as stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Cables will be considered defective if they do not pass tests and inspections. Perform corrective action, including replacement and retest.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding
2. Common ground bonding
3. Panelboard bonding

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells
2. Ground rods
3. Ground rings
4. Grounding arrangements and connections for separately derived systems

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rod, ground rings, grounding for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Equipment grounding conductor insulation color shall be continuous green, except for wire sizes No. 4 AWG and larger which shall be identified per NEC.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B3
2. Stranded Conductors: ASTM B8
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding and Grounding Conductor: Unless otherwise indicated on the drawings, use No. 4 or No. 6 AWG minimum, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

D. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn solid copper.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

E. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8 by 96 inches in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.

1. Bury at least 24 inches below grade

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, connect horizontal buses with No. 4/0 AWG bare copper over doorway at right angles. Bond metal door frames to horizontal buses or No. 4/0 AWG conductor.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Exothermic-welding connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Compression or welded connectors.
4. Connections to Structural Steel: Exothermic-welding connectors.
5. Test Wells: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductor's level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Pad-Mounted Transformers and Switches: Unless otherwise indicated, install minimum of four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bond concrete pad rebar to ground ring with tinned-copper conductor not less than No. 2 AWG. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated copper equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated copper equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated copper equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 6 AWG minimum unless indicated otherwise on the drawings, insulated copper grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a grounding bus as indicated on the drawings and Specification Section 27 11 00.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor for each pole in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in non-metallic conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least twenty (20) feet from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven in open bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductor(s), in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductor(s) to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas or other metal piping system downstream from equipment shutoff valve to the service equipment ground bus or grounding electrode bus.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install copper grounding conductor at the steel column closest to the electrical service equipment or grounding electrode system to the ground bus or grounding electrode system as indicated.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building foundation.

J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s)

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems
2. Construction requirements for concrete bases

B. Related Sections include the following:

1. Division 26 Section "Vibration and Seismic Restraints for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing

B. IMC: Intermediate metal conduit

C. RMC: Rigid metal conduit

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems
2. Nonmetallic slotted support systems

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit
b. Cooper B-Line, Inc.; a division of Cooper Industries
c. ERICO International Corporation
d. GS Metals Corp.
e. Thomas & Betts Corporation

f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit
b. Cooper B-Line, Inc.; a division of Cooper Industries
c. Fabco Plastics Wholesale Limited
d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit

2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti, Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.
8. Plastic Nylon Ties: Not acceptable.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by the NEC. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: For horizontal pendent installation, install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits. For vertical surface installation, install steel slotted support system anchored to structural wall system for the entire length of run.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT REQUIREMENTS

A. General

1. Provide materials, equipment, supplies and labor necessary as required to adequately support, brace and strengthen all equipment and materials furnished as part of this work.
2. Materials, equipment, apparatus supports and mounting hardware shall be approved for use in the location installed. For example, use electroplated galvanized, hot dipped galvanized, epoxy coated, PVC coated, stainless steel or aluminum in wet/outdoor locations.

B. Attachment to Building Structure

1. Light fixtures, raceways, boxes, cable trays, wireways, and other utilities shall not be supported by roof deck.
2. Light fixtures, raceways, boxes, cable trays, wireways may be suspended from floor deck provided the attachment is designed and supplied by the Contractor.
3. Transformers, switches, starters, apparatus, or any group of conduits in excess of 100 pounds shall not be supported by floor deck, regardless of concrete thickness above steel deck.
4. Transformers, switches, starters, apparatus, or any group of conduits in excess of 100 pounds shall not be suspended by concrete roof or floor slabs unless specifically shown on the contract drawings.
5. Whenever possible, support shall be provided directly to the main steel or concrete framing beams. If spacing of structure exceeds the spacing required to sufficiently support the electrical work, supplemental steel member or steel channel shall be designed and provided by the Contractor.
6. Support all Electrical work independently of any other trades. Under no circumstances shall work be supported or suspended from ceiling grids, ductwork, piping, or other supports for other trades.
7. Before drilling concrete for attachments, carefully check Drawings and Shop Drawings for such concrete and locate drilled holes to miss reinforcing by at least 1 inch.
8. Inserts in precast concrete to support Work of Division 26 will be furnished and installed by precast concrete supplier. Prepare drawings locating such inserts for review by Architect before distribution.

3.3 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Install steel slotted channel-racks to finish wall anchored and fastened to structural floor and ceiling, and wall were crossing structural members. Anchor and fasten electrical items to the steel slotted support system. The steel slotted channel-racks shall be anchored and fastened by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Structural Steel: Beam clamps, angle clips welded or powder-driven studs.
6. Exterior: Anchors, screws, bolts, etc., exposed to weather and corrosion shall be rustproof finished or nonferrous material.
7. Adhesive Anchors: The use of adhesive anchors is prohibited.
8. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
9. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
10. To Light Steel: Sheet metal screws.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

A. Unless otherwise indicated, construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing

B. ENT: Electrical nonmetallic tubing

C. EPDM: Ethylene-propylene-diene terpolymer rubber

D. FMC: Flexible metal conduit

E. IMC: Intermediate metal conduit

F. LFMC: Liquidtight flexible metal conduit

G. LFNC: Liquidtight flexible nonmetallic conduit

H. NBR: Acrylonitrile-butadiene rubber

I. RNC: Rigid nonmetallic conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, conduits, wireways and fittings, boxes, enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

    a. Duct entry provisions, including locations and duct sizes
    b. Frame and cover design
    c. Grounding details
    d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons
    e. Joint details

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex
7. Maverick Tube Corporation
8. O-Z Gedney; a unit of General Signal
9. Wheatland Tube Company

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1
2. Coating Thickness: 0.040 inch, minimum

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
4. Fittings, couplings and connectors in general shall be of the same material as the conduit to which applied. Die cast fittings are not acceptable.
5. Fittings and couplings for use with rigid and intermediate metal conduit shall be threaded type.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose
3. Arnco Corporation
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Heritage Plastics
10. Lamson & Sessions; Carlon Electrical Products
11. Manhattan/CDT/Cole-Flex
12. RACO; a Hubbell Company
13. Thomas & Betts Corporation

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Arnco Corporation
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products

B. Description: Comply with UL 2024; flexible type, approved for installation.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman
3. Square D; Schneider Electric

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hoffman
2. Lamson & Sessions; Carlon Electrical Products

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Thomas & Betts Corporation
b. Walker Systems, Inc.; Wiremold Company (The)
c. Wiremold Company (The); Electrical Sales Division

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Butler Manufacturing Company; Walker Division

b. Enduro Systems, Inc.; Composite Products Division
c. Hubbell Incorporated; Wiring Device-Kellems Division
d. Lamson & Sessions; Carlon Electrical Products
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The)
g. Wiremold Company (The); Electrical Sales Division

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric
3. Erickson Electrical Equipment Company
4. Hoffman
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
6. O-Z/Gedney; a unit of General Signal
7. RACO; a Hubbell Company
8. Robroy Industries, Inc.; Enclosure Division
9. Scott Fetzer Co.; Adalet Division
10. Spring City Electrical Manufacturing Company
11. Thomas & Betts Corporation
12. Walker Systems, Inc.; Wiremold Company (The)
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Interior Sheet Metal Outlet and Device Boxes: NEMA OS1.

1. General: Provide pressed galvanized sheet steel boxes with knockouts to suit raceway system to be used. Supports shall also be galvanized steel.
2. Ceiling: Provide flush, 4 inch, octagonal boxes not less than 1-1/2 inches deep with 4 knockouts. Provide 3/8 inch luminaire studs where required. Surface, 4 inch, square boxes not less than 1-1/2 inches deep.
3. Walls: Provide flush 4 inch boxes not less than 2 inches deep with matching plaster ring for single or 2 gang outlets. For larger boxes use 1-piece construction to suit application. In masonry use deep boxes with square corners so masonry units will fit closely to box.
4. Do not use sectional or handy boxes unless specifically noted

C. Exterior Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with threaded hubs sized for conduit to be used, deep type, covers fitted with gaskets.

D. Communication Outlet and Device Boxes:

1. Unless noted otherwise, all communication outlet and devices boxes shall comply with paragraph titled “Sheet Metal Outlet and Device Boxes” above.

E. Nonmetallic Outlet and Device Boxes: Not allowed.

F. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

G. Nonmetallic Floor Boxes: Nonadjustable, round.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

J. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

K. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer in the state of the project location shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit for Lighting and Branch Circuits: RNC, Type EPC-Schedule 80-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed in Unfinished Areas, Not Subject to Physical Damage: EMT.
2. Exposed in Unfinished Areas and Subject to Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

    a. Loading dock
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units
    c. Mechanical rooms
    d. Boiler rooms
    e. Warehouses
    f. Shipping and receiving areas
    g. Fire pump rooms

3. Exposed in finished areas; Formed metallic surface raceway systems using suitable factory fabricated fittings and devices.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
11. All Raceways Used for Medium Voltage (Above 600V) Wiring Installed in Buildings or Outside (Above Grade): Rigid steel conduit.
12. Exposed to Corrosive Environment: PVC coated rigid steel conduit.

C. Minimum Raceway Size: 3/4-inch trade size for power; 1-inch trade size for all communications and security outlets; 1-1/4-inch trade size for all TV/AV outlets.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. Use UL approved expansion fittings complete with grounding jumpers where conduits cross building expansion and expansion/seismic joints. Install bends or offsets in conduit adjacent to building expansion and expansion/seismic joints where conduit is installed above suspended ceilings.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3.2 RACEWAY INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, including walls of unfinished spaces, unless otherwise indicated.

H. Raceways below slab on grade:

1. Install RNC (Type EPC-40 PVC), rigid steel conduit or IMC.
2. Before rising above the floor slab, conduit elbows and stub ups shall be RNC (Type EPC-80 PVC), rigid steel conduit or IMC.
3. Conduits shall be located below the vapor barrier. Conduit penetrations through the vapor barrier shall be sealed in accordance with the barrier manufacturers recommendations.

I. Do not install conduits in concrete floor slabs.

1. Maximum embedded conduit size shall be 1” nominal.
2. Embedded conduit shall be galvanized rigid steel.
3. Minimum center to center spacing of conduit shall be 6 inches. Conduit runs with multiple conduits spaced 6 inches on center must maintain that spacing until they exit the slab – reduced spacing between conduits as they approach the slab turn out will not be permitted.

4. Embedded conduit shall be placed within the middle third of the concrete section. A maximum of two layers of conduits running in opposing directions shall be permitted within this section.
5. A minimum of 1 inch of concrete shall be maintained between the face of rebar and the face of conduit.
6. Embedded conduit will not be permitted in columns or shear walls, and at shear stud rail locations.
7. Run conduits parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

M. Raceways for Optical Fiber and Communications Cable: Provide raceways, metallic and nonmetallic, rigid and flexible, as previously indicated herein with minimum size to be 1-inch (25mm) or larger as noted on drawings.

1. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

O. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

P. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Q. Flexible metal conduit shall be secured in place at intervals not exceeding 4-1/2 feet and within 12 inches of every outlet box, junction box, cabinet or fitting.

R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

S. Set metal floor boxes level and flush with finished floor surface.

T. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

U. Communication, Security, TV and AV Outlets: Unless otherwise noted, electrical contractor shall provide conduit with pullcord from outlet/junction box to cable tray for all outlets shown on Electrical, IT, AV and Security Drawings.

3.3 BOX INSTALLATION

A. Mount outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above removable ceilings. Secure firmly in place and set true and square with finished surfaces. Provide raised covers for boxes as required to suit the wall or ceiling, construction, and finish.

B. Do not fasten boxes to ceiling support wires or other piping systems.

C. Install pull and junction boxes above accessible ceilings and in unfinished areas only.

D. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire. Note: Removable luminaires can only be considered an access point for pull and splice boxes (housing no active components nor devices requiring routine maintenance or repair).

E. Locate flush mounted boxes in masonry walls so that only a corner need be cut from masonry units. Coordinate masonry cutting to achieve neat opening.

F. Do not install flush mounted boxes back to back within the same wall; Install with minimum 6 inch separation. For acoustic rated walls, boxes shall be separated by at least one stud and a minimum 12 inch separation.

G. Do not use two-gang and multi-gang boxes in such a manner that one section contains a switch or receptacle circuit or combination of such circuits operating at more than 277V.

H. For boxes mounted in exterior walls install insulation behind outlet boxes to prevent condensation in boxes and air movement. Install boxes without damaging wall insulation or reducing its effectiveness.

I. All boxes shall be provided with a far side support bracket to prevent movement.

J. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.

K. Support boxes independently of conduit.

L. Install stamped steel bridges to fasten flush mounted outlet boxes between studs.

M. Install adjustable steel channel fasteners for hung ceiling outlet boxes.

N. Fire-resistance-rated walls and ceilings; Device outlet boxes shall only penetrate one face of a fire-resistance-rated assembly. Steel electrical boxes shall not exceed 16 square inches (i.e. a typical 4” x 4” outlet box), and the sum of such penetrations shall not exceed 100 square inches within 100 square feet of wall or ceiling space. Additionally, electrical boxes on opposite sides of the walls must either be separated by a distance of 24 inches, by a distance not less than the depth of a wall cavity when filled with insulation, by solid fireblocking, by listed putty pads, or by other approved listed materials and methods. Contractor can utilize a shallow (4” x 4” x 1 ½”) depth box to meet the above criteria if; volume of the box meets the minimum conductor fill requirements of the NEC and box is of sufficient depth to accommodate the device and terminations.

O. Clean Room and Biohazard Laboratory Sealing Requirements:

1. Seal completely all penetrations of device outlet boxes, backboxes and conduit through any surface.
2. Seal completely all penetrations of device outlet boxes, backboxes and conduit through above ceiling full height partitions.
3. Seal completely the perimeter of all luminaires and devices, including faceplates and covers, applied to any surface.
4. Seal completely the perimeter of all access doors or panels in any surface.

3.4 UNDERGROUND CONDUIT INSTALLATION

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Tape: Bury warning tapes approximately 12 inches above direct-buried conduits. Refer to Standard Details where applicable.

3.5 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND STRUCTURES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes
2. Cover design
3. Grounding details
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. All drawings shall be submitted for review and approval prior to commencement of work.

E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Construction Manager no fewer than 14 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other new and existing utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

A. Furnish cable-support stanchions, arms, insulators and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings of same material as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products
10. Manhattan/CDT; a division of Cable Design Technologies
11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct:

1. NEMA TC 6 & 8, Type EB-60-PVC and Type DB-80-PVC, ASTM F512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. All active and spare underground power and communication ducts leaving manholes and entering building foundation walls and floor slabs shall be provided with an inflatable bladder as manufactured by Tyco-Raychem, Product No. RDSS. Refer to manufacturer's recommendations for bladder size and installation methods.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AC Miller
2. Carder Concrete Products
3. Hanson, Heidelberg Cement Group
4. Oldcastle Precast Group
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC
7. Utility Vault Co.

B. Comply with ASTM C858 for design and manufacturing processes, with structural design loading as specified in Part 3, "Underground Enclosure Application" Article and with interlocking mating sections, complete accessories, hardware and features.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC" or “COMMUNICATION”.
4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension shall provide increased depth of 12 inches.
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color:

    a. Gray for other than in lawns.
    b. Green for lawn installations.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATION."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armorcast Products Company
    b. Carson Industries LLC
    c. CDR Systems Corporation
    d. NewBasis
    e. Quazite

2.5 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AC Miller
2. Carder Concrete Products
3. Christy Concrete Products
4. Elmhurst-Chicago Stone Co.
5. Oldcastle Precast Group
6. Riverton Concrete Products; a division of Cretex Companies, Inc.
7. Utility Concrete Products, LLC
8. Utility Vault Co.

B. Comply with ASTM C858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.7 UTILITY STRUCTURE ACCESSORIES

A. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.

    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
    c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.

B. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.

E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

I. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

A. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

B. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in concrete-encased duct bank, unless otherwise indicated.

E. Underground Ducts Crossing Driveways, Roadways and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Detectable Underground Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally. Warning tape shall be traceable type with embedded wire or foil permitting such tape to be detected above surface at its indicated depth.

E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."

G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

H. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or

reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
7. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.

4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Install handholes with bottom below the frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing and/or ThermoplasticSheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

A. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 48 - VIBRATION AND SEISMIC RESTRAINTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.
8. Vibration control devices, accessories, materials and related items for new and altered equipment and raceways as may be required to prevent the transmission of vibration to the building structure.
9. Seismic control devices, accessories, materials and related items for new and altered equipment and raceways as may be required to keep all components in place during a seismic event and operational where this specification so requires.
10. Certification of seismic analysis, design and installation.

B. Related Sections include the following:

1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

C. It is the intent of this specification to provide the basis of seismic design for providing seismic restraints for every system within the building, including equipment and raceways as specified herein.

D. Provide the following:

1. Seismic restraints for vibration isolated equipment such as motor-generators and transformers.
2. Seismic restraints for unisolated equipment raceways and cable tray.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. Raceway or raceways as referred to in this section of the specifications and by other sections in Division 26 to this section, shall mean any one and all of the following types as applicable to project: rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, surface metal raceways, wireways, busways and cable trays.

D. Failure: For the purpose of this project, is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 0.125 inch and/or horizontal permanent deformation greater than 0.250 inch.

E. Isolation Manufacturer: For the purpose of this project, manufacturer of vibration isolation and seismic restraint equipment.

F. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the raceway.

G. Positive Attachment: A cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps and power shots for support rods of piping, ductwork, or any other equipment are not acceptable on this project as positive attachment.

H. Restraint: Device(s) intended to keep component in place during a seismic event.

I. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the raceway.

J. High Hazard Systems

1. Systems conveying material that is either toxic or potentially explosive and in significant quantity could pose a threat to the general public.
2. Fuel oil, natural gas, propane, compressed air, high pressure steam or any piping containing flammable, combustible, toxic or corrosive material.

K. Life Safety Systems:

1. Emergency power systems as defined by the National Electric Code, NFPA 70, section 700.

L. Refer to ASCE 7, Section 9 for additional definitions of items related to seismic restraints.

1.4 REFERENCES

A. ASCE 7 American Society of Civil Engineers, latest edition.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading: Refer to the structural drawings and specifications for project specific seismic design components and factors.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Complete description of products to be supplied showing compliance with the specifications, including product data, dimension, specifications and installation instructions.

    a. A list of equipment and raceways that is not vibration isolated, but which is to be seismically restrained.
    b. Seismic Restraint Product Data and Shop Drawings:

        1) Drawings showing number and location of seismic restraints and anchors for each piece of equipment.
        2) Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and for raceway locations.
        3) Method and details for vertical restraints.
        4) Magnitude of seismic restraint force, structural stress condition and direction of seismic force at structural members for only those locations that produce an overstressed condition of the building structural member.

    c. Special details necessary to convey complete understanding of work to be performed.

2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

    a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
    b. Seismic calculations with professional engineer's stamp and signature separately from isolation product data and shop drawings for record purposes only. The

Architect will not review the seismic calculations. Professional engineer shall be registered in the same jurisdiction as project. Calculations are provided for owner's record purposes only and shall not be included with the submittal.

3. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
4. Field-fabricated supports.
5. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For professional engineer and testing agency.

F. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. It is the objective of this specification to provide the design for seismic restraint for the electrical systems. All seismic restraints shall be designed and furnished by a single manufacturer or his authorized representative, who shall be responsible for coordination of all phases of the work

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

C. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Comply with NEC.

F. Vibration isolators of appropriate sizes and proper loading are provided with the appropriate isolated equipment such as vibration isolators for emergency generator set. Coordinate seismic restraints with each isolated equipment so as not to affect performance of the vibration isolation.

G. Make certain that seismic restraints do not short circuit the isolation system and that the isolation system is unrestrained.

H. Quality assurance shall comply with the IBC.

I. Contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, or component listed in the quality assurance plan shall submit a written contractor's statement of responsibility to the building official and to the Owner prior to the commencement of work on the system or component. The Contractor’s statement of responsibility shall contain the following:

1. Acknowledgement of awareness of the special requirements contained in the quality assurance plan.
2. Acknowledgement that control will be exercised to obtain conformance with the construction documents approved by the building officials.
3. Procedures for exercising control within the Contractor's organization, the method and frequency of reporting and the distribution of the reports.
4. Identification and qualifications of the person(s) exercising such control and their position(s) in the organization.

J. Owner will retain and pay for services of a qualified structural/seismic engineering consultant to inspect and certify seismic restraint and equipment installation where special inspections are required by the applicable codes. The Contractor shall notify the Owner of all special inspection requirements included in the quality assurance plan. Special inspection reports shall be submitted to the Architect, seismic engineer, Owner and Contractor for record purposes. Evidence of the quality control program shall be permanently identified on each piece of equipment by label.

1. Equipment using combustible energy sources.
2. Electrical motors, transformers, switchgear, substations and motor control center.
3. Reciprocating and rotating type machinery.

1.8 DESIGN REQUIREMENTS

A. Refer to Section 260500 for seismic design requirements.

B. Design of seismic restraints shall be in compliance with Section 9.6 of ASCE 7 as modified by the IBC.

C. Design seismic components according to the IBC as described below. All electrical components and elements permanently attached to structures including supporting structures and attachments (hereinafter referred to as "components") shall be designed and constructed to resist the equivalent static forces and displacements determined in accordance with the IBC. The design and evaluation of support structures and equipment shall consider their flexibility as well as their strength. For the purpose of this section, components shall be considered to have the same Seismic Design Category as that of the structure that they occupy or to which they are attached unless otherwise noted in the IBC. The following components are exempt from the requirements of the IBC:

1. Electrical components in Seismic Design Categories A and B.
2. Electrical components in structures assigned to Seismic Design Category C provided that importance factor (I_p) is equal to 1.0.
3. Electrical components in Seismic Design Categories D, E and F where I_p = 1.0 and flexible connections between the components and associated conduit are provided and that are mounted at four feet or less above a floor level and weigh 400 lbs.
4. Electrical components in Seismic Design Categories D, E and F weighing 20 lbs. or less where I_p = 1.0 and flexible connections between the components and associated conduit are provided or for distribution system weighing 5 lbs./ft. or less.
5. The functional and physical interrelations of components and their effect on each other shall be designed so that the failure of an essential or nonessential architectural, mechanical, or electrical component shall not cause the failure of a nearly essential architectural, mechanical or electrical component.

1.9 MANUFACTURER'S RESPONSIBILITIES

A. Manufacturer of seismic control equipment shall have the following responsibilities:

1. Determine seismic restraint sizes and locations.
2. Furnish seismic restraints as scheduled or specified.
3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
4. Provide certification of seismic restraints and attachments capability to safely accept loads resulting from seismic forces determined by methods defined above. Certification must be substantiated by calculations or test reports verified by a licensed engineer.
5. Advise Contractor of special size and anchor bolt requirements for foundations and housekeeping pads to develop strength equal to that for which the seismic restraints are designed to resist.
6. The licensed engineer employed by the contractor to perform seismic calculations shall be responsible to check the structural members of the building for localized stress at points of attachment for seismic restraint. The engineer shall submit to the Architect, the magnitude of seismic restraint force and include direction on shop drawings, together with computation of stress conditions at localized attachments only in the event that an overstressed condition is determined by the engineer. The Architect will review only such identified locations for additional bracing or reinforcing at these localized conditions.

B. Manufacturers of electrical equipment and systems shall be responsible for design and manufacture of their equipment to safely resist and accept earthquake generated external forces as mentioned herein. Seismic supports and anchorage locations shall be provided and indicated in equipment installation manuals just as are lifting and weight supporting elements.

1.10 SEISMIC ENGINEER'S RESPONSIBILITIES

A. Seismic Engineer retained by Electrical Contractor(s) shall have the following responsibilities:

1. Seismic calculations, seismic analysis and design certification.
2. Development of a seismic restraint quality assurance plan when required by the applicable building code.
3. Identification of any overstressed conditions and notification to Architect of overstressed conditions.
4. Review of seismic restraint manufacturer's component certifications.
5. Development of special inspection requirements for this project as required by applicable codes and standards.
6. Shop drawing review and certification of compliance with seismic analysis and design.
7. Provide calculations to determine restraint loads resulting from seismic forces presented in governing codes and project seismic requirements; with a minimum seismic acceleration applied at the equipment center of mass as specified in the DESIGN REQUIREMENTS Article in Part 1 of this section. Seismic calculations shall be certified by a licensed engineer, experienced in the design of seismic restraints. Submit calculations with professional engineer's stamp and signature to Owner for record purposes.
8. Check the structural members of the building for localized stress at points of attachment for seismic restraint. The engineer shall provide to the architect the magnitude of seismic restraint force and include direction on shop drawings, together with computation of stress conditions at localized attachments only in the event that an overstressed condition is determined by the engineer. The engineer shall certify that the architect has been advised of all overstressed condition information. The architect will review only such identified locations for additional bracing or reinforcing at these localized conditions.

1.11 COORDINATION

A. Coordinate work with other trades to avoid having isolated systems coming in contact with the building. Inform other trades following this work to avoid causing any contact which would reduce the vibration isolation.

B. Coordinate size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pad.

C. Bring to the Architect's attention prior to installation any conflicts with other trades which will result in unavoidable contact to the equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the Contractor's expense.

D. Bring to the Architect's attention any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

1.12 INSPECTION AND INSTRUCTION

A. Notify the isolation manufacturer's representative prior to the general installation of vibration isolation devices and seismic restraints so that the isolation manufacturer's representative can instruct and demonstrate the proper installation procedures with the Contractor's foremen.

B. Obtain written and/or oral instructions from the isolation manufacturer's representative as to the proper installation and adjustment of vibration isolation devices and seismic restraints.

C. Obtain inspection and approval from the isolation manufacturer's representative of the completed installation. Perform all work and make all adjustments as directed by the isolation manufacturer's representative as a result of the inspection.

D. Obtain inspection and approval from the isolation manufacturer's representative, and perform all directed work and adjustments, of any installation to be covered or enclosed prior to such closure.

E. Where special inspection and periodic special inspection of seismic restraints is required by the referenced building code, Contractor must submit a written statement of responsibility as part of the Quality Assurance Program including identification of components, control procedures for all inspection and testing including frequency and method of reporting, and list of qualified personnel responsible for certifying seismic restraints.

F. The following systems require special inspection and periodic special inspection for anchorage during the course of construction:

1. Electrical Components of Standby or Emergency Generator: Periodic.
2. All flammable combustible and highly toxic and associated systems: Periodic.
3. Equipment Using Toxic or Combustible Energy Sources: Special.
4. Reciprocating and Rotary Machinery: Special.
5. Conduit larger than 3 Inches: Special.
6. Tanks: Special.
7. Isolator Units for Seismic Isolation System: Periodic.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Kinetics Noise Control
4. Mason Industries
5. Vibration Eliminator Co., Inc.
6. Vibration Mountings & Controls,Inc.

D. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.; a division of Cooper Industries
4. Hilti Inc.
5. Mason Industries
6. Unistrut; Tyco International, Ltd.

D. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Restraints shall be capable of safely accepting external forces specified without failure, shall maintain electrical systems and accessories in a captive position, and shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

2. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

3. Systems that incorporate vibration isolation support within seismic restraint housing are not permitted. Seismic restraints must be separate from isolation mounts.

E. Type I Restraint

1. All directional, double acting seismic snubber consisting of interlocking steel members restrained by shock absorbent elastomeric material compounded to bridge bearing specifications as required.
2. Elastomeric bushing shall be replaceable and a minimum of 3/4 inch thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.
3. The snubber shall be constructed to allow easy inspection of snubber internal clearances.
4. The elastomeric bushing shall be capable of rotation to verify that no short circuiting of the vibration isolator exists.

F. Type II Restraint

1. Cable type system consisting of steel cable and end fastening devices.
2. The cable size and attachment to the suspended item and structure shall be designed by a licensed engineer.
3. Submittal drawing shall indicate method of vertical restraint.

G. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

H. Restraint Cables: ASTM A603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

I. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

J. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

K. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

L. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

M. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

N. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Bring to the Architect's attention any discrepancies between the specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

D. Coordinate work with electrical equipment and systems furnished under other sections of Division 26, Related Work, and with other trades to avoid inadequate space, etc., for mounting and supporting seismic restraints. Corrective work necessitated by conflicts after equipment installation shall be at the Contractor's expense.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Notify the seismic restraint manufacturer's representative prior to the general installation of seismic restraints so that the manufacturer's representative can instruct and demonstrate the proper installation procedures with the Contractor's foremen.

G. Obtain written and/or oral instructions from the seismic restraint manufacturer's representative as to the proper installation and adjustment of seismic restraints.

H. Obtain inspection and approval from the seismic restraint manufacturer's representative of any installation to be covered or enclosed prior to its concealment.

I. Obtain inspection and approval from the seismic restraint manufacturer's representative of the completed installation and submit certified statement of approval to the Owner.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

D. Seismically restrain in all directions the complete new and altered electrical equipment and raceways as required in this section, per the IBC. Seismic restraints for ceiling mounted lighting luminaires are specified in Division 26, Lighting.

E. Isolated Equipment

1. The static deflections of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

2. Floor Mounted Isolated Equipment: Provide a minimum of four Type I restraints located as close to the vibration isolator as possible to facilitate attachment to the base and the structure. For equipment with high center of gravity, provide additional Type II restraints connected above center of gravity, as required, to limit forces and motion caused by rocking.
3. Suspended Isolated Equipment: Provide minimum four point Type II restraints. Provide upstop snubbers for vibration isolators and suspension rod stiffener angles or pipe sleeves as required.

F. Rigidly Mounted Equipment: Restrain by properly sized anchor bolts or hanger rods and bracing and, if required, by additional Type I and Type II seismic restraints. The need for additional restraints shall be determined by the seismic restraint manufacturer.

G. Rigidly Mounted Raceways: Provide Type II restraints at locations as determined by the seismic restraint manufacturer including, but not limited to the following locations:

1. On runs of conduit.
2. On runs of busway not to exceed a spacing as determined by busway manufacturer.
3. On runs of cable tray not to exceed a spacing as determined by cable tray manufacturer.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Install restraints in accordance with the manufacturer's written instructions and the verbal instructions of his authorized representative.

B. Shim snubbers as required to achieve and maintain clearance.

C. Overstress of the building structure must not occur. Do not support overhead supported equipment from slab diaphragms between beams unless specifically approved. Support can occur from:

1. Flanges of structural beams
2. Cast-in-place inserts or drilled in adhesive type anchor, Hilti or equal, in concrete. Shot pins are not allowed.
3. At the panel points of truss chords of bar joists.

D. Install Type II restraints with slack as required, 1/2 inch maximum, to prevent excessive seismic motion for vibration isolated systems and equipment and to allow for thermal movement where applicable.

E. Restraints shall not interfere with the performance of the vibration isolation system and shall not restrict normal vibratory movement of equipment during normal operation, startup or stopping. Install carefully and adjust carefully after system startup and with equipment in operation to insure that proper clearances are maintained.

F. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment. Securely anchor restraints to the supporting structure and securely fasten to the equipment and raceways in accordance with the reviewed submitted data.

2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: A qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METALLIC-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners. Attach with self-tapping screws.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT AND DEVICE IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with whiteletters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.

3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

C. Accessible Raceways and Metallic-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with self-adhesive vinyl label.

D. Hospital Grade Metal Clad or Hospital Grade Armor Clad Cables: Green painted or anodized exterior cladding, applied by manufacturer.

E. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

F. Fire Alarm System: Each junction and pull box shall be painted Red. Use Black indelible liquid marker to label “FA” in 3/8 inch letters minimum.

G. Feeders Shown on Single Line Diagram: Each junction and pull box shall be marked with black indelible liquid marker with the assigned feeder number (example: “FDR #3B) in 3/8 inch letters minimum.

H. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use aluminum wraparound marker labels. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

I. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.

K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

L. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

N. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

All switchboards, distribution panels and panelboards shall also indicate the name of the device or equipment where the power supply originates.

Example: Panel AP-1
Fed from Substation SS-1

1. Labeling Instructions:

   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Transformers.
   d. Motor-control centers.
   e. Disconnect switches.
   f. Enclosed circuit breakers.
   g. Motor starters.
   h. Push-button stations.
   i. Contactors.
   j. Remote-controlled switches, dimmer modules, and control devices.
   k. Battery inverter units.
   l. Battery racks.
   m. Voice and data cable terminal equipment.
   n. Master clock and program equipment.
   o. Intercommunication and call system master and staff stations.
   p. Television/audio components, racks, and controls.
   q. Fire-alarm control panel and annunciators.
   r. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   s. Monitoring and control equipment.
   t. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3. Devices to be Labeled:

   a. Receptacles

1) Normal Power Receptacles: Provide self-adhesive 3/8 inch high white label with 3/16 inch high black lettering mounted at top of device cover plate.
2) Emergency Power Receptacles: Provide self-adhesive 3/8 inch high white label with 3/16 inch high red lettering mounted at top of device cover plate.
3) Wrap edges of self-adhesive label around edges of cover plate such that label is pressed between cover plate and wall.
4) Lettering may be printed either on the back or front of label. Lettering shall be permanently affixed to label and resist damage from normal building operations.
5) Label shall indicate branch circuit number and panelboard from which device is fed. Example: "A-1C-1 #2". Review nomenclature with the Owner.

4. Services to be Engraved:

   a. Receptacles – Cover plates shall be engraved with "circuit no. and panel source" at bottom of plate.

5. Panel Schedule: For all new and/or altered existing panelboards, provide neatly typed Excel format panel schedules for each panel. Provide Owner with an electronic copy of Excel files for all panel schedules and post copy of each printed schedule on inside of panelboard door. Refer to 'Panelboards' Section 26 24 16 for additional requirements.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.
d. Neutral: Gray.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 26 05 53

SECTION 26 05 73 - ELECTRICAL SYSTEMS STUDIES AND ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, arc flash hazard analysis and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted only where series ratings are allowed and indicated on Drawings and/or schedules.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: Submittal information shall be signed and sealed by a registered professional engineer (licensed in the State where project is located) indicating that the studies and analysis are in compliance with applicable codes and the requirements of this specification. Also refer to Section 1.4 “Quality Assurance” for qualification requirements.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Provide five (5) bound copies of complete final report and CD in PDF format.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.
4. One-Line Diagrams.
5. Description, Purpose and Scope of the Study.
6. PPE Ratings.
7. Incident Energy and Flash Protection Boundary Calculations.

E. Study: The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory. Protective device coordination in regards to selective coordination is required prior to the applicable equipment review process.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional Electrical Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer. The Registered Professional Engineer shall be a full-time employee of the Engineering Services Organization.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with NFPA 70 and 70E.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

D. Computer software program capable of performing an Arch Flash Hazard Analysis in accordance with IEEE 1584 equations that are presented in NFPA 70E, Annex D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
2. Maximum available fault current and impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear bus
2. Medium voltage controller
3. Motor control center
4. Switchboard bus.
5. Distribution panelboard.
6. Branch circuit panelboard.
7. Elevator controllers.
8. Mechanical equipment starters/controllers
9. Fire pump controller.
10. Automatic and/or manual transfer switches.
11. Standby generator.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10
b. ANSI C57.12.40
c. ANSI C57.12.22.
d. IEEE C57.96.
e. IEEE C57.12.00.

2. Low-Voltage Circuit Breakers: IEEE 1015 and ANSI C37.13.
3. Low-Voltage Fuses: IEEE C37.46.
4. Medium voltage circuit breakers: IEEE C37.010

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5 cycle) and time delayed currents (6 cycles and above) on medium voltage breakers as needed to set relays and access the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.
3. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit current.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

    a. Device tag.
    b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
    c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
    d. Fuse-current rating and type.
    e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

    a. Device tag.
    b. Voltage and current ratio for curves.
    c. Three-phase and single-phase damage points for each transformer.
    d. No damage, melting, and clearing curves for fuses.
    e. Cable damage curves.
    f. Transformer inrush points.
    g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

H. The protective device coordination study shall determine the final selection of protective devices that are required to provide selective coordination per the NEC.

All modifications to the electrical distribution system and protective devices required to ensure selective coordination are to be determined by this study and are the responsibility of the electrical contractor. These modifications are to be implemented by the contractor at no additional cost to the Owner. Notify Architect, in writing, as part of the Submittal, where selective coordination is unachievable. Provide the best solution that achieves coordination over the long term and short term ranges.

3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E, Annex D.

B. The short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant new equipment locations in the electrical distribution system (transformers, switchboards, automatic transfer switches, distribution panelboards and panelboards) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all significant locations in 208 volt systems fed from transformers equal to or greater than 75 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual over current protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B1.2. The arch flash analysis shall be based on the lowest clearing time setting of the over current protective device to minimize the incident energy level without compromising selective coordination.

3.6 FIELD ADJUSTMENT

A. Adjust protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Project Office in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a two-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.7 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location device analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy range
6. Working distance
7. Engineering report number, revision number and issue date.
8. PPE Ratings/classification

C. Labels shall be machine printed, with no field markings.

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards, one arc flash label shall be provided.
2. For each low voltage switchboard, one arc flash label shall be provided.
3. For each distribution panelboard, one flash label shall be provided.
4. For each panelboard, one flash label shall be provided.

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.8 ARC FLASH HAZARD TRAINING

A. The equipment vendor shall train Owner’s personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 8 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET). Provide the video of the training recorded on DVD to the Owner.

END OF SECTION 26 05 73

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor and indoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.
6. Emergency shunt relays.
7. Wall box dimmers.

B. Related Sections include the following:

1. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
2. Division 26 Section "Wiring Devices" for manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Occupancy Sensor Submittals

1. Submit data sheets on sensors control modules, wiring diagrams and any related accessories.

2. Submit shop drawings showing sensor layout and coverage pattern on floor plans. Layout shown on floor plans is based on Hubbell Building Automation.
3. Confirm finish of occupancy sensor during shop drawing submittal process, finish to be determined by Architect.

D. Occupancy Sensor Contract Close-Out

1. Provide operating instructions, maintenance manuals and warranty information to Owner.
2. Provide as-built drawings of sensor system wiring.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics
2. Grasslin Controls Corporation; a GE Industrial Systems Company
3. Intermatic, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls; a Genlyte Company
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Paragon Electric Co.; Invensys Climate Controls
8. Square D; Schneider Electric
9. TORK
10. Touch-Plate, Inc.
11. Watt Stopper (The)
12. Lutron

B. Digital Programmable Timer: Provide digital countdown timer, Hubbell Cat. No. TD300 or approved equal. Dual voltage 120/277 VAC, 60 Hz, three year warranty.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics
2. Grasslin Controls Corporation; a GE Industrial Systems Company
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Novitas, Inc.
6. Paragon Electric Co.; Invensys Climate Controls
7. Square D; Schneider Electric
8. TORK
9. Touch-Plate, Inc.
10. Watt Stopper (The).
11. Lutron

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley/Rockwell Automation
2. Area Lighting Research, Inc.; Tyco Electronics

3. Eaton Electrical Inc; Cutler-Hammer Products
4. Grasslin Controls Corporation; a GE Industrial Systems Company
5. Intermatic, Inc.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. MicroLite Lighting Control Systems
8. Novitas, Inc.
9. Paragon Electric Co.; Invensys Climate Controls
10. Square D; Schneider Electric
11. TORK
12. Touch-Plate, Inc.
13. Watt Stopper (The)
14. Lutron

A. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements and basis of design, provide products by one of the following:

1. Hubbell Lighting (basis of design).
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. Watt Stopper (The).
7. Lutron

B. Quality Assurance

1. The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry.
2. Sensors and related relays shall be compatible with the specific lighting types controlled.
3. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.
4. All sensors and related equipment shall have a five-year warranty.

5. All sensors and control modules connected to more than 50VAC shall be listed by Underwriters Laboratories.
6. All sensors and related equipment shall be manufactured in the United States of America.

C. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.

D. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit. All sensors shall have selectable auto-on/auto-off and manual-on/auto-off operations.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
4. Occupancy sensors shown on floor plans are based on the following Hubbell catalogue numbers. Approved equal manufacturers must demonstrate equal coverage patterns and equal characteristics to the specified sensors.

Ceiling Mounted Dual Technology

	Sensor Hubbell Cat. No	Application Area
A..	OMNI-DT2000	1000 to 2000 sq.ft. area
B..	OMNI-DT1000	500 to 1000 sq.ft. area
C.	OMNI - DT500	Up to 500 sq.ft. area

5. Wall-switch sensors – Dual/Adaptive Technology

    a. Single-relay: Hubbell Cat. No. LH-MTS1-HL; Two-relay/dual switch: Hubbell Cat. No. LH-MTD2-W
    b. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 1000 sq. ft.

6. Long-Range Wall-Switch Sensors:

    a. Hubbell; LODT
    b. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.

7. All ceiling mounted occupancy sensors, and long range wall-switch sensors require the use of a power supply, Hubbell Cat. No. MP-Power Pack or approved equal. Ceiling mounted occupancy sensors in rooms controlling 120V and 277V luminaires require an additional auxiliary relay, Hubbell Cat. No. MP-S auxiliary relay or approved equal. Contractor is responsible for field verification of required number of power packs:

    a. One power pack is required for each circuit to be controlled
    b. One Power pack is required for every three sensors in the zone.
    c. If multiple circuits are to be controlled by a sensor, an auxiliary relay can be used in conjunction with the power pack.
    d. The maximum number of sensors that can be put on a power pack is to be reduced by one for each slave pack used.

8. Where ceiling mounted occupancy sensors are provided, provide local wall switch for additional user control, to turn "off" lights when room is occupied.
9. Wall-mounted occupancy sensors shall have manual "on/off" override.

2.5 OUTDOOR MOTION SENSORS (PIR)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. RAB Lighting, Inc.
6. TORK.
7. Watt Stopper (The).
8. Lutron

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
    b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Detection Coverage: Up to 35 feet, with a field of view of 180 degrees.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.6 WALL BOX DIMMERS

A. Approved Manufacturer: Lutron Electronics Co.

B. Controls Lutron Nova T Style

1. Performance

    a. Dimmers shall provide full-range, continuously variable control of light intensity.
    b. Controls shall fit a 1 inch wide, 1.5 inch tall wallplate opening with a vertical linear-slide. Controls shall be thin profile with no exposed heatsink/yoke. Unless otherwise specified, controls shall have a matte finish.

c. Controls shall provide a vertical slider allowing the light level or fan speed to be set by the user. Provide "preset" dimmers where the on/off function is independent of the dimmer slider position. This preset function shall be provided as a push on/push off switch integral to the slider knob and visibly distinct from the slider. For preset dimmers, when the lights are on, the slider shall change the light level and when the lights are off, the slider shall preselect the light level the lights will turn on to.
d. Control on/off function must be accomplished utilizing a mechanical air-gap switch to totally disconnect power from the load during "off" condition, no leakage current shall be present at the fixture(s).
e. Slider shall be captured behind wallplate.
f. Preset dimmers shall be capable of multi-location on and mechanical air-gap off using standard 3-way and 4-way switches. Multi-location switches shall be Nova T style.
g. Controls shall be able to have their visible plastic parts replaced, for color changes in the field, without removing the body of the control from the wall and without requiring special tools.
h. Within rated capacity, dimmers shall be available for direct control of incandescent, electronic low voltage, magnetic low voltage, and fluorescent.
i. Controls shall be capable of operating at the rated capacity; this includes modified capacities for ganging configurations which require the removal of fins. Operation at rated capacity shall be possible across the full ambient temperature range without shortening design lifetime.
j. Dimmer shall provide smooth and continuous Square Law dimming curve, for the full slider travel, on their rated load.
k. Controls shall meet the applicable requirements of UL 20 and UL 1472 referring to the inclusion of a visible, accessible air-gap off switch and the limited short circuit test.
l. Controls shall meet ANSI/IEEE Std. C62-41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
m. Dimmers shall be designed to reduce interference with radio, audio, and video equipment.
n. Controls shall incorporate power-failure memory. Should power be interrupted and subsequently returned, the lights or fans will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
o. Controls shall not be susceptible to damage or loss of memory due to static discharge.
p. Dimmer shall include voltage compensation to compensate light output for variation in the AC line-voltage. Dimmers in which the light output is not held constant with varying AC line-voltage shall not be acceptable.
q. Controls shall operate in an ambient temperature range of 0° C (32° F) to 40° C (104° F).
r. 3-way controls shall wire using conventional 3-way and 4-way wire runs.
s. Contractors shall install all backboxes with a minimum wallbox depth of 2.5 inches.

2. LED Driver Dimmers

a. Provide wall box dimmer compatible with LED driver.
b. Dimmer shall be designed to operate:

1) 3 wire driver
2) ELV driver
3) 0-10V driver
4) Addressable driver

3. Remote dimming modules for high power loads.

a. Where lighting loads exceed the full rated capacity of single dimmers, provide a Nova T incandescent dimmer driving high power modules. High power module and dimmer shall be from the same manufacturer to ensure compatibility.
b. High power modules shall be remotely mounted.
c. High power module shall be rated and UL listed for control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and neon/cold cathode loads in increments of 2,000 watts up to 30,000 watts.

C. Wallplates Lutron Nova T Style

1. Wallplates shall be manufactured from durable polycarbonate plastic with matte finish, and shall attach to the basic components without using exposed hardware or screws.
2. Multigang wallplates shall provide a continuous, seamless cover for control and/or accessory combinations with no exposed hardware or screws. Custom wallplate configurations shall be available.
3. Multigang wallplates shall include snap in auto-align adapter plate for proper device alignment and wallplate attachment.
4. Control, accessory and wallplate profiles shall not exceed .30 inches from wall surface to faceplate front surface.

D. All dimming controls shall be 100% function tested at the time of manufacture. Stastical sampling plan shall not be acceptable.

2.7 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.

10. TORK.
11. Touch-Plate, Inc.
12. Watt Stopper (The).
13. Lutron

2.8 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design, Inc.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 and 277 V.

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. All sensor locations are approximate, refer to manufacturer's installation instructions prior to installation.

C. Ceiling mount sensors should be located a minimum of six feet from HVAC supply/return vents.

D. Contractor is responsible for: proper sensitivity and time delay settings (for nonadaptive products) recommended placement, and field verification within respect to power placement.

E. Sensors mounted over the door must be placed one foot inside the threshold.

F. Contractor is responsible for installing equipment in compliance with local code.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections in metallic junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Exposed cable splices, taps and terminations are not acceptable.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. The contractor shall be responsible for making all proper adjustments to assure owner's satisfaction with the occupancy sensor system. A manufacturer's representative shall provide on-site adjustments and train owner's personnel to ensure owner's satisfaction with the occupancy system.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes manually operated lighting controls with relays and control modules.

B. This Section includes manually operated, PC-based, digital lighting controls with external signal source, relays and control modules.

C. This Section includes individually addressable lighting control devices communicating with data-entry and -retrieval devices using DALI protocol.

D. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.
2. Division 26 Section "Central Dimming Controls or Modular Dimming Controls" for dimming control components.

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. DALI: Digital addressable lighting interface.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

G. PC: Personal computer; sometimes plural as "PCs."

H. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

I. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.4 SUBMITTALS

A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

E. Field quality-control test reports.

F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.
2. Coordinate lighting controls with BAS. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Two years from date of Substantial Completion.
3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Electrically Held Relays: Equal to 100 percent of amount installed.
2. Electrically Operated, Molded-Case Circuit Breakers: Equal to 100 percent of amount installed.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.

1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Easylite Ballasts and Controls, Inc.
2. Intelligent Lighting Controls, Inc.
3. Leviton Mfg. Company Inc.
4. Lighting Control & Design, Inc.
5. Lightolier Controls; a Genlyte Company
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Company, Inc.
8. MicroLite Lighting Control Systems
9. NexLight; Northport Engineering Group
10. Square D; Schneider Electric
11. Starfield Controls, Inc.
12. Touch-Plate, Inc.
13. TRIATEK, Inc.
14. ULTRAWATT Energy Systems, Inc.
15. Watt Stopper (The)

2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

C. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

D. Performance Requirements: Individually addressable devices (such as electronic ballasts, dimmers, and manual switches) are operated from digital signals received through a DALI-compliant bus, from data-entry and -retrieval devices (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and -retrieval devices though the bus.

2.3 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

2.4 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.

    a. Barriers separate low-voltage and line-voltage components.
    b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
    c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.

a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
c. Endurance: 50,000 cycles at rated capacity.
d. Mounting: Provision for easy removal and installation in relay cabinet.

B. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

1. Cabinets: In addition to requirements specified below, comply with Division 26 Section "Panelboards."
2. Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.

a. Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
b. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
c. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
d. Listed and labeled as complying with UL SWD, HCAR, and HID ratings by a national recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction.

C. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

D. Line-Voltage Surge Suppression: Field-mounting surge suppressors that comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

E. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for Category A locations.

2.5 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.

1. Match color specified in Division 26 Section "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."

C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."

D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 PROGRAMMING

A. This article outlines a preliminary sequence of operations for factory pre-programming purposes. Priorities and programming shall be verified with Engineer and Owner during shop drawing process and at On-site Set Up and Programming.

B. Preliminary Programming shall be as follows:

1. Network

    a. Control signals from the network shall override all other control signals.
    b. This includes setting a load shedding setting for energy management.

2. Astronomical Time Clock

    a. Time clock events shall be programmed for corridor lighting and common area lighting for a night-time set back on all floors. Lights shall be "on" from 7:00 a.m. to 8:00 p.m., and during "off" hours may be overridden by corridor override switches for a period of one hour after which occupants will be given a blink warning prior to shut off.

3. Photocell Controls

    a. Photocells shall dim the active lighting where indicated on the plans.

b. Photocells shall dim the lighting in order to maintain 75 fc on lab work surfaces and 50 fc on office work surfaces and 20 fc in corridors when daylight is present.
c. Photocells may be overridden by local override switches by the occupants to either raise or lower the lighting levels.

4. Occupancy Sensors

a. Where occupancy sensors are shown, they shall control the lighting in the space.
b. Occupancy sensors shall always function regardless of time of day.
c. Occupancy sensors time delay shall initially be set at 30 minutes.
d. All areas shall have automatic on/off control of the lights by the occupancy sensors, with the wall switches acting as overrides for the occupants.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 43

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Electric Corporation; Power Distribution Products Division
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Eaton Electrical Inc.; Cutler-Hammer Products
4. General Electric Company
5. Magnetek Power Electronics Group
6. Siemens Energy & Automation, Inc.
7. Sola/Hevi-Duty
8. Square D; Schneider Electric

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Manufacturer’s standard.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 3 to 15 kVA: Two 5 percent taps below rated voltage.

I. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Transformers shall meet DOE Energy Efficiency Standards (DOE 10CFR Part 431 Energy Conservation Standards). Transformers shall be provided with DOE 2016 efficiency levels at 50% load.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

N. Wall Brackets: Manufacturer's standard brackets.

O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

P. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA
2. 30 to 50 kVA: 45 dBA
3. 51 to 150 kVA: 50 dBA
4. 151 to 300 kVA: 55 dBA
5. 301 to 500 kVA: 60 dBA

6. 501 to 750 kVA: 62 dBA
7. 751 to 1000 kVA: 64 dBA

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Manufacturer’s standard.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution and buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Equipment anchoring shall follow the anchoring details and calculations performed specifically for this project. The calculations and details shall be submitted as a separate submittal as indicated in the "Submittals" article within this specification section.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Qualification Data: For qualified Installer.

E. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

D. Front- and Rear-Accessible Switchboards:

1. Main Devices: Fixed or Drawout, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking.

I. Barriers: Between adjacent switchboard sections.

J. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

K. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

L. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

M. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

N. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

O. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

P. Buses and Connections: Three-phase, four-wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

R. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

S. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, third edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 240-kA interrupting capacity, unless otherwise noted.
2. Fabrication using bolted compression lugs for internal wiring.
3. Redundant suppression circuits.
4. Redundant replaceable modules.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
9. Six-digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase, unless otherwise noted.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time time adjustments.
c. Ground-fault pickup level, time delay, and I^2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 40-V dc.

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.

1. Meters: 4-inch diameter or 6 inches square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.
2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

2.7 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch-thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.

1. Nameplate: At least 0.0625-inch-thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment anchoring shall follow the anchoring details and calculations performed specifically for this project. The calculations and details shall be submitted as a separate submittal as indicated in the "Submittals" article within this specification section.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards
3. Load centers
4. Electronic-grade panelboards

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating

B. TVSS: Transient voltage surge suppressor

C. SPD: Surge protective device

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field Quality-Control Reports:

1. Test procedures used
2. Test results that comply with requirements
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Provide electronic files in Excel format.

G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NEC.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NEC.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Spares as indicted on schedules on drawings.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1
b. Outdoor Locations: NEMA 250, Type 3R
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

    a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Same finish as panels and trim.
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
8. Color Identification Scheme for Grounded Conductors of each voltage system: Provide a permanent factory label on the inside cover of each panelboard.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals, as noted in panelboard schedule in Division 26 Section "Schedules for Electrical" and single line diagram drawings. Provide fully rated panelboards unless otherwise noted.

H. Selective Coordination: Comply with NFPA 70, specification 26 05 73 “Electrical-Systems Studies and Analysis” and as indicated on drawings.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated on Drawings and/or Schedules.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers, thermal-magnetic trip.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; solid-state electronic trip.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on drawings and/or schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

G. Panelboard configurations shall be dependent on the number of branch breakers required in each panel. For panels requiring 12 to 42 branch breaker poles, provide a single backbox with nominal dimensions of 20 inches wide by 5.75 inches deep. For panels requiring 43 to 84 branch poles, provide a single back box with nominal dimensions of 26 inches wide by 5.75 inches deep.

2.4 LOAD CENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Load Centers: Comply with UL 67.

C. Mains: As indicated on drawings and/or schedules.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. HACR Circuit Breakers: Single-, two- and three-pole configurations, rated for protecting heating, air conditioning and refrigeration equipment.
9. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
    j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
    k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
    m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.6 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution
4. Liebert Corporation
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

a. LED indicator lights for power and protection status.
b. Audible alarm, with silencing switch, to indicate when protection has failed.
c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on structural channel framing.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 78 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch empty conduits from each flush mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future. Where applicable, stub four 1-inch empty conduits into raised floor space.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

L. Install arc flash warning labels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Provide neatly typed Excel format panel schedule for each panel and provide Owner with an electronic copy of Excel files for all panel schedules. Post copy of each printed schedule on inside of panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Electrical Systems Studies and Analysis."

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes equipment for utility company's electricity metering and electricity metering by Owner.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:

1. Electricity-metering equipment.

B. Shop Drawings for Electricity-Metering Equipment:

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
3. Mounting and anchoring devices recommended by manufacturer to resist seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Manufacturer Seismic Qualification Certification for Electricity-Metering Equipment: Submit certification that equipment components and their mounting and anchorage provisions have been designed to remain in place without separation of any parts or loosening of factory-made connections when subjected to the seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.
2. Detailed description of equipment mounting and anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center as specified in NECA 400.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power and communication services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. Modular Meter Center: Factory-coordinated assembly of a main service disconnect device, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.

1. Manufacturers:

    a. Cutler-Hammer; Eaton Corporation.
    b. General Electric Company; Electrical Distribution & Control Div.
    c. Siemens Energy & Automation, Inc.
    d. Square D; Schneider Electric.

2. Housing: NEMA 250, Type 1 enclosure.

    a. Structural strength of the housing, its anchorage and component attachment provisions, and anchorage devices recommended for anchoring the housing in place shall be adequate to prevent separation of equipment and its components from their installed positions during a seismic event as defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3. Minimum Short-Circuit Rating: As calculated amperes symmetrical at rated voltage.
4. Main Disconnect Device: As designed.
5. Tenant Feeder Circuit Breakers: Series-combination-rated molded case units, rated to protect circuit breakers in downstream tenant and house loadcenters and panelboards that have 10,000-A interrupting capacity.

    a. Identification: Complying with Division 26 Section "Identification for Electrical Systems" with legend identifying tenant's address.
    b. Physical Protection: Tamper resistant, with hasp for padlock.

6. Meter Socket: Type as approved by utility company, with rating coordinated with indicated tenant feeder circuit rating.

2.3 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers:

1. E-MON L.P.
2. Osaki Meter Sales, Inc.
3. Square D; Schneider Electric.

B. Kilowatt-Hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: Digital liquid crystal, indicating accumulative kilowatt hours and current kilowatt load.

C. Kilowatt-Hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
3. Demand Signal Communication Interface: Match signal to input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
4. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.
5. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
6. Identification: Comply with Division 26 Section "Identification for Electrical Systems."
7. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
8. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

    a. Type: solid core.

9. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.
10. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

D. Provide meter(s) with the capability of exporting data digitally through Ethernet, Modbus, or other communications protocol for remote monitoring and data storage by the owner. Provide software and PC hardware for viewing and storing the data on site at a location specified by the owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 FIELD QUALITY CONTROL

A. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Isolated-ground receptacles.
5. Hospital-grade receptacles.
6. Snap switches and wall-box dimmers.
7. Solid-state fan speed controls.
8. Communications outlets.
9. Pendant cord-connector devices.
10. Cord and plug sets.
11. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 26 Section “Lighting Control Devices” for indoor and outdoor occupancy sensors, and wall box dimmers.
2. Division 27 Section "Communications Horizontal Cabling" for work station outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEC.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Eaton Wiring Devices/Arrow Hart.
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; 1877 (single), 5362 (duplex).
    b. Hubbell; HBL5351 (single), CR5362 (duplex).
    c. Leviton; 5891 (single), PS5362 (duplex).
    d. Pass & Seymour; 5381 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; IG5362RN.
    b. Hubbell; CR 5253IG.
    c. Leviton; 5362-IG.
    d. Pass & Seymour; IG6300.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; TR5362.
    b. Hubbell; TR5362.
    c. Leviton; TCR20.
    d. Pass & Seymour; TR5362.

D. USB Charger, Tamper Resistant, Duplex Convenience Receptacles, 125 V, 20 A with two USB Type A, Class 2.0 ports, 3.1 A minimum, 5 Volt DC: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; TR7756
    b. Hubbell; USB20X2
    c. Leviton; T5832
    d. Pass & Seymour; TR5362USB

E. Receptacles located in damp or wet locations shall be listed weather-resistant (WR) type.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI (Self Test) Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; SGF20.
    b. Pass & Seymour; 2084.
    c. Hubbell
    d. Leviton

C. Receptacles located in damp or wet locations shall be listed weather-resistant (WR) type.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; AHL520R.
    b. Hubbell; HBL2310.
    c. Leviton; 2310.
    d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; IGL520R.
    b. Leviton; 2310-IG.

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eaton/Arrow Hart; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eaton/Arrow Hart; 1221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymou
e. r; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; 1995L.
    b. Hubbell; HBL1221L.
    c. Leviton; 1221-2L.
    d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; 1995.
    b. Hubbell; HBL1557.
    c. Leviton; 1257.
    d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; 1995L.
    b. Hubbell; HBL1557L.
    c. Leviton; 1257L.
    d. Pass & Seymour; 1251L.

2.8 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable toggle switch, 1.5A.

2.9 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Eaton/Arrow Hart; 3560-6.
    b. Leviton; 40649.

2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eaton/Arrow Hart; 3562.
b. Leviton; 40595.

2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.10 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, rain-tight while in use with lockable cover.

2.11 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

2.12 POKE-THROUGH ASSEMBLIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Square D/ Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold Company (The).

C. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.
2. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, 4-pair, Category 5e voice and data communication cables.

2.13 MULTIOUTLET ASSEMBLIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

C. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Configuration: Wiremold Series AL4400 Aluminum with two separate compartments. Upper compartment shall contain UL heavy-duty, specification grade 20 ampere, 125 volt, three-wire, NEMA 5-20R, gray duplex receptacles on 24 inch centers. Alternately circuit adjacent receptacles on multioutlet raceways served from multiple branch circuits as indicated on the drawings. Lower compartment shall contain provisions for voice/data outlets on 60 inch centers. Each outlet provision shall consist of a punched hole and associated screw mounting holes (two screw holes per punched hole). Each punched hole and associated screw mounting holes shall accommodate a duplex voice/data outlet device as specified in Division 27, Section “Communications Horizontal Cabling”. Cover plates shall be 12 inch wide sections.

F. Wire: No. 12 AWG.

2.14 RETRACTABLE CORD REELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daniel Woodhead Co.
2. McGill
3. Hubbell Company

B. Description:

1. Electric Cord reel shall be lightweight corrosion-resistant macroblend plastic housing with automatic spring retraction, ratchet lock and lifetime lubrication. Cord reel should be rated for light to medium duty.
2. Cord reel shall have an external spring tension adjustment and an adjustable ball stop on the cord. Provide a 330° pivot base for each cord reel.
3. Cord reel shall have a Type SJO cord with three (3) #16 AWG conductors rated for 300 volts and a length of 30 feet.
4. Cord reel shall have a yellow finish and be UL listed.
5. Provide a NEMA 5-20R, 2 pole, 3 wire receptacle rated for 20 amperes at 125 volts on the end of the cord as indicated on the drawings.

2.15 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NEC or device listing.
2. TVSS Devices: Blue.
3. Isolated-Ground Receptacles: Orange
4. Wiring devices for Automatic Outlet Control Systems shall be permanently marked with the I/O power symbol and the word “Controlled” in accordance with the NEC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Light Switch Installation

1. Neon or LED lighted handle type light switches - Illuminated when load is "OFF" (meeting the device type, style and color requirements described in other specification sections and drawings) shall be provided for the following applications:

    a. All "E" designated switches shown on the drawings.

    b. Manual light switches serving normal and emergency lighting within the following spaces:

        1) Electrical Rooms
        2) Communications Rooms
        3) Mechanical Equipment Rooms

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Arrangement of Devices: Unless otherwise indicated, mount flush to finished wall surface, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches
2. Nonfusible switches
3. Molded-case circuit breakers
4. Molded-case switches
5. Enclosures

1.3 DEFINITIONS

A. GD: General duty

B. GFCI: Ground-fault circuit interrupter

C. HD: Heavy duty

D. RMS: Root mean square

E. SPDT: Single pole, double throw

F. GFEP: Ground-fault equipment protection

G. HACR: Heating, air conditioning, refrigeration rated circuit breaker

H. AFCI: Arc-fault circuit interrupter

I. SWD: Switch rated circuit breaker

J. HID: High-intensity discharge switch rated circuit breaker

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.
5. Hubbell

B. Fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 600A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 FUSED POWER CIRCUIT DEVICES

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.

b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A 5-mA trip sensitivity.
7. GFEP Circuit Breakers: Single- and two-pole configurations with Class B 30-mA trip sensitivity.
8. AFCI Circuit Breaker: Single- and two-pole configurations with arc-fault protection.
9. SWD Circuit Breaker: Single-pole configuration, rated for switching fluorescent lighting circuits.
10. HID Circuit Breaker: Single- and two-pole configurations, rated for switching high-intensity discharge circuits.
11. HACR Circuit Breakers: Single-, two- and three-pole configurations, rated for protecting heating, air conditioning and refrigeration equipment.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment; Type HID for switching high-intensity discharge lighting loads.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Arc-Fault Protection: Integrally mounted relay and trip unit with fixed pickup and time-delay settings, push-to-test feature, and arc-fault indicator.
6. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
8. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:

1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.5 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Infrared Scanning:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.

b. Instruments, Equipment and Reports:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 28 16

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced-voltage controllers.
3. Multispeed controllers.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
3. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer and testing agency.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
2. Cerus
3. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Eaton Corporation; Cutler-Hammer Products
5. General Electrical Company; GE Industrial Systems
6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group
7. Siemens/Furnas Controls
8. Square D
9. Toshiba International Corporation

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.

B. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:

    a. Control power available.
    b. Controller on.
    c. Overload trip.
    d. Loss of phase.
    e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.

2.4 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Provide pilot light in cover, LED type.

C. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop push button.

D. Provide two sets of normally closed auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor. Provide one set of auxiliary contacts convertible to normally open. Where starter is provided with Division 23 equipment, it is to be provided with necessary contacts required to operate mechanical equipment and Automatic Temperature Controls, Division 23.

E. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

F. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

G. Control Relays: Auxiliary and adjustable time-delay relays.

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled. Horsepower ratings indicated on drawings are for basis of design only. Coordinate horsepower rating of controllers with the motor horsepower supplied with the equipment furnished under Division 22 and 23.

3.3 INSTALLATION

A. For control equipment at walls, mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 29 13

SECTION 26 29 23 - VARIABLE FREQUENCY MOTOR SPEED CONTROLLERS (VFD)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 22 drawings and specification sections, apply to this Section.

C. Division 23 drawings and specification sections, apply to this Section.

D. Division 22 and/or 23 ”Variable Frequency Drive Schedule” indicated on the Division 22 and/or Division 23 drawings.

E. Division 26, Section “Low Voltage Electrical Power Conductors and Cables”.

1.2 SUMMARY

A. This Section includes solid-state, PWM, variable frequency motor speed controllers (VFD) for speed control of three-phase, squirrel-cage induction motors, rated 600V and less, and applied harmonic mitigation filters to reduce harmonic currents drawn from the power supply by the VFDs. The drive manufacturer shall supply the VFD as an integral package as specified. Chiller and fire pump solid-state motor controllers and their corresponding harmonic mitigation equipment are included with the equipment in their respective division and not included in this Section. Unless otherwise noted or specified, all VFDs installed under this project shall be from the same manufacturer.

B. Related Sections include the following:

1. Division 26 Section “Common Materials and Methods for Electrical”.
2. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.
3. Division 26 Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

C. Division 22 and/or 23 shall furnish all VFDs, including line reactors (LRs) and/or harmonic passive filters (HPF), with the specific equipment in accordance with this Section and indicated in Division 22 and/or 23 ”Variable Frequency Drive Schedule” on the drawings. Line reactors and/or harmonic passive filters shall be mounted within the VFD enclosure and factory installed and wired by the VFD manufacturer.

D. Division 22 and/or 23 shall furnish all Harmonic Active Filters (HAF) specified in this Section and indicated in the Variable Frequency Drive Schedule and Electrical drawings.

E. Division 26 shall install VFDs with their integral corresponding line reactors (LRs) and/or harmonic passive filters (HPFs) that are not factory mounted with the equipment. Provide all wiring, connections and mounting methods in accordance with equipment installation requirements and this section. Coordinate installation with Division 22 and/or 23.

F. Division 26 shall install harmonic active filters (HAFs) as shown on the drawings. Provide all wiring, connections and mounting methods in accordance with equipment installation requirements and this section. Coordinate installation with Division 22 and/or 23.

G. Division 25 shall provide all remote control devices/BAS and connections to each VFD.

H. Division 22 and/or 23 shall provide field quality control, start up, adjustments and demonstration of VFDs and HAFs with respective equipment.

1.3 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. BMS: Building management system.

C. BAS: Building automation system.

D. HAF: Harmonic active filter.

E. HPF: Harmonic passive filter.

F. IGBT: Insulated gate bipolar transistor.

G. LAN: Local area network.

H. LR: Line Reactor.

I. PCC: Point of common coupling.

J. PID: Control action, proportional plus integral plus derivative.

K. PWM: Pulse-width modulated.

L. TDD: Total demand (harmonic current) distortion

M. THD (V): Total harmonic voltage demand.

N. VFD: Variable frequency drive or variable frequency motor speed controller.

O. NETA: International Electrical Testing Association.

P. NRTL: Nationally Recognized Testing Laboratory.

Q. SCCR: Short Circuit Current (withstand) Rating.

R. OCPD: Overcurrent Protective Device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of VFD and HAF. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD and HAF.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current (withstand) rating of each integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs, LRs , and HPFs and HAFs. Provide schematic wiring diagram for each type of VFD, LR , and HPFs and HAFs.

1.5 INFORMATION SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFD and HAF where pipe and ducts are prohibited. Show VFD and HAF layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Manufacturer Seismic Qualification Certification: Submit certification that VFD, and HAF accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Restraints for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For manufacturerand testing agency.

D. Field quality-control test reports.

E. Product Certificates: For each VFD, LR , HPF and HAF from manufacturer.

F. Harmonic Distortion Analysis

1. The VFD manufacturer shall perform a harmonic analysis and include it with the VFD and harmonic filter submittals. The purpose of the analysis is to confirm compliance with IEEE 519-2014 edition, inclusive of the VFD types and harmonic mitigating filters specified. The results of the study are not to be used to negate the need for the VFD types and/or harmonic mitigating filters specified in the Contract Documents.
2. The analysis shall be performed assuming all VFDs operating in synchronism and include standby use and/or future installations, where shown in the ”Variable Frequency Drive Schedule” and/or on the Electrical drawings. The analysis shall compute at each point of common coupling on the electrical distribution system the percent amplitude RMS value of current and voltage of all harmonic orders of zero through 50 and percent total RMS harmonic voltage and current. The analysis shall include all harmonic distortion filters (LRs, HPFs and/or HAFs) connected on the effective system distribution network, including Division 21 fire pump and/or Division 23 chiller motor controllers and harmonic distortion filters. Coordinate controller and harmonic mitigation type with respective Division and Sections.
3. A Point of Common Coupling (PCC) shall be any and all of the following electrical locations that are on the effective system distribution network:

    a. A common junction or node to more than one path of power distribution which is considered to have no impedance between two or more points (e.g., bus of distribution equipment, wire troughs, etc.).
    b. Primary and secondary terminals of a transformer or substation.
    c. Point of service connection to the utility company.

4. IEEE 519-2014 shall be utilized as the design guideline for the harmonic analysis and the computation of THD, TDD and current/voltage distortion of the individual harmonic orders at each PCC. The analysis shall demonstrate compliance with IEEE 519 harmonic limits at each PCC and shall be included in the VFD and HAF submittal. The initial computation shall be based on the VFD type and Harmonic Distortion Filter type shown in the ”Variable Frequency Drive Schedule” on the drawings. If the analysis demonstrates compliance with IEEE 519, then no additional computation is required. If the analysis does not demonstrate compliance with IEEE 519, provide additional computation(s) where non-contractual design changes to the Contract Documents are required to comply with IEEE 519. The submittal shall indicate the changes required to the Contract Documents in the harmonic analysis along with the original and revised computations. The information will be reviewed by the Engineer and Owner to determine the course of action to be taken after the submittal is reviewed by the Engineer.

5. Maximum short circuit current, wire sizes and transformer sizes are shown on the electrical single line diagrams. For new utility services, obtain the available short circuit current from the utility company or the electrical contractor. Equipment locations are shown on the electrical plans. Utilize standard manufacturer transformer impedances, unless otherwise shown on the single line diagrams and emergency generator impedances from the electrical contractor and/or Owner. The maximum demand load current to be used for the TDD calculation at each PCC shall be 80% of the service and/or equipment rating.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFDs, LRs, HAFs and HPFs, all installed devices, and components to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFDs, LRs, HAFs and HPFs, and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

B. Load-Current and List of Settings of Adjustable Overload Relays for bypass controllers: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.7 WARRANTY

A. Provide warranty for twenty-four (24) months from date of authorized service representative completion of startup including parts and labor for repair, or replacement of defective unit.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs. The drive manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty (20) years.

B. Testing Agency Qualifications: Member company of NETA or NRTL.

1. Testing Agency's Field Supervisor: Currently certified by the NETA.

C. Source Limitations: Obtain VFDs, LRs, HAFs and HPFs of a single type through one source from a single manufacturer, unless otherwise noted or specified by Division 22 and/or 23 to be provided as part of packaged equipment. Units provided as part of packaged equipment must meet all the requirements specified herein.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application..

E. Comply with NEC.

F. Comply with NEMA ICS 3.1 – Safety Standard for Construction and Guide for Selection, Installation and Operation of Variable Frequency Drive Systems.

G. Comply with UL 508C (Power Conversion).

H. Comply with UL 508A (Industrial Control Panel).

I. Comply with IBC 2009 Seismic – ASCE 7.

J. Comply with IEEE519-2014 for following harmonic distortion limits:

1. Design VFD to limit the harmonic distortion generated by the drive(s) on the electrical distribution system.
2. Maximum allowable total (THD%) and individual harmonic voltage distortion limit with simultaneous operation of the VFDs shall not exceed the limits as set forth by IEEE 519 - 2014 edition at each individual PCC.
3. Maximum allowable total (TDD%) and individual harmonic current distortion limit for each odd harmonic with simultaneous operation of the VFDs shall not exceed limits as set forth by IEEE 519-2014 edition at each individual PCC.
4. Provide all equipment, analyses, accessories, hardware and installation required to successfully comply with Division 22 and/or 23 ”Variable Frequency Drive Schedules” and this specification at no additional cost to the owner.

K. Factory Testing: Each VFD and HAF shall be factory tested prior to shipment for compliance to meeting all requirements specified herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs and HAFs in shipping splits of lengths that can be moved past obstructions in delivery path, if required. Investigate field conditions to determine.

B. Store VFDs and HAFs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs and HAFs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFDs and HAFs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 14 to 104 deg F (-10 to 40 deg C).
2. Humidity: Less than 95 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

1.11 COORDINATION

A. Coordinate layout and installation of individual VFDs, and HAFs including conduit, piping, equipment and adjacent surfaces, with other construction trades, especially with Divisions 22 and/or 23 . VFDs and HAFs are shown schematically for purposes of approximate location for wiring connections. Exact locations of VFDs and HAFs will be field determined by Divisions 22 and/or 23 during construction. Maintain required workspace clearances and required clearances for equipment access doors and panels in accordance with the code and manufacture's installation guidelines.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFDs, and HAFs installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFD and HAF and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY CONTROLLERS (VFD)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Eaton Corporation; Cutler-Hammer Products.
3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
4. Siemens Energy and Automation; Industrial Products Division.
5. Square D/Schneider Electric.
6. Toshiba International Corporation.
7. Honeywell Automation and Control Solutions
8. Yaskawa

B. Description: NEMA ICS 7, IEC 61800-1 & 2, UL 508C, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed and variable torque of a NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency inverter duty rated motor as defined by NEMA MG 1. Part 31, "Definite – Purpose Invertor Fed Polyphase Motors".
2. Listed and labeled for integrated short circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

3. Provide 6-pulse, twelve-pulse, eighteen-pulse or higher order bridge converter (rectifier) invertor drive as indicated in Division 22 and/or 23 ”Variable Frequency Drive Schedule(s)."

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: 3-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating and Construction Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
4. Input Internal Reactor Impedance: 5%.
5. Minimum Efficiency: 60 Hz - 96 percent at half speed; 98% at full speed.
6. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
7. Overload Capability: 1.1 times the base load current for 60 seconds; 1.35 times the base load current for 2 seconds to 1 minute for variable torque applications.
8. Starting Torque: 100 percent of rated torque from 3 to 60 HZ.
9. Speed Regulation: Plus or minus 1 percent.
10. Output Carrier Frequency: selectable; 1.0 to 15 kHZ.
11. Stop Modes: Programmable; include fast, free-wheel and dc injection braking.
12. Power Factor: 0.98.
13. Ambient Operating Temperature: 14 to 104 deg F.
14. Service Factor: 1.0.
15. Minimum Short-Circuit Current (withstand) Rating: 100,000 Amperes RMS Symmetrical at rated operating voltage.
16. Output Internal Reactor: Tuned dv/dt resistor-inductor (optional).

F. Isolated Control Interface: Allow controller to follow control signal over a minimum 40:1 speed range.

1. Electrical Signal: 0-10V dc and 4 to 20 mA at 24 V dc inputs.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9. seconds
4. Deceleration: 0.1 to 999.9. seconds
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad for Class 10/20/30; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.
12. Single phase protection on VFD and Bypass controller.
13. Run interlock protection.
14. Power loss ride through of 2 seconds.
15. DC injection braking capability to prevent 'wind milling' at start or stop, adjustable, current limited.

I. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

J. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker, molded-case switch, with power fuse block and current-limiting fuses, thermal-magnetic circuit breaker or NEMA KS 1, fusible switch with current limiting fuses in a pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating for VFD without bypass system: Not less than 115 percent of VFD input current rating.
2. Disconnect Rating for VFD with bypass system : Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades or circuit breaker opens.

N. Controls and Indication:

1. Status Lights: Via keypad or door-mounted LED indicators displaying the following conditions:

a. Power on.

b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.

2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

1) Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

3. Motor Sensing: Adjustable motor sensing circuit for the bypass and VFD mode (proof of motor operation).

4. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last four faults with time and date stamp for each.

4. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percent).
f. Fault or alarming status (code).
g. PID feedback signal (percent).
h. DC-link voltage (V dc).
i. Set point frequency (Hz).
j. Motor output voltage (V ac).
k. Single phase (phase failure).
l. Trap filter connected.
m. Trap filter blown fuse.
n. Motor sensing display.

5. Control Signal Interfaces:

a. Electric Input Signal Interface:

1) A minimum of two programmable analog inputs: 0- to 10-V dc or 4- to 20-mA dc
2) A minimum of six multifunction programmable digital inputs.

b. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

1) 0- to 10-V dc.
2) 4- to 20-mA dc.
3) Potentiometer using up/down digital inputs.
4) Fixed frequencies using digital inputs.
5) FLN, N2, BACnet and Modbus Interface as standard.

c. Output Signal Interface: A minimum of one programmable analog output signal 4- to 20-mA dc, which can be configured for any of the following:

1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (V dc).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set point frequency (Hz).

d. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

1) Motor running.
2) Set point speed reached.
3) Fault and warning indication (overtemperature or overcurrent).
4) PID high- or low-speed limits reached.
5) Unit in hand mode.
6) Unit in bypass mode

O. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-485

P. Embedded BAS Protocols for Network Communications: BACnet IP; protocols accessible via the communications ports. Provide internal network interface card (NIC) to allow for Ethernet (BACnet) connectivity of VFD to facility LAN for BACnet IP.

Q. Line Conditioning and Filtering

1. Input Line Reactor (LR): Provide a 5% impedance series input line reactors (AC chokes) or 5% minimum dual DC link reactors (DC link chokes) in each VFD to reduce harmonics on the electrical system.

2. Input Harmonic Passive Filter (HPF): Provide a parallel harmonic passive tuned LC filter inclusive with a series input LR for equipment indicated in Division 22 and/or Division 23 "Variable Frequency Drive Schedule" on the drawings. The harmonic passive tuned LC filter (HPF) shall be factory installed and wired in the VFD enclosure by the VFD manufacturer. The HPF shall include power monitoring and contactors to disconnect filter automatically when drive is off line or at low load and frequency (generally below 35% of motor power). Indicating lights on front panel of VFD shall display filter operation, motor sensing, over temperature alarm and fuse failure. No field wiring of HPF shall be required.
3. VFD Output dv/dt Filter (optional): For motor lead length distances greater than 100 feet, between drive and motor, provide an output dv/dt filter. Filter shall be a tuned resistor-inductor (RL) type approved by motor manufacturer, to increase voltage rise time and reduces dv/dt at the motor due to motor cable length.
4. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

R. Bypass Systems

1. Provision (optional): Provide bypass switching and motor OCPD in accordance with Division 22 and/or 23 "Variable Frequency Drive Schedule" requirements.
2. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
3. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
4. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
5. Bypass Contactor: Load-break, NEMA-rated contactor.
6. Output Isolating Contactor: Load-break, NEMA-rated contactor.
7. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism. A three-contactors-style bypass is an option to accomplish isolation of the VFD in lieu of an isolation switch.
8. Bypass Contactor Configuration: Full-voltage (across-the-line) or solid-state reduced-voltage type. Utilize full-voltage type for motors less than or equal to 10HP@ 208V or 25HP@460V and solid-state type for all other motor horsepowers, unless otherwise indicated in the "Variable Frequency Drive Schedule".

    a. NORMAL/BYPASS selector switch.
    b. HAND/OFF/AUTO selector switch.
    c. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
    d. Contactor Coils: Pressure-encapsulated type.
    e. Operating Voltage: Depending on contactor IEC or NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

f. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

9. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 50 VA.

10. Overload Relays: NEMA ICS 2.

a. Solid-State Overload Relays:

1) Switch or dial selectable for motor-running overload protection.
2) Sensors in each phase.
3) Class 10/20/30 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

b. NO isolated overload alarm contact.
c. External overload reset push button.

11. Operation: The bypass system shall not depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair or replacement. Serial communications shall remain functional even with the VFD removed.

S. Optional Features

1. Multiple-Motor Capability: VFD suitable for variable-speed service to multiple motors. Overload protection shuts down VFD and motors served by it, and generates fault indications, when overload protection activates. The VFD shall be capable of supporting the total load of all motors with input control of the HPF as the load on the VFD varies to prevent introduction of capacitive reactive power (kVAR) on the electrical system greater than 20% of its rating. The HPF shall be sized in accordance with the ”VFD schedule”.

T. Enclosures

1. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
2. Dry and Clean Indoor Locations: Type 1.
3. Outdoor Locations: Type 3R.
4. Wash-Down Areas: Type 4X, stainless steel.
5. Other Wet or Damp Indoor Locations: Type 4.
6. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
7. Plenum Rating: When located in plenum, UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

U. Accessories

1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

    a. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oiltight type.
    b. Push Buttons: Covered type; maintained or momentary.
    c. Pilot Lights: LED or transformer types. Red; push to test.
    d. Selector Switches: Rotary type.
    e. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

2. Reversible NC/NO bypass contactor auxiliary contact(s).
3. Control Relays: Auxiliary and adjustable solid state time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
6. Supplemental Digital Meters (or provided via keypad):

    a. Elapsed-time meter.
    b. Kilowatt meter.
    c. Kilowatt-hour meter.

7. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
8. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
9. Cooling Fan and Exhaust System: For NEMA 250, or UL 508 component recognized: Supply fan, with composite stainless steel intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT
10. Sun shields installed on fronts, sides, and tops of NEMA 3R enclosures installed outdoors and subject to direct and extended sun exposure. Outdoor NEMA 4X units shall include an AC unit.
11. Spare control-wiring terminal blocks; unwired
12. Run interlock protection for remote motor disconnect monitoring.

V. Source Quality Control

1. Testing: Test and inspect each VFD prior to shipment with line reactor and/or HPF according to requirements in NEMA ICS 61800-2 and the following:

    a. Test VFD while connected to a motor that is comparable to that for which the VFD is rated.

b. Verification of Performance: Rate VFDs according to operation of functions and features specified.
c. Test the harmonic distortion for compliance with IEEE 519, 2014 edition.

2. VFDs will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.
4. Certify compliance with specifications.

W. Low Harmonic Drive Solution

1. Provide an Active Front End-Ultra Low harmonic drive for each VFD as indicated in the Variable Frequency Drive Schedule.
2. Harmonic mitigation hardware shall be provided to limit the current distortion to 3% total harmonic current distortion, when measured at the lugs of the drive. The harmonic mitigation hardware shall be internal to the drive package and include the following characteristics:

a. An IGBT based active front end shall be used for mitigation of low frequency harmonics. An LCL filter shall be installed in front of the IGBTs to remove high frequency harmonics.
b. The drive shall provide full motor nameplate voltage while operating the motor at nameplate RPM. The output IGBTs must be modulating and in control of the motor during this 100% speed/load operating condition. The specified 3% current distortion and 1.0 displacement power factor shall be achievable during this operating condition.
c. The hardware structure of the front end shall boost the DC bus voltage by 10% during low line conditions.

3. The VFD shall be ABB ACH580-31 (Basis of Design) or approved manufacturer equal.

2.2 HARMONIC PASSIVE FILTER (HPF)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. TCI, LLC
2. MTE Coorporation
3. Mirus International, Inc.
4. Eaton Corporation
5. Square D/Schneider Electric

B. Description: Tuned frequency inductor-capacitive network designed to filter characteristic low frequency harmonics (5^{th}, 7^{th}, 11^{th}, 13^{th}, etc.) generated from VFD three-phase diode rectifier full wave converters, while inproving the system power factor at the fundamental frequency. The harmonic filter shall suppress the characteristic harmonics without adversely reacting with or resonate with the power system or attract harmonics from other sources.

1. The HPF shall be a component installed in the VFD enclosure by the VFD manufacturer.

2. The HPF shall be factory tested and certified by the HPF manufacturer prior to shipment to the VFD manufacturer. Test reports, certifications, operations and parts manual, plus warranty shall be forwarded to VFD manufacturer for inclusion in the Operations and Maintenance Manual.
3. The HPF shall be factory wired and tested with the VFD by the VFD manufacturer.

C. Design and Rating: The HPF shall consist of an input LR in series with the load and an inductive-capacitive network in parallel with the load (shunt). The HPF shall be capable of feeding a three-phase input rectifier with AC line reactor or DC link choke, with a combination line reactor and DC link choke. The shunt circuit inductors and series line reactors shall be designed for harmonic filtering application and for slowing rate of rapid current changes.

1. HPF shall be UL-listed and labeled.
2. The combination of the VFD and HPF shall meet all requirements specified in IEEE Standard 519, latest edition for harmonic distortion.
3. edtition for harmonic distortion.
4. Suitable with multi-motor VFD variable-speed control of multiple motors.
5. Full load efficiency of the HPF shall be greater than 97 percent.
6. SCCR rating shall equal to that of the VFD.
7. Emergency generator compatibility. The HPF shall not introduce a capacitive reactive power (kVAR) greater than 40% of its HP rating over the full load range.
8. All internal wiring and bus shall consist of Class B, 98 percent conductivity copper.
9. High-endurance harmonic-rated capacitors with input contactors rated for 600 volts, control power transformer and connection terminals in the filter to control the insertion of the inductive-capacitive circuit through the use of a relay contact wired in the VFD. The contactor shall be programmed by the VFD manufacturer to open/close on low motor load or speed preventing leading power factor on the electrical system (generally connected at 20% load and disconnected at 35% load). Bleeding resistors located on the capacitors shall discharge capacitor kVARs upon filter shutdown.
10. Over temperature switch circuit to open contactor to internal reactors and capacitors to prevent filter damage due to abnormal operating conditions exceeding the design rating of the inductive-capacitive network.
11. Filter contactor monitoring and indication by the VFD.

D. Options: The following options shall be supplied in accordance with the manufacture design.

1. Fuses sized to protect the inductive-capacitor circuit.
2. Systems with fuses shall have voltage monitoring of the circuit to report the status of the fuses connected to the VFD indication panel.
3. Heaters to prevent harmful effects of corrosion and condensation on the sensitive electronic equipment for use in applications which require the environmental protection of a NEMA 3R or 4X enclosure.

2.3 ACTIVE FILTER (HAF)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. TCI, LLC

2. MTE Coorporation
3. Eaton Corporation; Cutler-Hammer Products
4. Square D

B. Description:

1. Listed and labeled for integrated short circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

C. Output Rating: 3-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs and HAFs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD and HAF installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFD and HAF to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs and HAFs if not factory installed with equipment and with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels. Adhere to manufacturer’s written instructions and NEMA ICS 3.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with VFD disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall lightweight structural-steel channels bolted to wall, floor and/or ceiling. For controllers not installed on walls, provide freestanding racks complying with Division 26, Section "Hangers and Supports for Electrical Systems." Maintain manufacturer and code clearances around VFDs and HAFs for access, maintainence and ventilation.

C. Floor-Mounting Controllers: Install VFDs and HAFs on 4-inch nominal thickness housekeeping concrete base similar installations of transformers, switchboards, etc., whether shown on not on

the Contract Drawings. Maintain manufacturer and code clearances around VFDs and HAFs for access, maintenance and ventilation. Comply with requirements for concrete base specified in Division 03, Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Roof-Mounting Controllers: Install VFDs on roofs with tops at uniform height and with VFD disconnect operating handles not higher than 79 inches above finished roof or platform surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs, structural steel, roof and/or platform. Seal roof penetrations after raceways are installed. Maintain manufacturer and code clearances around VFDs for access, maintenance and ventilation.

1. Curbs and roof penetrations are specified in Division 7, Section "Roof Accessories."
2. Structural-steel channels are specified in Division 26, Section "Hangers and Supports for Electrical Systems."

E. Seismic Bracing: Comply with requirements specified in Division 26, Section "Vibration and Seismic Restraints for Electrical Systems."

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Install fuses in each fusible-switch VFD if not factory installed.

H. Install fuses in control circuits if not factory installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

K. Disconnect switches between the VFD output and driven motor shall include a dry contact auxiliary switch for the run interlock protection feature that will open upon moving disconnect switch to the “off” position. This contact shall be wired into the VFD safety circuit per manufacturer’s specifications.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Common Materials and Methods for Electrical," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify separately mounted VFDs, HAFs components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFDs and HAFs including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD and HAF.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between VFD and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Install HAF current transformers (CT) on line side of HAF as shown in accordance with manufacturer’s instructions.

C. Bundle, train, and support wiring in enclosures.

D. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

E. Provide interlock wiring for each VFD load side motor circuit disconnect and coordinate with the VFD manufacturer for proper connections at the disconnect switch and wiring knockout location on the VFD. Allow enough wiring in the VFD to make final connections to the interlock run protection terminals. The VFD manufacturer will make final connections at the VFD and perform testing and certification for the electric run interlock protection feature. Provide 2#12 AWG in ½ inch EMT raceway.

3.7 CONNECTIONS

A. Install wiring between HAF and electrical equipment circuit breaker according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Follow HAF manufacturer’s installation wiring instructions for connecting HAF(s).

B. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

C. Conductor type requirements are specified in Division 26, Section “Low Voltage Electrical Power Conductors and Cables”.

D. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

E. Ensure point to point conduit is utilized for all conductors in dedicated conduit. No other conductors shall be in conduits other than the equipment point to point connection.

1. Input/Output Conductors: VFD separately mounted shall have their input power conductors isolated from VFD output conductors to motor by installing in separate and dedicated conduits.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD and HAF element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFD and HAF wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD and HAF element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Test each motor for proper phase rotation.
5. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification or the manufacturer’s factory certified startup requirements. Certify compliance with test parameters.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
7. Test the harmonic distortion at the connection or bus of each PCC for compliance with IEEE 519, 2014 edition. Compare test results with final harmonic analysis submittal report.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFDs and HAFs will be considered defective if they do not pass tests and inspections. Make correction and retest.

E. Prepare test and inspection reports, including a certified report that identifies the VFD, HAF and describes all test and scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.10 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors (if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Division 26, Section “Electrical Systems Studies and Analysis”

E. Set field-adjustable pressure switches.

3.11 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs, LRs, HPFs, and/or HAFs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers and harmonic active filters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 29 23

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply for supply of power in event of failure of the normal supply, which shall consist of, but not be limited to, the following:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Engine Generator Vibration Isolators
5. Batteries and Battery Charger
6. Generator Control Panel
7. Automatic Controls
8. Exhaust Silencer, Solenoid Drain Valve(s) and Flexible Connections
9. Engine Generator Foundation
10. Remote Annunciator
11. Weatherproof Enclosure
12. Jacket Heaters
13. Battery Holder with Heater(s)
14. Oil Heater(s)
15. Fuel Tank
16. Fuel/Water Separator
17. Fuel Oil
18. Day Tank Mounting Pad
19. Load banks
20. Outdoor enclosure

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

C. Provide fully automatic operation so that the generator accepts rated load within 10 seconds after loss of normal electric power. Upon restoration of normal electric power, the system shall automatically transfer the emergency load back to the normal power portion of the electrical system and shut down the generator, returning the emergency system to standby, ready to accept load.

1.3 WORK NOT INCLUDED

A. Contractor for DIVISION 26, ELECTRICAL, will furnish the following for installation by DIVISION 23, MECHANICAL:

1. Remote radiator with expansion tank
2. Engine exhaust muffler and flexible connection
3. Solenoid drain valve for automatic drain of engine exhaust muffler
4. Solenoid drain valve for automatic drain of engine exhaust piping
5. Fuel water separator

1.4 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

1.5 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For installer, manufacturer, and testing agency.

E. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than two (2) hours normal travel time from Installer's place of business to Project site.

2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. The engine generator manufacturer or his authorized distributor shall maintain a parts depot and 168 hour/week service facility within a 75-mile radius of the job site. To prevent unnecessary or prolonged periods of time for service or repairs, the unit supplier shall have at least 85% of all engine replacement parts in his stock at all times. Certified proof of this requirement shall be available from the supplier. A personal inspection of the supplier's facilities may be made by the Architect to verify that this requirement is met.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with the NEC.

I. Comply with NFPA 110 requirements for Level 2 emergency power supply system.

J. Comply with UL 2200.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two weeks in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet.

1.8 EMISSIONS

A. To maintain environmental quality, engine shall be equipped with a precombustion chamber fuel system; or have suitable emission control equipment to ensure that gaseous exhaust emissions meet Federal, State and Local EPA emission standards.

B. The maximum exhaust emissions shall be at manufacturer's rated speed and load as measured by SAE-J177 and SAE-J215 recommended practices. Verification of the ability to meet these emission specifications shall be provided by the engine manufacturer.

1.9 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Equipment furnished under this Section shall be guaranteed against defective parts or workmanship for a period of 2 years from date of field testing and acceptance by the Owner or 1500 hours of operation, whichever comes first.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

B. Scheduled Oil Sampling: Provide quarterly scheduled oil sampling and provide owner with detailed analysis and report. Satisfactory test results shall allow up to three (3) years between lube oil changes.

1.12 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar
2. Kohler Co.; Generator Division
3. Onan/Cummins Power Generation; Industrial Business Group
4. Generac Power Systems Inc.
5. MTU Onsite Energy

B. Governor

1. Barber-Colman Company
2. Woodward Governor Co.

C. Muffler

1. Riley-Beaird, Inc. (basis of design)
2. Donaldson Company, Inc.
3. York

D. Fuel Tanks

1. Simplx, Inc. (basis of design)
2. Tramont
3. Preferred Utilities Manufacturing Corp.

E. Vibration Isolators

1. Amber-Booth Co.
2. Korfund Dynamics Corp.
3. Peabody Noise Control, Inc.
4. Mason Industries, Inc.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 0.25 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 seconds.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

    a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Ultra Low Sulfur Diesel (ULSD)

B. The governor shall maintain engine speed at 1800 rpm and steady state frequency regulation within ±0.25%.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. The engine shall be a liquid cooled, 4-cycle, turbocharged and aftercooled diesel of the size specified above. It shall meet specification when operating on No. 2 diesel fuel (ASTM D396). Manufacturers who require different fuel composition for various seasons will not be acceptable.

E. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

F. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. The engine shall have an engine-driven or electric fuel transfer pump capable of lifting fuel twelve feet, fuel filters, electric solenoid fuel shutoff valve, fuel water separator and a fuel distribution system. It shall have a positive displacement, full pressure lubrication oil pump, cartridge oil filter(s), dipstick, oil drain, flexible fuel line, dry type replaceable air cleaner elements and a positive-engagement solenoid shift-starting motor.
3. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

G. Coolant Jacket Heater: Forced-circulation type, factory installed in coolant jacket system, thermostatically controlled electric block heater to maintain engine coolant at not less than 90° F. (32° C.). The wattage shall be 9KW and the heater shall operate on a 208-volt single phase AC, 60 Hertz source. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

H. Governor: Electronic, adjustable isochronous, with speed sensing.

I. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame, blower fan, integral engine driven coolant pump, thermostat and radiator duct flange. It shall maintain full-load operation continuously at 110° F. maximum ambient temperature with up to 0.5 inches of water static pressure on the fan.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent distilled water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100% load with 10% spare capacity.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

J. Muffler/Silencer: Furnish a gasproof, seamless, stainless steel, flexible exhaust connection and silencer rated for critical application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. The silencer shall provide a sound level of 8 dBA or less than the specified noise level of the enclosure measured 90° off axis, at a distance of 10 feet from exhaust discharge and after installation is complete.
2. Exhaust muffler shall be internally insulated and installed inside the custom sound attenuated enclosure.
3. External Generator Exhaust Piping:

    a. If this generator system includes an exhaust piping extension beyond the piping and muffler provided by the manufacturer, the generator manufacturer shall coordinate sizing and performance of all exhaust system components and shall confirm that this coordination is included in the submittal. The generator manufacturer shall confirm that the exhaust system as specified and shown on the documents does not exceed the engine manufacturer’s back pressure specifications. See Division 23 drawings and specifications for external exhaust system requirements.

K. Furnish a drain valve for the silencer to remove condensate when engine is not operating. Valve shall be normally closed.

L. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

M. Starting System: 24-VDC electric, with negative ground.

1. Redundancy: Provide two completely redundant starting systems including dual starters, dual battery strings and a best battery selector switch. If one complete battery string is down the other shall be able to start the engine.
2. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
3. Cranking Motor: Dual heavy-duty units that automatically engage and release from engine flywheel without binding.
4. Cranking Cycle: As required by NFPA 110 Level 1
5. Battery Sets: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
6. Battery Cables: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
7. Battery Racks: Factory fabricated of metal with acid-resistant finish. Include accessories required to support and fasten batteries in place.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 45-A minimum continuous rating.
9. Battery Chargers: Current-limiting, automatic-equalizing and float-charging type. Units shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA IP20, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel for 24 hours' continuous operation of at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

5. High level 90 and 95% fill alarm with remote contacts for audible annunciation at the unit, with automatic shut off of fill device at 95%.
6. Low level fuel level alarm when the fuel level reaches 25% of tank capacity.
7. Overspill containment boot with (5) gallon capacity at fuel fill opening and drainage back into the tank for overspill during fueling.
8. Provide fuel tank venting per California Fire Code.
9. Provide dedicated 2" supply and return ports on the fuel tank for use with a portable fuel polisher.

2.5 CONTROL AND MONITORING

A. A controller capable of facing right, left, or rear shall be mounted as described below. The microprocessor control board shall be conformal coated. Relays will be acceptable only in high-current circuits. Circuitry shall be of plug-in design for quick replacement. Controller shall be equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine. The controller shall include a three-position (Automatic-OFF-TEST) selector switch. In the TEST position, the engine shall start and run regardless of the position of the remote starting contacts. In the Automatic position, the engine shall start when contacts in the remote-control circuit close and stop five minutes after those contacts open. In the OFF position, the engine shall not start even though the remote start contacts close. This position shall also provide for immediate shutdown in case of emergency. Reset of any fault shall also be accomplished by putting the switch to the OFF position.

B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.

12. Generator overload.
13. Engine cool down cycle, timed at 15 minutes.

E. Indicating and Protective Devices and Controls:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Start-stop switch.
11. Overspeed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

G. Connection to Data Link: Provide MODBUS TCP communication via ethernet.

H. Connection to Fire Alarm: A separate terminal block, factory wired to Form C dry contacts, for each required alarm and status indication to fire alarm annunciator.

I. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Engine high-temperature shutdown.
2. Lube-oil, low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature prealarm.
6. Lube-oil, low-pressure prealarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

J. Remote Alarm Annunciator: An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

K. Remote Emergency-Stop Switch: Provide an emergency engine generator shutdown station within the central plant electrical room for manual shutdown of engine generator. The station shall be a mushroom type pushbutton with a hinged and alarmed lexan cover. Provide an identification plate fixed permanently to the wall above the station indicating its use, such as: "FOR EMERGENCY SHUTDOWN OF EMERGENCY GENERATOR, LIFT COVER AND PUSH BUTTON"

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. The alternator shall be synchronous type, brushless, self-ventilated of drip-proof construction with single maintenance free bearing and amortisseur rotor windings. The insulation shall meet NEMA standards for Class H and shall be further protected with epoxy varnish. The brushless excitation system shall be controlled by a solid-state, three phase regulator capable of maintaining ±2% from no load to full rated load. Conformal coating shall protect the regulator from the environment.

C. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

D. Electrical Insulation: Class H.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Drip-proof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point. The wattage shall be 1200W and the heater shall operate on a 208 volt single phase AC, 60 Hertz source.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding with coastal insulation protection.

L. Subtransient Reactance: 13 percent, maximum.

2.8 LOAD BANK

A. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive and reactive unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 80 percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch-square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

I. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.9 DUAL PURPOSE DOCKING STATION

A. 480/277V dual purpose docking station shall include two sets of Camloks. One set, readily accessible, for connection of a temporary load bank. The second set, shall be behind a Kirk Key Interlocked door. Permanent generator circuit breakers on both units shall be Kirk Keyed in common with the access panel covering the portable generator Camloks so that the portable generator cannot be connected to the Load bus while the permanent generator is connected to the Load bus.

B. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

C. Enclosures:

1. NEMA 3R rain-tight, aluminum enclosure.

a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall be maintained with access plate open for cable entry.
a. Front and side through a front access panel shall be accessible for maintenance.
b. Top, side, and back through a front access panel shall be accessible for permanent cabling.

2. Finishes:

a. Paint after fabrication. Powder coated Hammertone Gray.

D. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.

E. Load bank and portable generator connectors shall be Camlok style mounted on gland plate (male for the portable generator and female for the portable load bank). Male Camloks to be behind Kirk Key Interlocked Door.

1. Camlok shall be color coded according to system voltage

a. A phase – Brown
a. B phase – Orange
b. C phase – Yellow
c. N Neutral – White
d. G Ground - Green

F. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.

G. Voltage & Amperage shall be as shown on project one line drawing. Camloks shall be color coded as appropriate for the specified voltage.

2.10 DIESEL OXIDATION CATAYST (DOC)

A. The DOC substrate shall consist of alternating corrugated layers of stainless-steel alloy foil that is layered, stacked and electronically resistant welded. The channels shall provide a high surface area and multiple turbulent zones without causing excessive exhaust back pressure.

B. The catalytically active materials shall be a precious metal coating on the DOC that is made from a combination of Noble Group Metals selected by the manufacturer.

C. A single high temperature fiberglass gasket shall be wrapped around the element to seal it within the housing. The top surface of the sealing plate shall be sealed against the door when it is installed.

D. The catalyst substrate and metal foil shall not sinter or degrade when exposed to exhaust inlet temperature up to 1,250°F (677o C).

E. To facilitate maintenance, the catalyst(s) must be removable via bolt-on access doors.

2.11 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated or pre-engineered enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
2. Sound Requirements: Enclosure to achieve 75 dBA at 23 feet away.
3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads up to 110 mph.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
5. Hinged Doors: With padlocking provisions.
6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: Within enclosure.

B. Provide an external fuel fill with hinged door, level gauge, tank full indication (audible and visual) and an overfill prevention valve.

C. Hinged Doors: 36” wide commercial doors shall be of 18-gauge galvanized steel construction painted to match the enclosure exterior and incorporated into 16-gauge painted galvanized steel frames that are structurally integrated into the enclosure wall. The door(s) shall include heavy-duty stainless-steel hinges and a passage latch, which includes commercial key-sets. The passage latch shall incorporate a handicapped-access style lever-type operator for ease of egress in the event of emergency. The latch hardware shall allow escape from within when locked externally. Doors shall include a positive restraint to prevent the door from opening more than 100 degrees in normal operation. Door holdback hardware shall be provided to secure the door to the enclosure wall when the door is opened approximately 180 degrees during installation and maintenance evaluations. Wall adjacent to door includes aluminum protector plate for impact protection from the protruding door handle. All door openings include an overhead rain gutter for channeling rainwater away from the enclosure. Provide panic bar exit hardware.

D. Enclosure Electric: 100 amp 120/208V panelboard and 30kVA transformer. Feed all generator set loads and lighting from this panel.

E. All enclosure electric shall be run in surface mounted EMT.

F. Interior Lighting: Provide weather-resistant LED lighting with 50 fc average maintained.

G. (2) DC powered emergency lights with timer switch

H. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Fixed Dampers: At engine cooling-air inlet. Designed to be storm proof and self-draining to prevent entry of rain.
2. Inlet and exhaust air handling equipment shall be designed so as to maintain a combined total maximum static pressure drop of 0.5 inches of water gauge through the enclosure, including all air handling devices.
3. Inlet air will be through an operable louver, weather hood, acoustigrid, or a combination thereof, and shall provide the necessary level of attenuation. Inlet air handling devices shall be sized and designed so as to minimize the entrance of debris, rain and snow. Inlet openings will be screened to prevent the entrance of rodents, miscellaneous debris, etc.
4. Dampers shall not be used as inlet air handling devices, except where incorporated within the primary air handling device for the purpose of providing a controlled temperature environment within the enclosure.
5. Air discharged from the enclosure shall be through gravity-discharge dampers, weather hoods, acoustigrids, plenums, or combination thereof, and shall provide the necessary level of attenuation. Discharge openings in hoods or acoustigrids shall be protected with screen.

I. Convenience Outlets (2 minimum): Factory-wired, GFCI, connected to enclosure electrical panel.

J. Provide stairs and landings for all personnel doors complete with handrails. This shall be submitted along with the enclosure submittals.

K. Weight: The weight of the entire unit consisting of generator set, enclosure and other specified items including all liquids (i.e., fuel oil and cooling solutions) shall be calculated by the enclosure manufacturer. The base of the unit shall be designed and manufactured as a heavy duty, structural steel construction with lifting provisions to support the calculated weight.

2.12 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.13 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FACTORY TESTING

A. The Engineer and the Owner's Representative may witness factory tests and review generator operation.

1. Inform the Owner's Representative two weeks prior to tests and arrange for representatives to be present at the time of tests.
2. The cost of Engineer's and Owner's expenses for the factory visit to be part of contract price.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Equipment anchoring shall follow the anchoring details and calculations performed specifically for this project. The calculations and details shall be submitted as a separate submittal as indicated in the "Submittals" article within this specification section.

D. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch to fuel tank base. Install entire assembly on concrete base as indicated on the drawings. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Provide concrete mounting pad for packaged engine generator set with dimensions and materials as indicated on drawings. Verify dimensions with engine generator manufacturer prior to installing concrete pad. Allow proper clearances in accordance with manufacturer's installation manual or instructions for appurtenances to be fixed to unit and for proper maintenance.

F. Install piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified per Division 23 drawings and specifications.

G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Provide conduit, wiring, and connections required and recommended by unit supplier. Final connections to generator made with 18 inch lengths of flexible conduit.

D. Provide all control and alarm wiring in steel conduit in accordance with Division 26 Section Raceways and Boxes for Electrical Systems.

E. Connect neutral point of generator and generator frame to ground by green insulated copper conductor. See grounding detail on drawings.

F. Provide necessary electrical feeder to serve transformer. All control wiring and connections shall be made in accordance with manufacturer's approved wiring and installation diagrams.

G. All control wiring and connections shall be made in accordance with manufacturer’s approved wiring and installation diagrams.

H. Connect engine remote shutdown station to control circuit of generator.

I. Install new remote annunciator as required and as indicated on drawings and connect to generator control panel.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

L. Prior to testing of the generator, fill the fuel-oil system with diesel fuel oil. After testing is completed, refill the system so that the Owner is furnished with a full supply of fuel oil.

3.5 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. Provide a full load test utilizing a portable test bank, if required, for a minimum of four hours. Record the following at 20 minute intervals during the four hour test:

a. Kilowatts
b. Amperes
c. Voltage
d. Frequency
e. Coolant temperature
f. Room temperature
g. Oil pressure
h. Provide six certified copies of final performance tests.

6. Simulate power failure including operation of transfer switches, automatic starting cycle, and automatic shutdown and return to normal.
7. Test alarm and shutdown circuits by simulating all conditions. Correct any defects which may become evident during the test period.
8. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and retest as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

J. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 32 13

SECTION 26 33 23 - CENTRAL BATTERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes UPS central battery inverters with the following features:

1. Output distribution section.
2. Internal maintenance bypass/isolation switch.
3. External maintenance bypass/isolation switch.
4. Multiple output voltages.
5. Emergency-only circuits.
6. Remote monitoring provisions.

1.3 DEFINITIONS

A. LCD: Liquid-crystal display

B. LED: Light-emitting diode

C. THD: Total harmonic distortion

D. UPS: Uninterruptible power supply

1.4 SUBMITTALS

A. Product Data: For the following:

1. Electrical ratings, including the following:

a. Capacity to provide power during failure of normal ac.
b. Inverter voltage regulation and THD of output current.
c. Rectifier data.
d. Transfer time of transfer switch.
e. Data for specified optional features.

2. Transfer switch.
3. Inverter.
4. Battery charger.

5. Batteries.
6. Battery monitoring.
7. Battery-cycle warranty monitor.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
2. Elevation and details of control and indication displays.
3. Output distribution section.

C. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association or is an NRTL.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Central Battery Inverter System: UL 924 listed.

D. Comply with NFPA 70 and NFPA 101.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:

1) Full Warranty: Two Years
2) Pro Rata: 19 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bigbeam Emergency Systems, Inc.; Siltron Division.
2. Chloride Systems.
3. Cooper Industries, Inc.; Sure-Lites Division.
4. Dual-Lite.
5. Hubbell Incorporated; Hubbell Lighting.
6. Lithonia Lighting; Emergency Lighting Systems.
7. Thomas & Betts Corporation; Emergi-Lite Division.

2.2 OPERATION

A. The system consists of batteries, battery charger, AC to DC converter, DC to AC inverter, transfer and control circuitry, and bypass switch. When system is in service, the inverter operates continuously. The power to drive the inverter is feed from the normal source through the AC to

DC converter. When normal service is interrupted, power to drive the inverter is drawn from the system's batteries through a diode-output, and the wave form shall be uninterrupted. Upon restoration of normal service, the battery charger is automatically turned on. The AC to DC converter again supplies the power to drive the inverter. Inverter failure causes bypass switch to connect load directly to normal service.

2.3 INVERTER PERFORMANCE REQUIREMENTS

A. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.

1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

B. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.

1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

C. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.

1. Automatic Operation:

a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.
b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
c. If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
e. If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float-charge mode.
f. If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.

g. If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
h. When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
i. If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

2. Manual Operation:

a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

2.4 SERVICE CONDITIONS

A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Ambient Temperature for Electronic Components: 32 to 98 deg F.
2. Relative Humidity: 0 to 95 percent, noncondensing.
3. Altitude: Sea level to 4000 feet.

2.5 INVERTERS

A. Description: Solid-state type, with the following operational features:

1. Automatically regulate output voltage to within plus or minus 5 percent.
2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.

a. THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.

4. Output Protection: Current-limiting and short-circuit protection.
5. Output Protection: Ferroresonant transformer to provide inherent overload and short-circuit protection.
6. Surge Protection: Include as required by the NEC.
7. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
8. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

2.6 BATTERY CHARGER

A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.7 BATTERIES

A. Description: Premium, valve-regulated, recombinant, lead-calcium batteries.

1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2.8 ENCLOSURES

A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.

B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.9 SEISMIC REQUIREMENTS

A. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1 "Submittals" Article.

2.10 CONTROL AND INDICATION

A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.

B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.

C. Indications: Labeled LED.

1. Quantitative Indications:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. System output voltage, each phase, line to line.
d. System output current, each phase.
e. System output frequency.
f. DC bus voltage.
g. Battery current and direction (charge/discharge).
h. Elapsed time-discharging battery.

2. Basic Status Condition Indications:

    a. Normal operation.
    b. Load-on bypass.
    c. Load-on battery.
    d. Inverter off.
    e. Alarm condition exists.

3. Alarm Indications:

    a. Battery system alarm.
    b. Control power failure.
    c. Fan failure.
    d. Overload.
    e. Battery-charging control faulty.
    f. Input overvoltage or undervoltage.
    g. Approaching end of battery operation.
    h. Battery undervoltage shutdown.
    i. Inverter fuse blown.
    j. Inverter transformer overtemperature.
    k. Inverter overtemperature.
    l. Static bypass transfer switch overtemperature.
    m. Inverter power supply fault.
    n. Inverter output overvoltage or undervoltage.
    o. System overload shutdown.
    p. Inverter output contactor open.
    q. Inverter current limit.

4. Controls:

    a. Inverter on-off.
    b. Start.
    c. Battery test.
    d. Alarm silence/reset.
    e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. Inverter on battery.
2. Inverter on-line.
3. Inverter load-on bypass.
4. Inverter in alarm condition.
5. Inverter off (maintenance bypass closed).

E. Include the following minimum array:

1. Ready, normal-power on light.
2. Charge light.
3. Inverter supply load light.
4. Battery voltmeter.

5. AC output voltmeter with minimum accuracy of 2 percent of full scale.
6. Load ammeter.
7. Test switch to simulate ac failure.

F. Enclosure: Steel, with hinged lockable doors, suitable for floor mounting. Manufacturer's standard corrosion-resistant finish.

2.11 OPTIONAL FEATURES

A. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.

B. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.

C. Maintenance Bypass/Isolation Switch: Load is supplied, bypassing central battery inverter system. Normal supply, electromechanical transfer switch, and system load terminals are completely disconnected from external circuits.

D. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.

2.12 OUTPUT DISTRIBUTION SECTION

A. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

2.13 SYSTEM MONITORING AND ALARMS

A. Remote Status and Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

B. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 2

"Control and Indication" Article. Remote computer and connecting signal wiring will be provided by Owner. Include the following features:

1. Connectors and network interface units or modems for data transmission via RS-232 link.
2. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Division 26 Section "Electrical Power Monitoring and Control" and the operating system and configuration of Owner-furnished computers.

C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

1. Annunciation of Alarms: At inverter system control panel.

D. Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.

1. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
2. Additional monitoring functions and features shall include the following:

    a. Measuring and recording of total voltage at battery terminals; providing alarm for excursions outside proper float voltage level.
    b. Monitoring of ambient temperature at battery and initiating an alarm if temperature deviates from normally acceptable range.
    c. Keypad on device front panel provides access to monitored data using front panel display.
    d. Alarm contacts arranged to provide remote alarm for abnormal battery voltage or temperature.
    e. Memory device to store recorded data in nonvolatile electronic memory.
    f. RS-232 port to permit downloading of data to a portable personal computer.
    g. Modem to make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by Owner.

2.14 SOURCE QUALITY CONTROL

A. Factory test complete inverter system, including battery, before shipment. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment anchoring shall follow the anchoring details and calculations performed specifically for this project. The calculations and details shall be submitted as a separate submittal as indicated in the "Submittals" article within this specification section.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the NEC.

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that central battery inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 33 23

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches
2. Bypass/isolation switches
3. Nonautomatic transfer switches
4. Remote annunciation systems
5. Remote annunciation and control systems

B. Related Sections include the following:

1. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps
2. Division 21 Section "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches and bypass/isolation switches through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. AC Data Systems, Inc.
b. Caterpillar; Engine Div.
c. Emerson; ASCO Power Technologies, LP
d. Generac Power Systems, Inc.
e. GE Zenith Controls
f. Kohler Power Systems; Generator Division
g. Onan/Cummins Power Generation; Industrial Business Group
h. Russelectric, Inc.
i. Spectrum Detroit Diesel

2. Transfer Switches Using Molded-Case Switches or Circuit Breakers:

a. AC Data Systems, Inc.
b. Eaton Electrical Inc.; Cutler-Hammer
c. GE Zenith Controls
d. Hubbell Industrial Controls, Inc.
e. Lake Shore Electric Corporation

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

K. Battery Charger: For generator starting batteries.

1. Float type rated 10 A
2. Ammeter to display charging current
3. Fused ac inputs and dc outputs

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

O. Unless otherwise noted on the Drawings, all transfer switches 800 amperes or less shall be “front accessible only” type.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

H. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

I. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

J. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

K. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

L. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is not available.

2.4 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.5 NONAUTOMATIC TRANSFER SWITCHES

A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

B. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

C. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

D. Nonautomatic Transfer-Switch Accessories:

1. Pilot Lights: Indicate source to which load is connected.
2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

3. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

2.6 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.7 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.
7. Control of switch operation in either direction.
8. Control of time-delay bypass for transfer to normal source.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
3. Digital Communication Capability: Matched to that of transfer switches supervised.
4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.8 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Connect all new and existing automatic transfer switches to the appropriate emergency generator for starting and controls.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

D. Testing Agency's Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages

and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

E. Coordinate tests with tests of generator and run them concurrently.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Remove and replace malfunctioning units and retest as specified above.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes lightning protection for buildings.

1.3 DEFINITIONS

A. LPI: Lightning Protection Institute

B. NRTL: National recognized testing laboratory

1.4 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.

B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automatic Lightning Protection
2. ERICO International Corporation
3. Harger Lightning Protection, Inc.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. Robbins Lightning Inc.
7. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class aluminum, solid, unless otherwise indicated.

1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.

C. Stack-Mounting Air Terminals: Stainless steel.

D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal the following raceways and/or conductors:

1. System conductors
2. Down conductors
3. Interior conductors
4. Conductors within normal view from exterior locations at grade within 200 feet of building.
5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

G. A counterpoise installation based on requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to counterpoise conductor.
2. Bond grounded metal bodies on building within 12 feet of ground to counterpoise conductor.
3. Bond grounded metal bodies on building within 12 feet of roof to counterpoise conductor.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

B. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION 26 41 13

SECTION 26 43 13 – SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes SPD for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for devices with integral SPD.
2. Division 26 Section "Switchboards" for factory-installed SPD.
3. Division 26 Section "Panelboards" for factory-installed SPD.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. SPD: Surge protective devices.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283
2. UL 1449 (3rd edition 2009)

C. Qualification Data: For testing agency.

D. Field quality-control test reports, including the following:

1. Test procedures used
2. Test results that comply with requirements
3. Failed test results and corrective action taken to achieve requirements

E. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain surge protective devices and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Standard Surge Protective Devices." Provide a Manufacturer's Certificate certifying transient voltage surge suppression device complies with UL 1449 Third Edition Surge Voltage Ratings.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.

3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 12,000 feet above sea level.

1.7 COORDINATION

A. Coordinate location of field-mounted surge protective devices to allow adequate clearances for maintenance.

B. Coordinate surge protection devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within ten years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Protective Devices: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology, Inc.
2. Cutler-Hammer, Inc.; Eaton Corporation
3. General Electric Company
4. Liebert Corporation; a division of Emerson
5. Siemens Energy & Automation, Inc.
6. Square D; Schneider Electric
7. United Power Corporation

2.2 SERVICE ENTRANCE SURGE PROTECTIVE DEVICES

A. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 2 A and 24-V dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
11. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 240 kA per phase.

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 and 700 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.

2.3 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Modular design with field-replaceable modules, sign-wave-tracking type with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 2 A and 24-V, dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
10. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 120 kA per phase.

C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 and 700 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.

2.4 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:

1. LED indicator lights for power and protection status.
2. LED indicator lights for reverse polarity and open outlet ground.
3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
4. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
5. Rocker-type on-off switch, illuminated when in the on position.
6. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and No. 4.

B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.

C. Protection modes and UL 1449 VPR shall be as follows:

1. Line to Neutral: 475 V
2. Line to Ground: 475 V
3. Neutral to Ground: 475 V

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, 30-A (minimum) circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

C. Install indicator lights in face of switchboard.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Testing: Perform the following field tests and inspections and prepare test reports:

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 43 13

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts
2. Emergency lighting units
3. Exit signs
4. Lighting fixture supports
5. Retrofit kits for fluorescent lighting fixtures

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, wall box dimmers, and multipole lighting relays and contactors.
2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.3 DEFINITIONS

A. BF: Ballast factor

B. CRI: Color-rendering index

C. HID: High-intensity discharge

D. LER: Luminaire efficacy rating

E. Luminaire: Complete lighting fixture, including ballast housing if provided

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including manufacturer.
4. Energy-efficiency data, including lamp type, manufacturer.
5. Lamp and ballast warranty information.
6. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
7. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
8. Life, output, and energy-efficiency data for lamps.
9. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Luminaire submittals not including lamp and ballast types and manufacturer's name will be returned marked "not reviewed". Lamp and ballast types and manufacturer's name must be submitted with the luminaire submittals in order to review.

C. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets
    b. Speakers
    c. Sprinklers
    d. Smoke and fire detectors
    e. Occupancy sensors
    f. Access panels

5. Perimeter moldings.

E. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed
2. Accessories: Cords and plugs

F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

G. Qualification Data: For agencies providing photometric data for lighting fixtures.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70

E. Comply with the recommended standards of the Illuminating Engineering Society of North America.

F. Comply with the requirements of ASHRAE 90.1, Energy Standard for Buildings, Except Low-Rise Residential Buildings.

G. LED Compliance: LED components, lamps, drivers and fixtures shall comply with: PCC 47 CFR Part 15; UL 8750; ANSI/NEMA Standards C78.377, NEMA SSL-1, ANSI C82.77, IESNA Standards TM-16-05, RP-16, LM-79, LM-80 and TM-21.

H. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

I. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for LED luminaires: Provide a five year manufacturer’s warranty on LED luminaires including full replacement of any failed components and $50 labor allowance for each luminaire. Warranty shall be from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers

1. Luminaires

    a. Refer to "Luminaire Schedule", herein or on the Drawings.

2. LED Lamps and Modules:

    a. Philips
    b. General Electric
    c. Osram-Sylvania
    d. Cree
    e. Nichia

3. LED Power Supplies

    a. Osram-Sylvania
    b. General Electric
    c. Philips

4. LED Dimming Drivers

    a. Lutron

5. Substitutions - Under provisions of Division 1

    a. All proposed substitutions to the listed approved manufacturers must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the Bid Date and shall be made available to all bidders.
    b. Any substitutions (other than as directed by the owner) proposed by the contractor after the bid date shall be reviewed by the electrical engineer at a rate of $150 per hour at the contractors expense. A signed contract between the contractor and the design professional for such work is required before commencement of review.
    c. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuiting, devices and wiring. The contractor shall provided complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Luminaires shall bear UL inspection label, suitable to application and installed environment.

C. Furnish on request I.T.L. and/or E.T.L. test reports for luminaires furnished.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent
2. Specular Surfaces: 83 percent
3. Diffusing Specular Surfaces: 75 percent
4. Laminated Silver Metalized Film: 90 percent

H. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

    a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
    b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

I. Luminaire housing and door frame shall be fully sealed against light leakage. Light leaks between ceiling trims of recessed luminaires and ceiling will not be acceptable.

J. Alzak parabolic cones shall be guaranteed against fading for a minimum of 2 years. In the event of premature fading, luminaire manufacturer shall replace cones and pay for both labor and material costs.

K. Adjustable luminaires shall be capable of being locked into position. Aim and adjust all adjustable luminaires to the satisfaction of the Owner and the Architect.

L. Recessed luminaires shall be removable from below to provide access to outlet or prewired luminaire box.

M. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

N. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

O. A snap type local disconnect shall be provided for all luminaires. The disconnect shall disconnect all supply conductors simultaneously, including the grounded conductor. The line side terminals of the disconnecting means shall be guarded. The disconnecting means shall be located inside or outside the luminaire housing, but must be accessible to qualified persons before servicing or maintaining the ballast or lamps.

P. All luminaires located in Class 1, Division 2 areas shall be suitable for the application. Provide manufacturer labels defining the rating.

2.3 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
    g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

3. Master/Remote Sign Configurations:

    a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
    b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

4. Type "X" Directional Exit Signs shall have directional indicating chevrons pointing in direction of travel.

2.4 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 LED SYSTEMS

A. The LED module itself and all its components must not be subjected to mechanical stress.

B. Assembly must not damage or destroy conducting paths on the circuit board.

C. Installation of LED modules (with power supplies) shall adhere to all applicable electrical and safety standards.

D. Correct electrical polarity shall be clearly identified.

E. LED module must be protected from unbalanced voltage drop, and/or overload.

F. Ensure that the power supply is of adequate power to operate the total load.

G. Utilize standard ESD precautions when installing the module.

H. Install system according to the manufacturers heat sinking parameters.

I. For applications involving exposure to humidity and dust, the module shall be protected by a fixture or housing with a suitable protection glass. The module shall be protected against condensation water by treatment with an appropriate circuit board conformal coating. The conformal coating should have the following features.

1. Optical transparency
2. UV resistance
3. Thermal expansion properties matching those of the module (15-30 x 10-6cm/cm/K)
4. Low permeability of steam for all climate conditions
5. Resistance against corrosive environments

J. The LED Module shall be operated with an electronically stabilized power supply offering protection against short circuits, overload and overheating.

K. All LED products shall respect Intellectual Property Rights and shall have a Solid State License for the product. Unlicensed products are not acceptable.

L. LED Driver shall be installed inside an electrical enclosure suitable for use in dry, damp, or wet location as required by fixture listing.

M. Wiring inside electrical enclosure shall comply with 600V/105°C rating or higher.

N. LED Driver shall meet the following:

1. Class A sound rating.
2. An operating ambient temperature range of -20°C to 55°C.
3. A maximum life expectancy of 50,000 hours at Tcase of $\leq$ 70°C.
4. A maximum life expectancy of 100,000 hours at Tcase of $\leq$ 62°C.
5. Function to reduce output power to LEDs if its maximum allowable case temperature is exceeded.
6. A failure rate of $\leq$ 0.01% per 1,000 hours at Tcase of $\leq$ 70°C.
7. A failure rate of 0.01% - 0.02% per 1,000 hours at Tcase of 70°C - 80°C.
8. Tolerance for sustained open circuit and short circuit output conditions without damage.
9. Power Factor > 90%.
10. Total harmonic Distortion < 20%.
11. Compliance with FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).

O. Where addressable dimming LED driver is specified, provide Lutron A series driver.

P. Where 0-10V, ELV or 3-wire dimming LED driver is specified, ensure compatibility of driver and dimming control system of controller.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element. Coordinate with ceiling installer (Division 9).

1. Install a minimum of four ceiling support system rods or wires for each fixture. Attach to grid and locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities. Adjust to satisfaction of Architect and Owner.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Do not install reflector cones and visible trim of luminaires until completion of plastering, ceiling tile work, painting, and general cleanup. Installation of reflector cones and visible trim of luminaires shall be carefully coordinated with ceiling openings to prevent light leaks at the ceiling plane. Handle cones and trim carefully to avoid scratching or finger printing. Luminaires shall be completely clean at time of acceptance by Owner.

H. Plaster frames (frame-in-kits) for all recessed fixtures shall be installed per manufacturer’s instructions and in a rigid manner so as not to allow fixture frame or housing to move or shift when trim is removed or fixture is relamped. If plaster frame shifts when relamped or trim is not tight to ceiling, or the fixture has not been installed per the manufacturer’s instructions, the

Contractor shall resecure frames and have ceiling patched and refinished at their expense. General Contractor to spackle gap between rough g.w.b. opening and the plaster frame of light fixture to avoid light-leak and allow for narrow or flangeless trims to be used.

I. Drywall suspension ceiling systems will be provided with supplemental steel stud channels at luminaire locations for supporting luminaires to ceiling system under Section 09 26 00, Gypsum Wallboard Systems. Securely fasten recessed and/or surface mounted luminaires to steel channels with approved earthquake clips or clamping devices. Where required by local codes, or where the weight of the luminaire may cause deformation of the suspended ceiling, provide independent seismic restraint supports for luminaires connected to the structure above. The amount of deformation allowed is specified in Section 09 26 00.

J. Where MC and/or AC cable is not allowed for branch circuiting as described in Specification Section 260519, extend conduit to an accessible junction box within six feet of luminaires and provide a maximum six foot length of flexible conduit (Greenfield) and wire to each luminaire. Where MC and/or AC cable is allowed for branch circuiting as described in Specification Section 260519, extend AC and/or MC cable to an accessible junction box within six feet of luminaires and provide a maximum six foot length of AC and/or MC cable to each luminaire. Locate box so that luminaires can be readily moved into adjacent modules and to provide access to space above ceiling. Support flexible conduit or cable from structure; do not lay on ceiling tiles or attach to any support systems.

K. Properly align all surface type luminaires. Bolt together so that alignment will be permanent.

L. Mount under cabinet luminaires as indicated on architectural details. If cabling to luminaires is not concealed, provide wiremold cover to conceal wiring, color as directed by Architect.

M. Provider mock-ups of fixtures as specified for approval of Engineer/Architect/Owner prior to release of fixture order.

N. Provide aiming of adjustable fixtures to the satisfaction of Engineer/Architect/Owner.

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. All fluorescent lamps for dimming applications shall have a burn-in time of 12 hours, in accordance with NEMA and manufacturer recommendations, prior to turn over to owner.

C. All metal halide lamps shall have a burn-in time of 100 hours, in accordance with manufacturer recommendations, prior to turn over to owner.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with drivers
2. Luminaire-mounted photoelectric relays
3. Poles and accessories
4. Luminaire lowering devices

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
2. Division 26 Section "Network Lighting Controls" for programmable control.

1.3 DEFINITIONS

A. CRI: Color-rendering index

B. Luminaire: Complete lighting fixture, including driver housing if provided

C. Pole: Luminaire support structure, including tower used for large area illumination

D. Standard: Same definition as "Pole" above

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 110 mph.

2. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with LED modules, drivers, and accessories.

    a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    c. Provide LM-80 testing reports as defined by IESNA for all LED luminaries.

6. Photoelectric relays & integral occupancy sensors, including internal time of day and light level reduction schedule.
7. Drivers, including energy-efficiency data, manufacturer, warranty information.
8. Lamps, including life, output, and energy-efficiency data, manufacturer, warranty information.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.

B. Luminaire submittals not including driver and manufacturer's name will be returned marked not reviewed. Drivers and manufacturer's name must be submitted with the luminaire submittals in order to review.

C. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations for pole installations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

    a. Design calculations shall include EPA values for all devices to be mounted to pole as part of project scope.
    b. Calculations shall be signed and sealed by a licensed professional engineer verifying pole meets design conditions.

3. Wiring Diagrams: Power and control wiring.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with the NEC.

E. Comply with the recommended standards of the Illuminating Engineering Society of North America.

F. Comply with the requirements of California Code of Regulations, Title 24, Part 6; Energy Code.

G. LED Compliance: LED components, lamps, drivers and fixtures shall comply with: PCC 47 CFR Part 15; UL 8750; ANSI/NEMA Standards C78.377, NEMA SSL-1, ANSI C82.77, IESNA Standards TM-16-05, RP-16, LM-79, LM-80 and TM-21.

H. Luminaires shall bear UL inspection label, suitable to application and installed environment.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 UNIT PRICING

A. Provide unit pricing for each luminaire including driver and LED module as noted on the contract documents.

B. Provide information to owner and architect as part of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Acceptable Manufacturers

1. Luminaires

a. Refer to "Luminaire Schedule", herein or on the Drawings.

2. LED Lamps and Modules

a. Phillips
b. Osram-Sylvania
c. General Electric
d. Cree
e. Nichia

f. Xicato
g. Bridgelux

3. LED Drivers

a. Philips
b. General Electric
c. Osram-Sylvania

4. Substitutions - Not permitted unless approved herein. The lighting fixtures and components have been specified to ensure that specific aesthetic and performance requirements will be satisfied. These products have been carefully researched and each specified item has unique qualities which were determined to be essential in satisfying the design criteria for the project.

a. Substitutions requests shall be formally presented to the engineer, by appointment only, at least ten (10) working days prior to bid. The substitution material shall meet the requirements as outlined in Division 1 and include all of the following:

1) Completed substitution request form as indicated in Division 1.
2) Operating product sample wired for 120V with cord and plug.
3) Documentation

a) Statement indicating why specified product cannot be provided, if applicable.
b) Product Data, including drawings and descriptions of products.
c) Certificates and qualification data, where applicable or requested.
d) Complete photometric analysis with point-by-point calculations that include proper lumen values, reflectance values and coefficient of utilization.
e) Cost information, including a proposal of change, if any, in the Contract Sum.
f) Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent
2. Specular Surfaces: 83 percent
3. Diffusing Specular Surfaces: 75 percent

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Adjustable luminaires shall be capable of being locked into position. Aim and adjust all adjustable luminaires to the satisfaction of the Owner and the Architect.

M. All exterior luminaires, and those in wet/damp locations, shall be fitted with seals and gaskets to form a weatherproof, watertight assembly, and shall be of rust resistant construction and finish.

N. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

O. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect from manufacturer's full range.

P. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As selected by Architect from manufacturer's full range.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff. Refer to luminaire schedule for further requirements.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 LED SYSTEMS

A. The LED module itself and all its components must not be subjected to mechanical stress.

B. Assembly must not damage or destroy conducting paths on the circuit board.

C. Installation of LED modules (with power supplies) shall adhere to all applicable electrical and safety standards.

D. Correct electrical polarity shall be clearly identified.

E. LED module must be protected from unbalanced voltage drop, and/or overload.

F. Ensure that the power supply is of adequate power to operate the total load.

G. Utilize standard ESD precautions when installing the module.

H. Install system according to the manufacturers heat sinking parameters.

I. For applications involving exposure to humidity and dust, the module shall be protected by a fixture or housing with a suitable protection glass. The module shall be protected against condensation water by treatment with an appropriate circuit board conformal coating. The conformal coating should have the following features.

1. Optical transparency
2. UV resistance
3. Thermal expansion properties matching those of the module (15-30 x 10-6cm/cm/K)
4. Low permeability of steam for all climate conditions
5. Resistance against corrosive environments

J. The LED Module shall be operated with an electronically stabilized power supply offering protection against short circuits, overload and overheating.

K. All LED products shall respect Intellectual Property Rights and shall have a Solid State License for the product. Unlicensed products are not acceptable.

L. LED Driver shall be installed inside an electrical enclosure suitable for use in dry, damp, or wet location as required by fixture listing.

M. Wiring inside electrical enclosure shall comply with 600V/105°C rating or higher.

N. LED Driver shall meet the following:

1. Class A sound rating.
2. An operating ambient temperature range of -20°C to 55°C.
3. A maximum life expectancy of 50,000 hours at Tcase of $\leq$ 70°C.
4. A maximum life expectancy of 100,000 hours at Tcase of $\leq$ 62°C.
5. Function to reduce output power to LEDs if its maximum allowable case temperature is exceeded.
6. A failure rate of $\leq$ 0.01% per 1,000 hours at Tcase of $\leq$ 70°C.
7. A failure rate of 0.01% - 0.02% per 1,000 hours at Tcase of 70°C - 80°C.
8. Tolerance for sustained open circuit and short circuit output conditions without damage.
9. Power Factor > 90%.
10. Total harmonic Distortion < 20%.
11. Compliance with FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).

O. Where a dimming LED driver or multi circuit-wiring is specified, ensure compatibility of driver and lighting control system.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps and LED modules in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Position adjustable flood luminaires and landscape luminaries at night to satisfaction of the Architect and Owner. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

D. Install exterior luminaires on building on rust-resistant nonferrous cast outlet boxes set flush in exterior walls and fitted with seals and gaskets. Conceal all wiring in or within the construction.

E. Install exterior luminaires where surface mounted using rust-resistant nonferrous outlet boxes and fittings.

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. All exterior lighting including ingrade uplights, landscape lighting and exterior cove shall be aimed by the Contractor with field supervision/direction from the Architect/Lighting Designer. Aiming shall occur at night and shall be combined with the exterior lighting control aim and focus visit. Contractor shall coordinate visit with all subcontractors, lighting control manufacturer and Architect/Lighting designer and provide at least 10 days' notice to Architect/Lighting Designer. Completely test entire installation and leave in satisfactory operating condition.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00

SECTION 27 05 00 - COMMON MATERIALS AND METHODS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section is intended to describe the basic materials and installation methods for electrical work; it applies in general to all Sections under DIVISION 27. All materials and equipment specified and/or shown on Drawings are new unless noted otherwise.

B. All new materials, equipment and systems shall be listed and labeled by a licensed nationally recognized testing laboratory as defined by OSHA and used for the specific purpose, environment or application for which it was tested and approved. No field modifications and/or noncompliant installation whatsoever shall be made to any materials, equipment and systems that would violate the listing and labeling.

C. This section includes the following:

1. Communications equipment coordination and installation
2. Common communications installation requirements
3. Cable testing devices and requirements

D. Related Sections

1. Division 26 Section “Common Materials and Methods for Electrical” for general electrical requirements, innerduct and installation responsibilities.
2. Division 26 Section “Raceways and Boxes for Electrical Systems” for pathway requirements and responsibilities.
3. Division 26 Section “Underground Ducts and Structures for Electrical Systems” for underground pathway requirements.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. EPDM: Ethylene-propylene-diene terpolymer rubber.

G. NBR: Acrylonitrile-butadiene rubber.

1.4 REFERENCES

A. Provide work in accordance with all applicable international, state and local, codes, rules, regulations, and standards, including but not limited to, requirements of the following:

1. Underwriters' Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association (NEMA)
3. National Electrical Contractors Association (NECA)
4. The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
5. Applicable NFPA Codes and Standards
6. American National Standards Institute (ANSI)
7. Code of Federal Regulations (CFR)
8. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual, Latest Edition
9. Telecommunication Industries Association/Electronic Industries Alliance / (TIA/EIA)
10. Local utility access provider

B. The following standards are referenced to establish a base level of quality and conformance with industry standards. These specifications and the contract drawings shall take precedence over any document listed below.

1. Lucent Systimax PDS, Fiber Installation Manual (LUCENT Document Number 555-401-102, Issue 2)

C. Conflicts

1. Nothing stated or shown in Specifications or on Drawings is intended to conflict with the above standards and regulations. Should Contractor find any apparent conflict, it shall be his responsibility to notify Architect before any of the work in question is performed or material purchased.

1.5 SUBMITTALS

A. Provide Product List of factory fabricated items, in accordance with Section 016000 “Product Requirements”, including name of proposed manufacturer, for all products specified in various sections of Division 27.

B. Provide submittals in accordance with Section 013300 “Submittal Procedures” in sufficient detail to verify full compliance with the requirements of the Contract Documents.

C. Product Data: Provide for each type of factory-fabricated product indicated.

D. Submit testing reports.

1.6 WARRANTY AND CONTRACT CLOSEOUT

A. Comply with warranty and contract closeout requirements specified in Division 01, GENERAL REQUIREMENTS.

B. Provide Special Warranties and/or warranty service in accordance with Section 016000 “Product Requirements” where specified in the various sections of Division 27 and as indicated below.

1. Warranty - Communications cabling systems shall be guaranteed in writing against defects in workmanship and defective materials for a period of one (1) year after acceptance by the Owner. During this time, communications cabling systems shall be kept in proper operating condition at no additional cost to the Owner.
2. Service - Provide one (1) year service contract on all communications cabling system components and equipment. Contract shall be based on 8 hours service and preventative maintenance per month.

3. All associated hardware and labor shall have a manufacturer and/or supplier's warranty for a minimum period of twenty-five (25) years from the date of acceptance by the Owner. This warranty must guarantee channel and link performance parameters that meet or exceed those specified in EIA/TIA 568-B.2-1 and offer an assurance for any application that is designed to operate on Category 6 and 6A UTP cable. This is to include the replacement of any defective components provided as part of this project at no cost to the Owner for either parts or labor.

C. Provide manufacturer’s certificates of supervision and startup service as specified in the various sections of Division 27.

D. Upon completion of work and tests, and at a time mutually agreed to by Contractor, Architect and Owner, operate all systems installed, in all parts, at Contractor's expense for sufficient length of time to demonstrate the mode of operation and definitely determine whether systems as a whole are in first class working condition. Defects and malfunctions that may develop during this period of operation shall be immediately corrected by Contractor at his own expense, and systems placed in first class working condition before being finally turned over to Owner.

E. Include information for all products specified in the operation and maintenance manual.

F. Provide electrical certificate(s) from electrical inspection agency - see Article titled “Inspections”.

G. Provide manufacturer's certification and warranty of system operation - see Article titled “Tests”.

1.7 QUALITY ASSURANCE

A. The specifications for certain products and alternative materials may appear in more than one section of Division 27. Work of Division 27 shall be coordinated for all sections of Division 27 to assure that where two or more items of any given product are furnished under Division 27 that they are of the same manufacturer and type and that alternative material is consistent throughout the work of Division 27.

B. Telecommunications Qualifications: Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1. Telecommunications Contractor: The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.
2. Key Personnel:

    a. Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.
    b. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.
    c. In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years’ experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All

of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the Owner's) contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

d. Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Owner.

e. Note that only the key personnel approved by the Owner in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel required approval from the Owner.

3. Minimum Manufacturer Qualifications: Cabling, equipment and hardware manufacturers shall have a minimum of 3 years' experience in the manufacturing, assembly, and factory testing of components which comply with TIA/EIA-568-B.1, TIA/EIA-586-B.2 and TIA/EIA-568-B.3.

C. Test Plan: Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the optical fiber components and accessories 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

D. Regulatory Requirements: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

E. Standard Products: Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1. Alternative Qualifications: Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
2. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle all material and equipment in accordance with manufacturer's instructions and recommendations. Such instructions and recommendations are hereby made part of these specifications.

B. Deliver products and equipment properly labeled and tagged. Maintain products in original shipping containers and store in a dry area until ready for installation.

C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 INSPECTIONS

A. Before starting any Work under this Contract, file for inspection with the agency approved by the AHJ. Upon completion of the work, furnish electrical certificates from said agency for all electrical equipment and systems installed or furnished and installed as part of the work.

B. Communications equipment or systems that are modified in the field shall be reinspected. Furnish a new electrical certificate covering such modifications.

1.10 COORDINATION

A. The communications systems are indicated on the Communications/Electrical Drawings. Certain pertinent information and details required by the communications work appear on the Architectural, Structural and Mechanical Drawings. Become familiar with all drawings and incorporate all pertinent requirements

B. Drawings are diagrammatic and indicate general arrangement of systems and requirements of the Communications work. Do not scale the drawings to obtain dimensional requirements. Exact locations of equipment must be coordinated and obtained prior to starting the work.

C. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

D. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

E. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

F. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

1.11 EQUIPMENT LOCATIONS

A. Locations are subject to changes in order to avoid obstacles in building construction. Verify all dimensions and conditions at site. Check layout for sizes and clearances, so that the apparatus and material may be installed and operated satisfactorily in space provided. Install equipment and raceways to preserve headroom and to keep openings and passageways clear.

B. Install equipment, boxes and outlets in accessible locations. Obtain final locations of all outlets and equipment from details on drawings and from Architect. Examine drawings of other trades and avoid interferences with their work.

C. In case of conflict in location of flush outlets, architectural details shall take precedence.

D. Install conduit to avoid mechanical and/or structural obstructions, minimizing crossovers.

E. Install all exposed conduits parallel or perpendicular to building lines.

F. Provide minimum of 6 inches clearance between communications work and electrical work, flues, steam pipes and other heat sources.

G. Mounting heights of outlets and equipment shall be as indicated on "Mounting Height" Schedule, or as specified herein.

H. Verify all door swings before installing switch boxes. In case of conflict between drawings, Architectural details shall take precedence.

I. Architect reserves the right to change, without additional cost, location of any communications outlet, provided such changed location is not more than 10 feet, and is ordered changed before said work is completely "roughed in".

J. Locations of communications equipment and connections to all other equipment are approximately correct, and are subject to such modifications as are required at time of installation, in order to meet field conditions or the dimensions of equipment actually being supplied.

K. No changes are to be made in the original design without written approval by Architect.

1.12 MAINTENANCE

A. Operation and Maintenance Manuals: Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system. Submit operations and maintenance data in accordance with Division 01 GENERAL REQUIREMENTS and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION.

B. Record Documentation: Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606-A. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum:

1. Cables: A record of installed cable shall be provided in accordance with TIA/EIA-606-A. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA/EIA-606-A. Include manufacture date of cable with submittal.
2. Termination Hardware: A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA/EIA-606-A. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606-A.

1.13 RESPONSIBILITIES

A. The Division 27 contractor shall be responsible for furnishing and installing the passive cabling infrastructure involving the following:

1. Outside Plant (OSP) fiber optic service cabling between buildings as shown.
2. All inter-building and intra-building fiber optic backbone cabling.
3. All unshielded twisted pair (UTP), optical fiber and coaxial workstation cabling as shown on the drawings.
4. All relay and equipment racks and cabinets in as shown on the drawings.
5. All cabling termination and management devices, including but not limited to, surge/lightning protectors, terminal blocks, patch panels, fiber optic terminal cabinets, horizontal/vertical wire managers, velcro straps and labeling.
6. Furnishing of copper and optical fiber patch cords.
7. Power Distribution Units (PDU) in equipment racks.
8. All testing of the passive cabling infrastructure cabling and devices as specified herein.
9. Bonding conductors between ground buses and relay racks, cabinets and similar low voltage equipment.

B. The Division 26 contractor shall be responsible for furnishing and installing the pathway system for the passive cabling infrastructure including the following:

1. All underground ductbanks and textile innerduct
2. All cable trays, conduit pathways and pull boxes
3. All outlet boxes and junction boxes
4. All ladder racks in telecommunications equipment areas
5. All conduit nylon bushings and pull cords
6. All ground buses, telecommunications bonding backbone (TBB) and bonds to building steel.

C. The Owner shall be responsible for furnishing and installing the following:

1. All telephone handsets and cord to connect to WAO (Work Area Outlet).
2. Personal computers, laptops, printers and faxing.

3. Workstation cords for telephone handsets, and workstation peripherals, except as specified herein.
4. All fiber optic converters
5. All network switches
6. All network routers
7. All wireless access points (WAP)
8. All other active network components

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. General

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.
6. Furnish, deliver, erect, connect and finish in every detail, all materials, equipment and accessories required for the Work. Select and arrange to fit properly into the building spaces.
7. Perform all work in accordance with the drawings, specifications, including manufacturer's installation instructions, all applicable codes and NECA's Standard of Installation guidelines.
8. Include in the Work and in the bid proposal minor details not shown or specified, but manifestly necessary for the proper installation and operation of the various systems, as if specified or shown.
9. Position and install all material and equipment to permit proper access and in such a manner that maintenance, adjustment, calibration, inspection, repair and replacement of the material and equipment can be accomplished with minimum effort and cost.
10. Perform the installation, wiring, cleaning, testing, calibration and startup of all material and equipment in accordance with the manufacturers' instructions and recommendations. Such instructions and recommendations are hereby made a part of these Specifications.
11. If any departures from Contract Documents are deemed necessary, submit details of such departures and the reasons there for to Architect for approval.
12. Pull and junction boxes shall be located and sized by electrical contractor in accordance with NEC, EIA/TIA, utility company requirements and Owner standards, unless otherwise noted on the drawings.

B. Layout and Coordination

1. Lay out all work from approved building and property lines and benchmarks. Verify and be responsible for the correctness of all measurements in connection with work. Any change made in major overall dimensions as shown which affect the physical size, shape, or location of any part of the Work, whether due to field check or changes due to the use of equipment of a manufacturer other than that used as the basis of design shall not cause any interference with other work.
2. Examine the drawings of other trades and initiate cooperation and coordination of the Work with the work of other trades to insure that the Work can be installed properly as designed and planned without interference with other work or delay. Furnish all necessary templates, patterns, measurements, etc., for installing work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
3. Investigate the structural and finish conditions affecting the Work. Offsets, bends or other items required by the Work may not be shown due to the small scale of the drawings; provide such offsets, bends or other items as required to meet structural or finish conditions.
4. Coordinate and be responsible for the required clearances of the Work in shafts, chases, double partitions and suspended ceilings. Coordinate and cooperate with the trades responsible for constructing such spaces, together with other trades sharing such spaces, and advise other trades of the requirements of the Work. Immediately submit for review space requirements that exceed those shown.
5. Install material and equipment as high as possible; at minimum, to clear the top of all doors, windows and other structural openings. Maintain maximum headroom and space conditions in every case. Where headroom or space conditions appear inadequate, notify the Architect before proceeding with the installation.
6. Install conduit, fittings, etc., to provide not less than 1/2 inch between their finished covering and the structure or adjacent work of any kind.
7. Communications equipment shall not interfere in any way with other material or equipment and shall be provided with adequate working space; see the National Electrical Code working space requirements.
8. Make reasonable modifications in the layout of the Work, as directed, to provide proper clearances or accessibility, or to prevent conflict with the work of other trades, at no increase in the Contract sum.
9. Cooperate fully with the Contractor for General Construction in regard to location of electrical equipment and work progress schedules. Notify him of all flush panelboard locations so that wall of proper thickness is provided.
10. Prepare large scale composite working drawings, including such section views and details as are necessary to clearly show how the Work is to be installed in relation to the work of other trades. Issue such drawings to the other trades for coordination of their work. Where such drawings show deviations from the Contract Drawings or conflict with other trades, detail and submit such deviation or conflicts to the Architect for review.
11. Locate wall switches at strike side of doors and at height indicated on "Mounting Height" schedule. Review all door swings with Contractor for General Construction prior to rough-in.
12. Locate receptacles at heights indicated in "Mounting Height" schedule. Mount receptacles vertically, ground pole at top. In special areas such as kitchens, laboratories, utility areas, coordinate locations with counters, benches and casework.
13. If work is installed before coordinating with all other trades and Owner's work, or so as to cause interference with the work of other trades, or so as not to provide proper access for

maintenance or repair, make necessary changes in work to correct the condition at no cost to the Owner.

C. Excavation, Trenching, Backfilling

1. Mass excavation to required basic construction elevations will be performed under Division 31, EARTHWORK.
2. Provide all other excavation, trenching and backfilling including shoring, sheeting, pumping, grading, barricading and other related work necessary for installation of electrical work.
3. Perform work in accordance with the requirements of Division 31, EARTHWORK.

D. Cutting and Patching

1. Except where specified otherwise in Division 27, provide cutting, patching and refinishing work in accord with the requirements of Division 01 Section, EXECUTION.
2. Horizontal chases shall not be cut into existing walls or partitions without approval of Architect.

E. Painting

1. Except where specified otherwise in Division 27, general painting will be provided under Division 09, FINISHES.
2. Touch up or paint out damage done to items having a factory applied finish, and which are installed under Division 27, utilizing materials and methods specified in Division 09. FINISHES.

F. Foundations

1. Provide concrete foundations required for the work specified under Division 27, unless specifically noted otherwise. Be responsible for preparing foundation drawings and setting foundation anchor bolts in time so as not to delay the work. Concrete foundations shall be of the types detailed or as specified.
2. Reinforce concrete foundations to suit the loads placed on them; foundations shall be in strict accordance with the equipment manufacturers' recommendations. Concrete materials and methods shall be as specified in Division 03, CONCRETE.
3. Unless otherwise indicated, concrete equipment pads shall be provided under all switchgear, motor control centers, substations, etc., and shall extend a minimum 4 inches above the finished floor, at least 4 inches beyond the equipment base in all directions, shall have the top edges and vertical corners chamfered and shall have the same surface finish as the adjacent and surrounding floor.
4. Securely anchor concrete foundations to the floor slab with steel dowels. When so indicated or where required, concrete foundations or concrete footings for structural steel supports for equipment too heavy to be placed in the floor slab shall be extended not less than 12 inches below the underside of the floor slab, except where bearing rock is encountered at a lesser depth. In such cases, after inspection and approval, concrete foundations may be set on bearing rock.
5. Furnish and set, with proper templates, anchor bolts and inserts required for the proper attachment of the equipment to the concrete foundations. Anchor bolts shall be of the size and number required by the equipment or as recommended by the equipment manufacturer

and shall be in accordance with the requirements detailed or specified. Anchor bolts shall also be compatible with vibration isolation requirements specified for the equipment.

6. Set equipment anchor bolts in pipe sleeves at least two sizes larger than the anchor bolt. Length of pipe sleeve shall be the same as the imbedded length of the anchor bolt. After the equipment is set in place and adjusted to its proper position, completely fill the annular space between the anchor bolt and the inside of the pipe sleeve for the full length of the pipe sleeve with Embeco, or equivalent, nonshrink cement grout.
7. Grout any openings between the top of the concrete foundation and the base of the equipment using nonshrink cement grout.
8. Piles, pile caps and foundation beams for exterior underground duct banks and for equipment foundations will be furnished under the General Construction Divisions of the Specifications.

G. Access Doors and Panels – Provide by Division 26.

H. Sleeves, Fire-stops and Waterseals – Provide by Division 26.

I. Flashing and Counterflashing – Provided by Division 26.

3.2 PROTECTION OF WORK

A. Protect all conduits, fittings, cabinets, racks, cable trays and other equipment before and during installation and keep clean.

B. Protect factory finished equipment and devices with approved temporary protective material where these items are subject to accidental damage or abuse. Communications equipment shall be stored indoors or otherwise securely protected and kept free of condensation by adequate electric heat. Contractor shall remove all temporary protective material at the conclusion of the Work or as directed.

C. The Contractor shall assume full responsibility for the cost of repairing or replacing any damaged Work or material caused by employees working under this Division.

3.3 TESTS

A. This article shall not be construed as deleting other tests specifically outlined in other sections of this Specification.

B. All materials and documentation to be furnished under this specification shall be subject to inspections and tests. Equipment and systems shall not be accepted until all required inspections and tests have been made, demonstrating that the equipment and systems conform to the specifications, and that all required equipment, systems, and documentation have been provided. The Owner reserves the right to request additional tests at no extra cost on any work that the Owner determines not to be in accordance with this specification.

C. The Owner shall have access to inspect the supplier/installer's quality assurance (QA) standards, procedures, and records that are applicable to this project. Inspection shall not relieve the supplier/installer of the responsibility for providing material and equipment conforming to the requirements of this specification.

D. Notify the Owner in writing of the test schedule at least two (2) weeks in advance. The test schedule shall be coordinated to permit the Design Professional to attend.

E. Twisted-Pair Media Tests - All UTP cables will be tested with equipment that meets or exceeds the requirements of TIA/EIA 568-B2 Level 2e and certified to ensure that the level of performance has been met. The tester must be calibrated with the cable used in the project to ensure that the correct NVP is utilized. The installation contractor shall provide documented proof that each line of the horizontal distribution system is capable of handling the required data rates. The customer may test random cables to ensure that they meet the documented test results provided. The installation contractor is responsible for correcting or reinstalling all systems that fail to perform to specification. The following is a summation of the tests that should be performed on a UTP cabling plant, basic link configuration. If any test indicates a lower level of performance, the link must be either repaired or replaced. The test instruments must have all the necessary tests preprogrammed into their logic circuits and require no further programming by the operator. The results must be available on both print out and on disk. All test reports will be provided to the Owner for future reference. The basic link shall be tested to the specifications set in EIA/TIA 568-B.2-1, Category 6 and 6A requirements. The basic link test results shall exceed "worst case" specifications as documented in the above said standard. The tests included are:

1. End To End Connectivity
2. Cable Delay Skew
3. Cable Length Testing
4. Insertion Loss
5. Worst Pair-to-Pair NearEnd Crosstalk (NEXT) Loss
6. Power Sum Near End Crosstalk (PSNEXT) Loss
7. Worst Pair-to-Pair Equal Level Far-EndCrosstalk (ELFEXT)
8. Power Sum Equal Level Far-End Crosstalk (PSELFEXT)
9. Propagation Delay
10. Return Loss, Measured from Local End
11. Return Loss, Measured from Far End

F. Optical Fiber Media Tests - Perform verification tests and enter results on the approved test sheets for all optical fiber cables as follows:

1. Visually inspect each installed optical fiber termination connector with an illuminated microscope. Inspect for scratches, pits or chips and reterminate if any of these conditions exist.
2. Measure end-to-end loss of each terminated optical fiber at 1300 nm and 850 nm wavelengths for multimode and at 1310 nm and 1550nm wavelengths for single mode.
3. Measure each terminated fiber length and signature with an optical time domain reflectometer (OTDR) from each end of the cable. The supplier/installer shall test each reel of cable prior to installation.
4. Replace any cable if any fiber within that cable exhibits greater than 0.2 dB localized attenuation or any discontinuities.
5. Verify polarity of all dual connectors.

G. Verify shield ground for riser distribution cables.

H. Replace any defective cabling system component if any applicable parameters do not meet the EIA/TIA Category 6 and 6A EIA/TIA 568-B.2-1.

I. Final Acceptance - The communications cabling system will not be considered accepted by the Owner until the certified results of the foregoing tests have been accepted by the Owner. Beneficial use of the system by the Owner will not be considered as acceptance.

J. Test Equipment shall be as follows:

1. Tester must have the functionality to test cables complying with current and upcoming proposed standards. Test frequency range must extend to 300 MHz.
2. Measurements must include: Wiremap, Length, Insertion Loss, PSNEXT, ACR, PSACR, ELFEXT, PSELFEXT, Return Loss, Resistance.
3. Autotest must comply with TIA/ISO/IEC standards, automatic increment of circuit ID.
4. Unit must have a replaceable, rechargeable battery, Flash ROM for field updates, and storage of 1000 Autotests.
5. Unit must be capable of testing single and multi-mode fiber optic cable with a supplied adapter.
6. Test results must be uploaded into a cable management software package that supports AutoCAD diagrams.
7. Unit shall be supplied with a carrying case and all necessary adapters to test any cable configuration installed and single mode fiber optic cables.
8. Tester shall be a Microtest OMNI Scanner, or approved equal.

3.4 WORKMANSHIP

A. Communications equipment shall be installed in a neat and workmanlike manner in accordance with latest and best practices of the trade.

B. Only mechanics skilled in this type of Work shall be employed and utilized by Contractor for this Division in the execution of this Work.

3.5 REFINISHING

A. All surfaces of boxes, cabinets and equipment shall have suitable lacquer, enamel or plated finishes. Touch up any finishes marred during construction. Supports and other metal work not furnished with a protective coating, shall be given two coats of approved paint after completion of the work.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping.

3.7 CONTINUITY OF EXISTING SERVICES

A. Perform alterations and connections to existing facilities with a minimum of interruption. Where interruption is necessary, prepare a time schedule for same, coordinate with Architect, Owner and other sections, and obtain prior written clearance from Owner. Provide and place notices in

affected areas, and on luminaires or equipment, etc., which will be temporarily out of use. Remove notices when interruption has been completed.

B. When Owner requires that work involving shutdown and interruption of existing facilities be performed on an overtime basis, Contractor shall pay all overtime costs.

3.8 DEMOLITION

A. Disconnect and cap existing DIVISION 27 services to demolished areas of existing and new building(s) as required. Cap services at points where directed by Contractor for Division 2, EXISTING CONDITIONS. Contractor for Division 2 will remove abandoned DIVISION 27 services between capped services and demolished areas, building and new building(s), and will do all excavation and backfill in connection with disconnection and removal of the services.

3.9 ALTERATIONS AND CONNECTIONS TO EXISTING FACILITIES

A. Make all necessary alterations to existing DIVISION 27 systems to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.

B. Make all necessary alterations to existing DIVISION 27 systems to permit the installation of new DIVISION 23 equipment, i.e. ductwork and piping, to permit connecting or extending these systems to new work and to permit existing systems to remain in use whether indicated or not. New materials used to alter existing systems shall match existing materials unless otherwise indicated. Record modifications for Owner's future use.

C. Where equipment, ductwork and piping is removed or disconnected under DIVISION 27, perform the work in such a manner that no damage is done to the structure or remaining portions of the systems.

D. Remove exposed conduit, hangers and supports made obsolete due to this modification.

E. Where existing concealed conduit is not to be reused, abandon same in place unless otherwise indicated or specified.

F. Unless otherwise specified, all materials and equipment removed or disconnected by Contractor which are not to be reused shall become the property of Contractor and be removed from premises.

G. Where excavation for new electrical work disturbs support of any existing underground services, materials, equipment and structures, provide new and suitable concrete or steel and supports as required. Review supports and supporting methods with Architect before beginning work.

3.10 COMMISSIONING

A. Commissioning will be provided as specified in Division 01 Section “Commissioning”. All contractors and subcontractors of the various sections of this specification shall cooperate and

participate in the commissioning work in accordance with requirements of Division 01 Section “Commissioning”.

B. Ensure participation of major equipment manufacturers or their representatives.

C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.

D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work.

3.11 OWNER TRAINING

A. Provide basic training to Owner's IT personnel as designated by the Owner.

B. Training course shall provide detailed instruction covering basic cable installation and termination techniques for Category 6 and 6A horizontal cabling, concentrating on 110-style punch down techniques and cable dressing.

C. Provide additional training seminar to include fiber optic cable installation and termination techniques.

D. Provide cabling, jacks, tools and other devices as required to provide a "hands-on" learning experience. Provide Owner with one set of tools including, but not limited to, impact tool with two (2) spare blades, shears, knife and tool pouch.

E. Training shall take place at a time to be specified by the Owner. Provide a minimum of two days of training time.

F. Provide facilities to record video of the training session for the Owner's future use and turn over digital recording to the Owner.

END OF SECTION 27 05 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.

B. Related Requirements:

270528	Pathways for Communications Systems
270529	Hangers and Supports for Communications Systems
270536	Cable Trays for Communications Systems
270544	Sleeves and Sleeve Seals for Communications Pathways and Cabling
271100	Communications Equipment Room Fittings
271116	Communications Racks, Frames, and Enclosures
271313	Communications Copper Backbone Cabling
271323	Communications Optical Fiber Backbone Cabling
271513	Communications Copper Horizontal Cabling

1.2 DEFINITIONS

A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.

B. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.

C. RBB: Rack bonding busbar, located in equipment cabinets and racks.

D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.

E. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.

F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.

G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.

H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installing wire connector on conductor.
2. Recommended torque values.

1.5 CLOSEOUT SUBMITTALS

A. Record Documentation: Project record documents in accordance with Section 017839 "Project Record Documents" must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of TBC connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF COMMUNICATIONS BUSBARS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. PBB:

1. Dimensions: 1/4 inch thick by 4 inch high.
2. Stand-Off Distance: 2 inch (minimum).

C. SBB:

1. Dimensions: 1/4 inch thick by 4 inch high.
2. Stand-Off Distance: 2 inch (minimum).

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Communications Busbar Connections:

1. TBC: Not smaller than 3/0 AWG and no smaller than largest TBB.
2. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
5. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
6. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

C. Cable Tray Connections:

1. Cable Tray Equipment Grounding Conductor: 6 AWG.
2. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than 6 AWG and not longer than 12 inches. If jumper is wire, it must be terminated with lug having one hole and standard barrel for one crimp. If jumper is flexible braid, it must be terminated with one- or two-hole ferrule. Attach with bonding screw or connector provided by cable tray manufacturer.

D. Underground Connections: Not smaller than 2 AWG. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

3.4 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Busbars:

a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 96 inches above finished floor unless otherwise indicated.

b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

2. Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.

d. Install without splices.

e. Support conductors at not more than 36-inch intervals.

f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Section 270528 "Pathways for Communications Systems," and bond both ends of raceway to SBB.

3. Provide TBC and terminate ends to PBB and intersystem bonding termination device or busbar, as applicable, at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together with BBCs where required by TIA-607.
5. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.
6. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
7. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide top-mounted RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.
8. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
9. Primary Protector: Bond to PBB with insulated bonding conductor.
10. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
11. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest PBB or SBB.
12. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest PBB or SBB.

3.5 IDENTIFICATION

A. Comply with ANSI/TIA-607-C “Commercial Building Grounding and Bonding Requirements for Telecommunications”.

B. Labels must be preprinted or computer-printed type.

1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.

2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

    a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

        1) If measured resistance from electrical service equipment to ground exceeds 5 Ω, notify Owner, Architect and Construction Management and include recommendations to reduce resistance to ground.

    b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

    a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB and to SBBs. Maximum acceptable AC current level is 1 A.

B. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

3.7 PROTECTION

A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Optical-fiber-cable pathways and fittings.
3. Metal wireways and auxiliary gutters.
4. Metallic surface pathways.
5. Hooks.
6. Boxes, enclosures, and cabinets.
7. Polymer-concrete handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Boxes, enclosures, and cabinets.
4. Underground handholes and boxes.

B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

C. Samples: For wireways and surface pathways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Seismic rating for all pathway seismic bracing, racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated GRC and IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

    a. Material: Steel or die cast.
    b. Type: Set screw or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 4 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Finish: Manufacturer's standard enamel finish in color selected by Architect.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.5 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized or stainless steel.

E. J or U shape.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
5. Gangable boxes are prohibited.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 POLYMER-CONCRETE HANDHOLES

A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.

B. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D and SCTE 77.

C. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.

D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
2. Cover Legend: Molded lettering, "COMMUNICATIONS".

E. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

F. Handholes 24 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: IMC.
3. Underground Conduit: Type EPC-40-PVC, concrete encased beneath roadways, driveways, pathways, sidewalks and vehicle parking areas.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway or EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway or EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, optical-fiber-cable pathway or EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw or compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete.
5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

M. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

X. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.

3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RMC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Bury underground warning tape approximately 4 inches above direct buried conduit warning planks but a minimum of 6 inches below grade. Align tape along centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Conduit and cable support devices.
4. Support for conductors in vertical conduit.
5. Structural steel for fabricated supports and restraints.
6. Mounting, anchoring, and attachment components.
7. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 270548 "Seismic Controls for Communications Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.

3. Aluminum slotted-channel systems.
4. Equipment supports.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Speakers.
    b. microphones
    c. Access panels.
    d. Projectors.
    e. Wireless Access Points
    f. Access control intrusion detection devices
    g. Video panel mounts
    h. Video cameras

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications:

1. Qualify procedures and personnel according to AWS D1.1/D1.1M and AWS D1.2/D1.2M.
2. Qualify procedures and personnel according to the following:

    a. AWS D1.1/D1.1M.
    b. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 STEEL SLOTTED SUPPORT SYSTEMS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

2.3 ALUMINUM SLOTTED SUPPORT SYSTEMS

A. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Material: 6063-T6 aluminum alloy.
3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width: Selected for applicable load criteria.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

2.4 CONDUIT AND CABLE SUPPORT DEVICES

A. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

2.5 SUPPORT FOR CONDUCTORS IN VERTICAL CONDUIT

A. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

2.6 STRUCTURAL STEEL FOR FABRICATED SUPPORTS AND RESTRAINTS

A. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.7 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.8 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101.
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps, using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

    a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

2. Comply with requirements in Section 099600 "High-Performance Coatings for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 27 05 29

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Cable tray accessories.
4. Warning signs.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 12 inches and 18 inches per NEC fill requirements unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 5AA.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Louvered type made of same materials and with same finishes as cable tray where required.

B. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33 or ASTM A1008/A1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

1) Hardware: Galvanized, ASTM B633, Chromium-zinc plated, ASTM F1136 or Stainless steel, Type 316.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90.

1) Hardware: Galvanized, ASTM B633 or Chromium-zinc plated, ASTM F1136.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

1) Hardware: Galvanized, ASTM B633.

g. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Hardware: Chromium-zinc plated, ASTM F1136 or Stainless steel, Type 316, ASTM F593 and ASTM F594.

h. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2. Aluminum:

a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: Stainless steel, Type 316, ASTM F593 and ASTM F594.
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, Type 304L or Type 316L, ASTM F593 and ASTM F594.

b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.4 WIRE-MESH CABLE TRAY

A. Description:

1. Configuration: Galvanized steel wire mesh, complying with NEMA VE 1.
2. Width: As required to meet NEC fill requirements plus 25 percent spare capacity unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 5AA.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33 or ASTM A1008/A1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

1) Hardware: Galvanized, ASTM B633 or Stainless steel, Type 316.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90.

1) Hardware: Galvanized, ASTM B633.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

1) Hardware: Galvanized, ASTM B633.

g. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.

2) Hardware: Chromium-zinc plated, ASTM F1136 or Stainless steel, Type 316, ASTM F593 and ASTM F594.

h. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."

B. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems.

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with trapeze hangers.

N. Support trapeze hangers for wire-basket trays with 3/8-inch-diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Wall Sleeves, Cast Iron:

1. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Pipe Sleeves, PVC:

1. Description: ASTM D1785, Schedule 40.

D. Molded Sleeves, PVC:

1. Description: With nailing flange for attaching to wooden forms.

E. Molded Sleeves, PE or PP:

1. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Description:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness must be 0.052 inch.
2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness must be 0.138 inch.

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.

1. Sealing Elements: EPDM and Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or Stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.6 FOAM SEALANTS

A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 27 05 44

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements
2. Backboards
3. Telecommunications equipment racks and cabinets
4. Telecommunications service entrance pathways
5. Grounding and bonding

B. Related Sections:

1. Division 26 Section "Cable Trays for Electrical Systems" for support of structured cabling.
2. Division 27 Section "Communications Backbone Cabling" for copper and fiber optic cabling associated with system panels and devices.
3. Division 27 Section "Communications Horizontal Cabling" for structured cabling associated with system panels and devices.
4. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for structured cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.

D. Ladder Rack/Cable Runway: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

I. EF: Entrance Facility

J. ER: Equipment Room

K. TR: Telecommunications Room

L. TE: Telecommunications Enclosure

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of bonding busbar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. The Contractor shall have a BICSI Certified Registered Communications Distribution Designer (RCDD) on staff who will ultimately be responsible for all work performed by the Contractor and/or his subcontractors under this Specification. The RCDD shall have the authority of the Contractor to make immediate decisions regarding implementation of changes to the project as directed by the Owner and/or Architect.

E. The Contractor shall provide with bid a Manufacturer Certification for the system solution bid issued in the bidder's company name, valid for the timeframe in which the installation will be completed. The technicians employed shall be BICSI certified, fully trained and qualified in the installation and testing of the systems being installed. The Contractor shall have a minimum of 25% of the installation crew being BICSI and manufacturer certified.

Seismic Qualification Certificates: For floor-mounted cabinets, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of a BICSI Certified Registered Communications Distribution Designer (RCDD).
2. Installation Supervision: Installation shall be under the direct supervision of BICSI Certified Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
4. The installation of all cables, connectors and testing shall be accomplished by contractor/technicians who have been regularly installing communications cable systems of the size, scope and complexity of this project for a period of not less than two (2) years and are certified by the specified supplier in the installation of communications cable systems. The contractor shall be certified by the cabling/equipment manufacturer on the specific components being installed under this project scope.
5. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical, 25-pair Category 5e UTP, 4-pair Category 6 UTP and 4-pair Category 6a UTP metallic premise distribution systems and have personnel who are adequately trained in the used of such tools and equipment.
6. The installation of all optical fiber cables, connectors, securing and testing shall be accomplished by technicians who have been regularly installing optical fiber systems of the size, scope and complexity of this project for a period of not less than two (2) years, and who have been certified by the specified supplier in the installation of optical fiber systems.
7. At the time of bidding, the Contractor shall submit, with the bid, a compliance letter noting any deviations from the Contract Documents, a list of projects previously installed and a copy of their certification that indicates that the Contractor is a Certified Installation Organization for the products proposed. The compliance letter shall include the names and addresses of references who may be contacted to verify the quality of the installing company's previous projects and performance.

B. Communications Components, Devices, and Accessories: Listed and labeled as defined in BICSI TDMM current edition and ANSI/TIA standards, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-E.

D. Grounding: Comply with ANSI/TIA-607-D and National Electrical Code (NEC) Article 250, 725, 770, 800, 810, 820, 830 and 840.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight and wet work in spaces is complete and dry. Coordinate with other trades and with construction management regarding the completion of floor and wall finishes, the completion of work above ceilings by other trades and the appropriate coordinated sequence of communications component installations.

B. Coordinate with other trades and where conflicts arise, provide request for information in writing to Architect and Construction Manager.

1.8 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with the Owner identified local exchange carrier Service Provider.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of PBX/VoIP equipment and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

C. Coordinate active component load information as provided by the Owner and equipment vendors with the Architect and the contractors for Divisions 23 and 26 to ensure the appropriate power devices and ventilation requirements are met.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA-569-E.

B. Cable Support (J-hook):

1. Cable Support (J-hook): NRTL labeled. Non-continuous pathway cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Minimum 1/2" slot to secure cables to cable support bracket (J-hook) with hook and loop straps (Velcro). Cable ties/ty-wraps are prohibited and SHALL NOT be utilized on this project.

   a. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
   b. Be compliant with communications rating of UTP cabling specified.
   c. Galvanized steel construction and 90 degree rolled safety edges.
   d. Fastened to structure at a maximum of five (5) foot on center with a maximum of 40 percent fill ratio.
   e. J-hooks shall have a static load capacity of 30 pounds per hook and fastener hole that accepts 1-1/4 inches bolts.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. nVent – CADDY Cat
   b. Eaton B-Line Series
   c. Monosystems

C. Cable supports shall be specifically manufactured to support high performance communication cable and installed in accordance with manufacturer's mounting and spacing criteria.

D. Ladder Rack/Cable Runways

1. Ladder Rack/Cable Runways shall be constructed of hollow steel or solid steel side bars in widths shown. Rung spacing shall be 9 inches typical. Refer to Telecommunications Room (EF, ER, TR) details and elevations for rack dimensions. Width dimension shall be based on NEC fill ratio requirements plus 25% and have a black or gray finish.
2. All Ladder Rack Cable Runways and connecting and mounting hardware shall be of uniform manufacture. All mounting hardware to be heavy-duty type with all through bolt connections.
3. All Telecommunication Rooms (EF, ER, TR) shall utilize horizontal and vertical ladder racks for riser and horizontal cable support unless specified otherwise on the associated project drawings.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Chatsworth
b. Eaton B-Line Series
c. Legrand

E. Cable Trays: Comply with the requirements in Division 27 Section 270536, “Cable Trays for Communications Systems.”

F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 4 inches square by 2-1/8 inches deep with up to 1.75” knockouts.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches with graypainted finish. UL fire-rating stamp shall be visible and not painted over. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry." Coordinate openings in plywood for electrical devices in the field with the Division 26 Contractor.

2.3 RELAY RACKS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth
2. TE Connectivity
3. Eaton B-Line Series
4. Hubbell Premise Wiring
5. Leviton Voice & Data Division
6. Belden
7. Legrand
8. Panduit Corp
9. Siemon Co. (The)
10. Legrand / Ortronics

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA/ECA-310-E standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard black, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

1. Relay racks shall be 19" wide freestanding relay racks with predrilled and pretapped uprights, drilled and tapped on both sides. Rack bases shall be predrilled to allow floor fastening. Rack units shall be 1.75" and tapped at 12-24.
2. Vertical wire management shall be provided on both sides of relay racks except where noted on drawings. Manufacturers:

    a. Chatsworth
    b. TE Connectivity
    c. Eaton B-Line Series
    d. Hubbell Premise Wiring
    e. Leviton Voice & Data Division
    f. Belden
    g. Legrand
    h. Panduit Corp
    i. Siemon Co. (The)
    j. Legrand / Ortronics

3. Network equipment rack shall have 6 inch channel depth, cable support hook and loop type straps, vertical cable management rings and space for 42 rack units on both front and back sides. Rack shall house fiber optic termination cabinet, network switch(es) and power receptacles.
4. Horizontal distribution relay racks (voice and data) shall have 6 inch channel depth, cable support hook and loop type straps, vertical cable management rings and space for 44 rack units. The racks shall house passive patch panels for horizontal work station data and voice cable terminations.
5. Relay rack height shall be 7 feet. Refer to (ER, EF, TR, TE) (MDF/IDF) details on the drawings for equipment layout and elevations.
6. Where indicated on the drawings "Back-to-Back" or double-sided relay racks shall have 14 inch channel depth, cable support hook and loop type straps, vertical cable management rings and 44 rack unit spaces on both sides.
7. All racks shall be UL listed and have UL label.
8. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and power distribution unit(s).
9. Baked-polyester powder coat finish.

D. Modular Freestanding Cabinets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Chatsworth
    b. Hubbell Premise Wiring
    c. American Power Conversions (APC)
    d. Panduit
    e. Great Lakes Case & Cabinet Co., Inc.

2. Each equipment cabinet shall be designed for mounting 19-inch wide standard networking and distribution equipment. Cabinet shall be 84" high (45 rack units) and 32" deep,

ANSI/TIA compliant and UL listed. Cabinet shall also be rated for the associated building-specific Seismic Zone with manufacturer's standard black finish.

3. Each cabinet shall have adjustable front and rear racks, removable side panels with pocket handles, leveling feet, smoked plexiglass or solid-vented, locking, hinged front door, solid-vented, locking, hinged rear door, and removable vented roof panel. Cabinet shall have roof and base cable entrance points.
4. Cabinets shall have integral grounding bus bar and ground lug.
5. Each cabinet shall have one (1) 550-cfm, 10 inch ventilation fan with fan guards rack mounted or mounted to roof panel. Fan shall be suitable for 120 volt and supplied with cord and end plug.
6. Cabinets shall be "close-coupled" in arrangement indicated on the drawings. Provide side panels for end cabinets only as patch cords will interconnect all cabinets to core switch. All cabinets shall be keyed alike. Provide two (2) sets of keys with each cabinet.

E. Modular Wall Cabinets:

1. Wall mounting
2. Steel or aluminum construction
3. Treated to resist corrosion
4. Lockable front and rear doors
5. Louvered side panels
6. Cable access provisions top and bottom
7. Grounding lug
8. Rack or Roof-mounted, 250-cfm fan
9. Power strip
10. All cabinets keyed alike

2.4 POWER DISTRIBUTION UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. APC by Schneider Electric
2. Tripp Lite
3. Eaton

B. Power Distribution Units: Comply with UL 1363.

1. Rack mounting.

   a. Horizontal mounting shall be compliant with standard 19-inch equipment frames (racks).
   b. Vertical mounting shall be provided with full length mounting bracket.

2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.

7. Close-coupled, direct plug-in cord connected with 15-foot line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 33kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

2.5 GROUNDING

A. Comply with requirements in Division 27 Section 270526 "Grounding and Bonding for Communications Systems." for grounding conductors and connectors.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Erico - Eritech
2. Panduit Corp.
3. Hubbell Premise Wiring

C. Primary Bonding Busbar/Secondary Bonding Busbar, Telecommunications Busbars (PBB/SBB):

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Busbar: Plated copper, minimum 1/4 inch thick by 4 inches wide with multiple 5/16-inch and 7/16-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan, halogen-free nylon with reinforced fiberglass or PVC, 2-inch standoff height, impulse tested at 5000 V.
4. Stand-off mounting brackets: Type 304 stainless steel, 1/8-inch.
5. Fastners: Type 304 stainless steel.

D. Comply with ANSI/TIA-607-C.

2.6 LABELING

A. Comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Horizontal Cables

1. Provide self-laminating adhesive labels, machine printable with a laser printer suitable for cable diameters installed on both ends of cable within two inches of termination.
2. Printable Area: 1-inch by 2-1/4-inch .
3. Color: White.
4. Manufacturer:

    a. Panduit # S100X225YAJ or Owner approved equivalent.

C. Faceplates

1. Provide faceplate labels for all outlet faceplates, machine printable with a laser printer
2. Color: White
3. Manufacturer:

    a. Belden # AX101552 or Owner approved equivalent.

D. Patch Panel

1. Provide labels for patch panels, machine printable with a laser printer
2. Color: white
3. Manufacturer:

    a. Belden #CPPLF-5 or Owner approved equivalent.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate with telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Install underground pathways complying with recommendations in ANSI/TIA-569-E, "Entrance Facilities" Article.

3.2 INSTALLATION

A. Install underground entrance pathways complying with Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Comply with NECA 1.
2. Comply with BICSI TDMM latest edition for layout and installation of communications equipment rooms (EF, ER, TR, TER).
3. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 RELAY RACK AND CABINET INSTALLATION

A. Bolt floor mounted racks to finished floor. Fasten wall-mounted racks to plywood backboards. Prior to mounting equipment and termination hardware in telecommunications rooms, ensure that rooms are complete with wall, floor and ceiling finishes.

B. Racks shall be installed plumb and level following manufacturer's recommended installation technique.

C. Plugs on each outlet strip power cord shall match outlets provided.

D. Wire managers shall be bolted or screwed to racks. Do not use adhesive mountings.

E. Ganged cabinets shall be bolted together.

F. Ground all cabinets and racks via #6 AWG green insulated ground wire from cabinet/rack to adjacent cabinet/frame (rack) and terminated on (EF, ER, TR, TER) (MDF/IDF) ground bus (PBB/SBB).

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with ANSI/TIA-569-C, "Firestopping."

B. Comply with BICSI TDMM, latest edition, "Firestop Systems" Chapter.

C. Firestop materials must be UL compliant.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, " Bonding and Grounding (Earthing) Electrical Protection" Chapter.

B. Comply with ANSI/TIA 607-C and the National Electrical Code (NEC) Articles 250, 725, 770, 800, 810, 820, 830 and 840.

C. Locate Primary and Secondary Bonding Busbars as shown on drawings and wall elevations. Connect bonding busbars with 3/0 AWG wire to the electrical grounding electrode system.

D. Bond metallic equipment to the primary and secondary bonding busbar, using not smaller than # 6 AWG grounding conductor.

1. Bond the shield patch panel of shielded cable to the primary and secondary bonding busbars in communications rooms and spaces. Bond distribution and riser cable, sheaths to bonding busbars where cable pairs enter/exit the cable sheath. Minimum bond conductor shall be green insulated copper #6 AWG.

E. Ground all communication equipment cabinets, equipment racks, vertical/horizontal cable trays and relay racks to the nearest ground bar within the MDF, each IDF and Entrance Facility. Ground bar shall be installed as shown on drawings and wall elevations.

F. Bond all incoming telecommunication conduits and pull boxes to EF bonding busbar. Minimum conductor size shall be green insulated #6 AWG.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-C for Class 2 level of administration.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 11 00

SECTION 27 11 16 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 19-inch freestanding and wall-mounted equipment cabinets.
3. Open Rack equipment racks.
4. Power strips.
5. Grounding.
6. Labeling.

B. Related Requirements:

1. Section 271110 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for PBBs and SBBs.
3. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
4. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
5. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
6. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. SBB: Secondary bonding busbar

G. PBB: Primary bonding busbar

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of SBB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of an RCDD.
2. Installation Supervision: Installation shall be under direct supervision of a certified Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL listed.

C. RoHS compliant.

D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.3 19-INCH EQUIPMENT RACKS

A. Description: Two and four-post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel, Extruded aluminum, Sheet steel or Sheet aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Floor-Mounted Racks:

1. Overall Height: 84 inches.
2. Overall Depth: 32 inches.
3. Upright Depth: 6 inches
4. Two-Post Load Rating: 400 lb.
5. Four-Post Load Rating: 1000 lb.
6. Number of Rack Units per Rack: 45.

    a. Numbering: Every rack unit, on interior of rack.

7. Threads: 12-24.
8. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
10. Top shall have provisions for attaching to cable tray or ceiling.
11. Self-leveling.

D. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 19-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel, Extruded aluminum, Sheet steel or Sheet aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Modular Freestanding Cabinets:

1. Overall Height: 84 inches.
2. Overall Depth: 32 inches.
3. Load Rating: 3000 lb.
4. Number of Rack Units: 45.

    a. Numbering: Every rack unit, on interior of rack.

5. Threads: 12-24.
6. Removable and lockable side and top panels.
7. Hinged and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Screened ventilation openings in roof and rear door.
10. Cable access provisions in roof and base.
11. SBB.
12. Rack or Roof-mounted, 550-cfm fan with filter.
13. Power strip.
14. All cabinets keyed alike.

D. Modular Wall Cabinets:

1. Height: 24 inches and 36 inches as indicated on Drawings.
2. Depth: 24 inches.
3. Load Rating: 200 lb.
4. Number of Rack Units: 12 (24 inch height) and 20 (36 inch height).
5. Threads: 12-24.
6. Lockable front and rear doors.
7. Louvered side panels.
8. Cable access provisions top and bottom.
9. Grounding lug.
10. Rack or Roof-mounted, 250-cfm fan.
11. Power strip.
12. All cabinets keyed alike.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.5 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Cord connected with 15-foot line cord.

9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 33kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet SBBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted SBB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal SBB: Designed for mounting in 19-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.7 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection".

C. Locate SBB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind SBB. Connect SBB with a minimum No. 4 AWG grounding electrode conductor from SBB to suitable electrical building ground. Connect rack grounding busbar to the nearest SBB or the PBB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to SBB or PBB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

D. Labels shall be machine printed. Type shall be 1/4 inch in height.

END OF SECTION 27 11 16

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backbone communications cables.

B. Related Requirements:

1. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 270500 "Common Materials and Methods for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Cable Types:

1. UTP: Unshielded twisted pair.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

1.3 SEQUENCING

A. Wet-work in spaces must be completely dry, and HVAC system must be operating and maintaining ambient temperature and humidity conditions within manufacturer's recommended limits, before delivering and installing cables and connecting materials.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Backbone communications cable.

B. Shop Drawings:

1. Cable labeling schedules.
2. Cabling administration diagrams.
3. Wiring diagrams.
4. Cross-connect and patch panel details.
5. Twisted-pair cable testing plan.

C. Field quality-control reports.

D. Sustainable design submittals.

1. Backbone communications cable.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Field Reports:

1. Factory Test Reports:

a. Backbone communications cable.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted-pair cable for open and short circuits.

1.8 WARRANTY FOR COMMUNICATIONS COPPER BACKBONE CABLE ASSEMBLIES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed communications copper backbone cable assemblies perform in accordance with specified requirements and agrees to repair or replace cable assemblies that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Type CMP: NFPA 262.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Factory Tests:

a. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.
b. Testing Administrant: Engage qualified electrical testing agency to evaluate cable reels.
c. Factory Tests and Inspections: Test and inspect cable on reels, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-568.2 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
d. Nonconforming Work:

1) Cable reels that do not pass tests and inspections will be considered defective.

e. Factory Test Reports: Prepare and submit factory test and inspection reports.

D. UL DUZX and DVBI - Type CMP, Category 5e Communications Cable:

1. Product Marking: Type CMP, Category 5e
2. Options:

a. Quantity of Pairs: 25.

b. Shielding/Screening: UTP
c. Jacket: White or Gray thermoplastic.

2.2 COMMUNICATIONS SIGNALING-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for use in residential or commercial communications-station applications for connections to communications circuit as defined in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Communications-Circuit Accessories: UL CCN DUXR; including UL 1863.
b. For Use in Air-Handling Spaces: UL 2043.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL DUXR - Connecting Block:

1. Options:

a. Configuration: 110-style IDC for Category 5e.
b. Quantity of Terminations: Number of cables terminated on block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. UL DUXR - Patch Panel:

1. General Characteristics:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 ports.
e. Construction: 16-gauge steel and mountable on 19 inch equipment racks.

2. Options:

a. Number of Jacks per Field: One for each cable pair,l terminated at one pair per port. The 25th cable pair shall be left unterminated (spared).
b. Performance Rating: Category 5e.

F. UL DUXR - 8P8C Jacks and Jack Assemblies:

1. General Characteristics:

a. Female; 8P8C; color-coded modular telecommunications connector designed for termination of 100 Ω UTP or FTP cable.
b. Designed to snap into patch panel or cover plate.
c. Marked to indicate transmission performance.

2. Options:

a. Performance Rating: Category 5e.

G. UL DUXR - Patch Cords:

1. General Characteristics:

a. Factory-made, four-pair cables; terminated with an 8P8C plug at each end.
b. Bend-relief-compliant boots and color-coded icons to ensure Category 6A performance.
c. Latch guards to protect against snagging.
d. Color-coded boots for circuit identification.

2. Options:

a. Length: 4 ft.
b. Performance Rating: Category 6A.

H. Accessories:

1. Spare Parts: Furnish to Owner spare parts, for repairing cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

a. Connecting Blocks: One of each type.
b. Patch Panels: One of each type.
c. Jacks: Ten of each type.

2. Special Tools: Furnish to Owner proprietary tools required to operate, maintain, repair, adjust, or implement future changes to cable assemblies and accessories, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Cable Labeling Schedules: Submit electronic files using software and format requested by Owner.

a. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

2. Wiring Diagrams:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

3. Cross-Connect and Patch Panel Details: Include mounting assemblies, elevations, and physical relationship between installed components.
4. Twisted-Pair Cable Testing Plan: Include list of cables to be tested, identification of tests to be performed, pass/fail criteria, and copy of testing procedures (may be separate volume). Indicate Installer's required tests for warranty compliance.

3.2 SELECTION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Air-Handling Spaces:

1. Type CMP.
2. Type CMP in metallic conduit installed in accordance with Rule 300.22 of NFPA 70.

B. Vertical Chases:

1. Type CMP.

3.3 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:

1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.

2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

    a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
    b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

2. Drawings indicate general arrangement of pathways and fittings.
3. Wiring Methods:

    a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.

        1) Install plenum cable in environmental air spaces, including plenum ceilings.
        2) Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

    b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.
    c. Within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

4. General Requirements for Cabling:

    a. Install 110-style IDC termination hardware unless otherwise indicated.
    b. Do not untwist twisted-pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
    c. With the exception of telco type patch panels where the 25th pzir in each cable binder is to be left unterminated (spare), terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
    d. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
    e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
    f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.

g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
i. In the communications equipment room, install 10 ft long service loop on each end of cable.
j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:

a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of 8 inch above ceilings by cable supports not more than 5 ft apart.
c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

6. Group connecting hardware for cables into separate logical fields.
7. Separation from EMI Sources:

a. Comply with BICSI N1 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
b. Separate open communications cables or cables in nonmetallic raceways from unshielded power conductors and electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum 5 inch.
2) Power Rating between 2 and 5 kVA: Minimum 12 inch.
3) Power Rating More Than 5 kVA: Minimum 24 inch.

c. Separate communications cables in grounded metallic raceways from unshielded power lines or electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum 2-1/2 inch.
2) Power Rating between 2 and 5 kVA: Minimum 6 inch.
3) Power Rating More Than 5 kVA: Minimum 12 inch.

d. Separate communications cables in grounded metallic raceways from power lines and electrical equipment located in grounded metallic conduits or enclosures as follows:

1) Power Rating Less Than 2 kVA: No minimum distance.
2) Power Rating between 2 and 5 kVA: Minimum 3 inch.
3) Power Rating More Than 5 kVA: Minimum 6 inch.

e. Separate communications cables from electrical motors and transformers rated 5 kVA or 5 HP and larger minimum 48 inch.
f. Separate communications cables from fluorescent luminaires minimum 5 inch.

8. Identify system components, wiring, and cabling in accordance with TIA-606.

    a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
    b. Paint and label colors for equipment identification must comply with TIA-606 for Class 2 level of administration.

9. Cable and Wire Identification:

    a. Label each cable within 4 inches of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
    b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
    c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
    d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

        1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
        2) Label each unit and field within distribution racks and frames.

    e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

10. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
11. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Interfaces with Other Work:

1. Entrance Facilities: Coordinate backbone cabling with Section 271100 "Communications Equipment Room Fittings" for cabinets, racks, and protectors and demarcation point provided by communications service provider.
2. Coordinate with Section 078413 "Penetration Firestopping" for sealing fire-rated penetrations.
3. Coordinate with Section 260533.16 "Boxes and Covers for Electrical Systems" for installation of outlet boxes and cover plates.
4. Coordinate with Section 270526 "Grounding and Bonding for Communications Systems" for grounding communications cabling and connectors.

5. Coordinate with Section 270528 "Pathways for Communications Systems" for installation of provisions for routing and terminating cable assemblies.
6. Coordinate with Section 270536 "Cable Trays for Communications Systems" for installation of cable trays.
7. Coordinate installation of new products for compatibility with existing conditions.

3.4 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Acceptance Testing Preparation:

1. Submit a proposed cable test plan and subsequent proposed test result record documentation to construction management and the Owner for approval prior to the start of cable infrastructure testing.

B. Field tests and inspections must be witnessed by the Architect, the Owner and an authorized member of the project's construction management team.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Visually inspect jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Nonconforming Work:

1. Cable assemblies will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective cable assemblies and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 271313

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type OFNP optical fiber cable.
2. Type OFCP optical fiber cable.
3. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.

D. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

1.3 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Type OFNP optical fiber cable.
2. Type OFCP optical fiber cable.
3. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.

b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials, from same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Plugs: 6 of each type.
3. Jacks: 6 of each type.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

    a. Performance: TIA-568.3.
    b. Inside Plant Mechanical Properties: ICEA S-83-596.
    c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
    d. Jacket:

        1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
        2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

C. Type OFNP, Designation OM4, Multimode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

a. Configuration: Strand count as indicated on the associated project drawings, tight buffer, optical fiber cable.
b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
c. Jacket Color: Aqua.

D. Type OFNP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

a. Configuration:

1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.

b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
c. Jacket Color: Yellow.

E. Type OFNP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

a. Configuration:

1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.

b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
c. Jacket Color: Yellow.

F. Type OFNP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

    a. Configuration: Strand count as indicated on the associated project drawings, tight buffered, optical fiber cable.
    b. Maximum Attenuation: 1.0 dB/km at 1310 nm wavelength; 1.0 dB/km at 1550 nm wavelength.
    c. Jacket Color: Yellow.

G. Type OFNP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

    a. Configuration:

        1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.

    b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
    c. Jacket Color: Yellow.

2.2 TYPE OFCP OPTICAL FIBER CABLE

A. Type OFCP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing noncurrent-carrying electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

    a. Performance: TIA-568.3.
    b. Inside Plant Mechanical Properties: ICEA S-83-596.
    c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
    d. Jacket:

        1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
        2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

C. Type OFCP, Designation OM4, Multimode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
    c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

3. Options:

    a. Configuration: Strand count as indicated on the associated project drawings, tight buffer, optical fiber cable.
    b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
    c. Jacket Color: Aqua.
    d. Armor: Steel or Aluminum.

D. Type OFCP, Designation OS1, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

    a. Configuration:

1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.

b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
c. Jacket Color: Yellow
d. Armor: Steel or Aluminum.

E. Type OFCP, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

a. Configuration:

1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.

b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
c. Jacket Color: Yellow.
d. Armor: Steel or Aluminum.

F. Type OFCP, Designation OS1, Inside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

a. Construction: TIA-492CAAA; 9 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

a. Configuration: Strand count as indicated on the associated project drawings, tight buffered, optical fiber cable.
b. Maximum Attenuation: 1.0 dB/km at 1310 nm wavelength; 1.0 dB/km at 1550 nm wavelength.
c. Jacket Color: Yellow.
d. Armor: Steel or Aluminum.

G. Type OFCP, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable:

1. Source Limitations: Obtain products from single manufacturer.
2. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

3. Options:

    a. Configuration:

        1) Strand count as indicated on the associated project drawings, loose tube, optical fiber cable.
        2) Strand count as indicated on the associated project drawings, stranded loose tube, optical fiber cable.

    b. Maximum Attenuation: 0.5 dB/km at 1310 nm wavelength; 0.5 dB/km at 1550 nm wavelength.
    c. Jacket Color: Yellow.
    d. Armor: Steel or Aluminum.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field except MPO type at one connector per each 12 strands of fiber, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

D. Connector Type: Type LC complying with TIA-604-10 and/or Type MPO complying with TIA-604-5 connectors as specified on the associated project drawings.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.4 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: Engage qualified testing agency to evaluate cables.

C. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

D. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. Type OFNP installed inside plenum rated innerduct or in metallic conduit.

2. Conductive:

    a. Type OFCP installed inside plenum rated innerduct or in metallic conduit.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

    a. Type OFNP in listed plenum communications raceway.
    b. Type OFNP in metallic conduit.

2. Conductive:

    a. Type OFCP in listed plenum communications raceway.
    b. Type OFCP in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNP installed inside plenum rated innerduct or in metallic conduit.
2. Conductive: Type OFCP installed inside plenum rated innerduct or in metallic conduit.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

    a. Install plenum cable in environmental airspaces, including plenum ceilings.
    b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10 ft long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Installation of Cable Exposed under Raised Floors (when/where applicable):

1. Install plenum-rated cable only.
2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable 6 ft long not less than 12 inches in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607 and NECA/BICSI-607.

C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least 2 inch clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to grounding bus bar in accordance with requirements specified in Section 270526, Grounding and Bonding for Communication Systems.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606.

1. Administration Class: Class 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification must comply with TIA-606 for Class 2 level of administration.

C. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

F. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
        2) Horizontal and singlemode backbone link measurements: Test at 1310 or 1550 nm in one direction in accordance with TIA-526-7, Method B, One Reference Jumper.
        3) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

B. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.

2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 271323

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Related Requirements:

270526	Grounding and Bonding for Communications Systems
270528	Pathways for Communications Systems
270529	Hangers and Supports for Communications Systems
270536	Cable Trays for Communications Systems
270544	Sleeves and Sleeve Seals for Communications Pathways and Cabling
271100	Communications Equipment Room Fittings
271116	Communications Racks, Frames, and Enclosures
271313	Communications Copper Backbone Cabling
271323	Communications Optical Fiber Backbone Cabling

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no transition points between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system wireless access point locations.
    d. Telecommunications grounding system.
    e. Telecommunications outlet locations.
    f. Typical telecommunications details.

C. Twisted pair cable testing plan.

D. Samples: For telecommunications jacks and plugs, one for each type and configuration and cover plates for color selection and evaluation of technical features.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: one of each type.
2. Cover Plates: one of each type.
3. Jacks: ten of each type.

4. Patch-Panel Units: one of each type.
5. Plugs: ten of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a BICSI certified Technician (minimum), who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685.
b. Type CMP in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. Non plenum rated cable is not permitted regardless of environmental spatial determination, condition or description per recognized code, standard or guideline.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6a TWISTED PAIR CABLE

A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP)

E. Cable Rating: Plenum.

F. Jacket: Color as specified on the associated project drawings, thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6a.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

D. Connecting Blocks:

1. 110-style IDC for Category 6a.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each horizontal distribution four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Patch Cords: Factory-made, four-pair cables in lengths specified by the Owner's IT representative. Contractor shall coordinate with the Owner's authorized IT representative to determine patch cable length, rating and color requirements prior to Contractor acquisition of patch cable products. Patch cables shall be terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.

3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

J. Cover Plate:

1. Single, two, three and four port (as specified on the associated project drawings), vertical single gang cover plates designed to mount to double gang wall boxes with single gang adapter (mud-ring) assemblies.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
3. Metal Cover Plate: Stainless steel, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, and non-continuous pathway (J-hook) systems except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.

5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA assemblies shall not be used.
7. Consolidation points shall not be used.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors (when/where applicable):

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

1. Administration Class: Class 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Contractor shall submit proposed Acceptance Test and Inspection plan to the Owner’s authorized IT representative and to the Architect for review and approval prior to the start of testing and acceptance procedures.

B. Field tests and inspections must be witnessed by Architect and by associated authorities having jurisdiction.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 27 15 13

SECTION 28 05 00 - COMMON MATERIALS AND METHODS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Electronic safety and security equipment coordination and installation
2. Sleeves for raceways and cables
3. Sleeve seals
4. Grout
5. Common electronic safety and security installation requirements

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber

B. NBR: Acrylonitrile-butadiene rubber

1.4 SUBMITTALS

A. Product Data: For sleeve seals

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.6 COMMISSIONING

A. Commissioning of components, equipment and/or system specified in this division is part of the construction process. Documentation and testing of these components, equipment and/or system, as well as training of the Owner's operation and maintenance personnel on these components, equipment and/or system, is required in cooperation with the Owner's Representative and Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13 – General Commissioning Requirements for detailed commissioning requirements.

B. Manufacturer's representative shall provide commissioning support for controller startup, controls checkout, and commissioning.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel or Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 3 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 28 05 00

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling
2. 50/125 micrometer, multimode optical fiber cabling
3. Coaxial cabling
4. RS-232 cabling
5. RS-485 cabling
6. Low-voltage control cabling
7. Identification products

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

H. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

I. RCDD: Registered Communications Distribution Designer.

J. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

K. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

L. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD
b. Minimum bending radius
c. Maximum pulling tension

B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 COMMISSIONING

A. Commissioning of components, equipment and/or system specified in this division is part of the construction process. Documentation and testing of these components, equipment and/or system, as well as training of the Owner's operation and maintenance personnel on these components, equipment and/or system, is required in cooperation with the Owner's Representative and Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13 – General Commissioning Requirements for detailed commissioning requirements.

B. Manufacturer's representative shall provide commissioning support for controller startup, controls checkout, and commissioning.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of category 6, category 6a and other security system related low voltage cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cable Management Solutions, Inc.
b. Cablofil Inc.
c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit
e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B633, Type 1, not less than 0.000472 inch thick or hot-dip galvanizing, complying with ASTM A123/A123M Grade 0.55, not less than 0.002165 inch thick.

a. Basket Cable Trays: Up to 12 inches wide and 4 inches deep per mandated NEC cable fill requirements plus 25% spare capacity for future growth. Wire mesh spacing shall not exceed 2 by 4 inches.
b. Ladder Cable Trays: 18 inches wide, and a rung spacing of 9 inches.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 4 inches square and 2-1/8 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, painted (gray) 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division
2. Berk-Tek; a Nexans company
3. CommScope, Inc.
4. Draka USA
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated
7. Mohawk; a division of Belden CDT
8. Nordex/CDT; a subsidiary of Cable Design Technologies
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand
11. 3M
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5E (25-pair) and Category 6 or 6a, as specified on the associated project drawings (4-pair).
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation
3. Hubbell Premise Wiring
4. KRONE Incorporated
5. Leviton Voice & Data Division
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies
8. Panduit Corp.
9. Siemon Co. (The)
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6a (4-pair category 6a cabling). Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company
2. CommScope, Inc.
3. Corning Cable Systems
4. General Cable Technologies Corporation
5. Mohawk; a division of Belden CDT
6. Nordex/CDT; a subsidiary of Cable Design Technologies
7. Optical Connectivity Solutions Division; Emerson Network Power
8. Superior Essex Inc.

9. SYSTIMAX Solutions; a CommScope, Inc. brand
10. 3M
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for type OM4 performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    b. General Purpose, Conductive: OFCP, or OFNP , complying with NFPA 262.
    c. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

4. Conductive cable shall be steel or aluminum armored type.
5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans Company
4. Corning Cable Systems
5. Dynacom Corporation
6. Hubbell Premise Wiring
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies
9. Optical Connectivity Solutions Division; Emerson Network Power
10. Siemon Co. (The)

B. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
2. Type LC connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Wire Company
2. Belden CDT Inc.; Electronics Division
3. Coleman Cable, Inc.
4. CommScope, Inc.
5. Draka USA

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CMP.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Black (color) communications multi-purpose plenum (CMP) or CATVP plenum rated jacket.
4. Suitable for indoor installations.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Plenum Rated: Type CMP complying with NFPA 262.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.8 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division
3. Siemon Co. (The)

B. Coaxial-Cable Connectors: Type BNC, 75 ohms or F-81, 75 Ohms as specified on the associated project drawings.

2.9 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.10 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors
2. Fluorinated ethylene propylene insulation
3. Unshielded
4. Fluorinated ethylene propylene jacket
5. Flame Resistance: NFPA 262, Flame Test

2.11 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x30) tinned copper conductors
2. Fluorinated ethylene propylene insulation
3. Unshielded
4. Plastic jacket
5. Flame Resistance: NFPA 262, Flame Test

2.12 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporatio
2. HellermannTyton
3. Kroy LLC
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 CONNECTIONS

A. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 27 Section 270526 "Grounding and Bonding for Communications Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

5. Coaxial Cable Tests: Test for opens, shorts, grounds, crosses and continuity.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 28 05 13

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping, or sealing site utilities.
7. Temporary erosion and sedimentation control.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 700 S. Martin Luther King Blvd.

1.3 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises, location to be coordinated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree-protection measures are in place.

E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
2. Use only hand methods or air spade for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks & pavements.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course and base course for asphalt paving.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at 700 S. Martin Luther King Blvd.

1.4 INFORMATIONAL SUBMITTALS

A. Material test reports.

1.5 FIELD CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

B. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487or a combination of these groups; free of rock or gravel larger than 3 inchesin any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Expansion Index: 50 or less

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavementswith a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches > of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inchthick, concrete-base slab support for piping or conduit less than 30 inchesbelow surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inchesof concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Initial Backfill: Place and compact initial backfill of bedding course free of particles larger than 1 inchin any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inchesin loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch
2. Walks: Plus or minus 1 inch
3. Pavements: Plus or minus 1/2 inch

C. Grading inside Building Lines: Finish subgrade to a tolerance of [**1/2 inch**] <**Insert dimension**> when tested with a 10-foot straightedge.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course[and base course to required crown elevations and cross-slope grades.
2. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95percent of maximum dry unit weight according to ASTM D1557.

3.16 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform inspections:

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes construction dewatering.

B. Related Sections:

1. Division 01 Section "Construction Progress Documentation and Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
3. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Division 33 Section "Subdrainage" for permanent foundation wall, underfloor, and footing drainage.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

1.4 SUBMITTALS

A. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For qualified Installer and professional engineer.

C. Field quality-control reports.

D. Other Informational Submittals:

1. Photograph and Videotape: Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to dewatering including, but not limited to, the following:

a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.
b. Geotechnical report.
c. Proposed site clearing and excavations.
d. Existing utilities and subsurface conditions.
e. Coordination for interruption, shutoff, capping, and continuation of utility services.
f. Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
g. Testing and monitoring of dewatering system.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Monitor dewatering systems continuously.

E. Promptly repair damages to adjacent facilities caused by dewatering.

F. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Facilities and Controls" and Division 31 Section "Site Clearing" during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 FIELD QUALITY CONTROL

A. Observation Wells: Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

END OF SECTION 31 23 19

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 700 S. Martin Luther King Blvd.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

B. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the City of Las Vegas, Nevada in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs or video recordings**,** show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.
4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A722/A722M.

I. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.

1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.

1. Trim excavation as required to install lagging.
2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to 60 inches.
2. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.7 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks daily during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.8 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.
5. Asphalt curbs.

B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
2. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 700 S. Marthin Luther King Blvd.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.
2. Prepare mix design; sample and test materials and equipment for compliance with the specifications. Properly mark samples to show the name of the material, name of the supplier, contract number and the segment of the work where the material represented by the sample is to be used. Submit copies of weighmaster's certificates or certified delivery tickets for each truck load of material.
3. ertified delivery tickets for each truck load of material.
4. Certificates: Submit manufacturer's certificate of compliance for the bituminous and paint materials.
5. Job-Mix Formula: Submit a job mix for each type of bituminous mixture prior to starting work. The formula shall be within the specified design range.
6. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
7. Job-Mix Designs: For each job mix proposed for the Work.

B. Sustainable Design Submittals:

1. SUSTAINABLE MATERIALS COVERSHEET (SMC):

a. Each material submittal shall include a completed SMC per Section 01 81 15 and required backup documentation.
b. All products shall comply with Sustainable Material Performance Requirements per Section 01 81 20.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

1. Aggregates.
2. Asphalt binder.
3. Tack coat.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located .

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of City of Las Vegas of Nevada for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D242/D242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, binder designation PG 64-10

B. Asphalt Cement: ASTM D946/D946M for penetration-graded material.

C. Tack Coat: ASTM D977 or AASHTO M 140 emulsified asphalt, or ASTM D2397/D2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

2.4 MIXES

A. Recycled Content of Hot-Mix Asphalt: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent or more than 50 percent by weight.

1. Surface Course Limit: Recycled content no more than 10 percent by weight.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed in accordance with procedures in AI MS-2, "Asphalt Mix Design Methods"; and complying with the following requirements:

1. *The bituminous concrete shall consist of mineral aggregate, uniformly mixed with bituminous material in a central plant in accordance with Section 302 of the Standard Specifications. The percentage of asphalt cement binder shall be in accordance with Section 302 of the Standard Specifications. The mixing plant and construction equipment shall conform to the requirements of Section 39 of the Standard Specifications.* Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Refer to NevadaDOT Division II
3. Binder Course: Refer to NevadaDOT Division II
4. Surface Course: Refer to NevadaDOT Division II

PART 3 - EXECUTION

3.1 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.
7. Handle milled asphalt material according to approved waste management plan required in Section 01 74 19 " Waste Management."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. Ensure that prepared subgrade is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
4.

3.5 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches (25 to 38 mm) from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of 250 deg F.

1. Hot-Mix Asphalt: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving.

1. Driveways.
2. Curbs and gutters.
3. Walks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of product, ingredient, or admixture requiring color selection.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer, and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Quality Control: Tests of concrete shall be made by a Testing Laboratory approved by the University's Representative. The cost of sampling and testing required by these specifications shall be borne by the University, except that any retesting of nonconforming material shall be paid for by the Contractor. Concrete shall have a compressive strength of 2,500 psi at the end of 28 days unless otherwise noted.

C. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

D. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

E. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

F. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

G. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

H. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by University's Representative and not less than 96 inches (2400 mm) by 96 inches (2400 mm). Include full-size detectable warning.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless University's Representative specifically approves such deviations in writing.

4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

I. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete paving subcontractor.
e. Manufacturer's representative of stamped concrete paving system used for detectable warnings.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

C. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

D. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports

according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.3 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Concrete shall be 520-A-2500 per Section 201-1 of the Standard Specifications
2. Concrete for curbs and gutters shall be Class 520-C-2500 per Section 201-1 of the Standard Specifications.
3. Concrete for cross gutters shall be Class 560-C-3250 per Section 201-1 of the Standard Specification.

4. Portland Cement: ASTM C150/C150M, gray portland cement Type II
5. Fly Ash: ASTM C618, Class F.
6. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 1N , uniformly graded. Provide aggregates from a single source.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Color: Match Architect's sample

F. Water: Potable and complying with ASTM C94/C94M.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. BASF Corporation; Construction Systems; MasterKure ER 50 (Pre-2014: Confilm.
    b. Brickform; a division of Solomon Colors; Evaporation Retarder.
    c. ChemMasters, Inc; Spray-Film.
    d. Kaufman Products, Inc; VaporAid.
    e. L&M Construction Chemicals, Inc; E-CON.
    f. Lambert Corporation; LAMBCO Skin.
    g. Sika Corporation; SikaFilm.
    h. SpecChem, LLC; SpecFilm.
    i. TK Products; TK-2120 TRI-FILM.
    j. W. R. Meadows, Inc; EVAPRE.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anti-Hydro International, Inc; A-H Curing Compound #2 DR WB.
    b. ChemMasters, Inc; Safe-Cure Clear DR.
    c. Kaufman Products, Inc; DR Cure.
    d. L&M Construction Chemicals, Inc; L&M CURE R.
    e. Lambert Corporation; AQUA KURE - CLEAR.
    f. Right Pointe; Clear Water Resin.
    g. SpecChem, LLC; PaveCure Rez.
    h. TK Products; TK-2519 DC WB.
    i. W. R. Meadows, Inc; 1100-CLEAR SERIES.
    j. Or Equal.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anti-Hydro International, Inc; A-H Curing Compound #2 WP WB.
    b. ChemMasters, Inc; Safe-Cure 2000.
    c. Kaufman Products, Inc; Thinfilm 450.
    d. L&M Construction Chemicals, Inc; L&M CURE R-2.
    e. Lambert Corporation; AQUA KURE - WHITE.
    f. SpecChem, LLC; PaveCure Rez White.
    g. Vexcon Chemicals Inc; Certi-Vex Enviocure White 100.
    h. W. R. Meadows, Inc; 1100-WHITE SERIES or 1200-White.
    i. Or Equal.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1-1/2 percent.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

G. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 4500 psi
2. Maximum W/C Ratio at Point of Placement: 0.45
3. Slump Limit: 4 inches, plus or minus 1 inch.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch(13 mm) according to requirements in Section 31 20 00 "Earth Moving."

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Expansion joints shall be located at 45' intervals and as required by Standard Drawing G-9. Joints shall be constructed per Standard Drawing G-10 and per Section 303-5 of the Standard Specifications.
2. Locate expansion joints at intervals of 50 feet (15.25 m)unless otherwise indicated.
3. Extend joint fillers full width and depth of joint.
4. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
5. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
6. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
7. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm)(10-mm)radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

    a. Tolerance: Ensure that grooved joints are within 3 inches (75 mm)either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-(3-mm-)wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

    a. Tolerance: Ensure that sawed joints are within 3 inches (75 mm)either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true

planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
2. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture-retaining-cover curing or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.10 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Joint-sealant backer materials.
4. Primers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 700 S. Martin Luther King Blvd.

1.3 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.

B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.

D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.

3.2 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.
2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

G. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION 32 13 73

SECTION 32 17 13 - PARKING BUMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete wheel stops.
2. Resilient wheel stops.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Precast concrete wheel stops.
2. Resilient wheel stops.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; 4000-psi minimum compressive strength; 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
2. Surface Sealer: Manufacturer's standard salt-resistant, clear, applied at precasting location.
3. Mounting Hardware: Galvanized-steel hardware as standard with wheel-stop manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.

B. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.

C. Install wheel stops in bed of adhesive before anchoring to substrate.

D. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 32 17 13

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.
2. Painted markings applied to concrete surfaces.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 700 S. Martin Luther King Blvd.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pavement-marking paint, solvent-borne.
2. Pavement-marking paint, acrylic.
3. Pavement-marking paint, latex.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design”

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint, Solvent-Borne: MPI #32, solvent-borne traffic-marking paint.

1. Color: White or Blue (ADA stalls)

B. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than 45 minutes.

1. Color: White or Blue (ADA stalls)

C. Pavement-Marking Paint, Latex: MPI #97, latex traffic-marking paint.

1. Color: White or Blue (ADA stalls)

PART 3 - EXECUTION

3.1 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface.

END OF SECTION 32 17 23

SECTION 32 17 26 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.
2. Surface-applied detectable warning tiles.
3. Detectable warning mats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for each type of exposed finish requiring color selection.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Material: Cast-fiber-reinforced polymer concrete tile
2. Color: Safety yellow.
3. Verify shapes and sizes available from manufacturers.
4. Shapes and Sizes:

a. Rectangular panel, 12 by 12 inches

5. Dome Spacing and Configuration: 1.67-inch spacing or Manufacturer's standard compliant spacing, in [square] [diamond] [manufacturer's standard] pattern.
6. Mounting:

    a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.
    b. Detectable warning tile set into formed recess in concrete and adhered with mortar.
    c. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish [Type 304] [Type 316] stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

C. Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean using methods recommended in writing by manufacturer.

D. Removable Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean tiles using methods recommended in writing by manufacturer.

E. Surface-Applied Detectable Warning Tiles: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Apply sealant in continuous bead around perimeter of installation.

F. Surface-Applied Detectable Warning Mats: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of mat and set mat in place. Firmly seat mat in adhesive bed. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface. Apply sealant in continuous bead around perimeter of mat.

G. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

H. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 32 17 26

SECTION 33 05 00 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Dielectric fittings.
3. Sleeves.
4. Identification devices.
5. Grout.
6. Piping system common requirements.
7. Equipment installation common requirements.
8. Concrete bases.
9. Metal supports and anchorages.

1.2 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D2235.
2. CPVC Piping: ASTM F493.
3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
4. PVC to ABS Piping Transition: ASTM D3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.3 IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

B. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

C. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

D. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

E. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

F. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

G. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

H. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch-thick, polished brass or aluminum.
2. Material: 0.0375-inch-thick stainless steel.
3. Material: 3/32-inch-thick plastic laminate with 2 black surfaces and a white inner layer.
4. Material: Valve manufacturer's standard solid plastic.
5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
6. Shape: As indicated for each piping system.

I. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

J. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
2. Thickness: 1/16 inch unless otherwise indicated.
3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

K. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.4 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric unions.
2. NPS 2-1/2 and Larger: Dielectric flanges.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric couplings or dielectric nipples.
2. NPS 2-1/2 and Larger: Dielectric nipples.

3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
5. PVC Nonpressure Piping: Join according to ASTM D2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.5 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.6 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
2. Locate pipe markers on exposed piping according to the following:

    a. Near each valve and control device.
    b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    d. At manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.9 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 33 05 00

SECTION 33 14 15 - SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water-distribution piping and related components outside the building for domestic water service & fire-suppression water service and terminated 5 ft. from building. Terminate water-service piping with appropriate fitting for extension by Divisions 21 and 22.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories."
2. Section 032000 "Concrete Reinforcing."
3. Section 211119 "Fire Department Connections."
4. Section 221216 "Facility Elevated, Potable-Water Storage Tanks."
5. Section 221219 "Facility Ground-Mounted, Potable-Water Storage Tanks."
6. Section 221223.11 "Facility Indoor Potable-Water Storage Tanks."
7. Section 315000 "Excavation Support and Protection."

1.2 ACTION SUBMITTALS

A. Product Data.

B. Shop Drawings:

1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
2. Include diagrams for power, signal, and control wiring for alarms.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service in accordance with requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.6 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.

C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

D. Piping materials to bear label, stamp, or other markings of specified testing agency.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

F. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

G. Comply with FM Approvals' "Approval Guide" and/or UL's "Fire Protection Equipment Directory" for fire-suppression water-service products.

H. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

I. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.

B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

B. Mechanical-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
3. AWWA C104/A21.4 cement mortar-lined.

C. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. AWWA C104/A21.4 cement mortar-lined.

D. Push-on-Joint, Ductile-Iron Fittings:

1. AWWA C110, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
2. Gaskets: AWWA C111/A21.11, rubber.
3. AWWA C104/A21.4 cement mortar-lined.

E. Grooved-End, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with cut, rounded-grooved ends.
2. AWWA C104/A21.4 cement mortar-lined.

F. Grooved-End, Ductile-Iron Pipe Appurtenances:

1. Grooved-End, Ductile-Iron Fittings:

a. ASTM A536, ductile-iron castings with dimensions matching pipe.
b. AWWA C104/A21.4 cement mortar-lined.

2. Grooved-End, Ductile-Iron-Piping Mechanical Couplings:

a. AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. PVC, Schedule 80 Pipe: ASTM D 1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

C. PVC, AWWA Pipe: AWWA C900, DR-14, with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.
2. PVC Fabricated Fittings: AWWA C900, DR-14, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Gaskets: AWWA C111, rubber.

5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PIPING JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

a. Standard: AWWA C219.
b. Center-Sleeve Material: Stainless steel.
c. Gasket Material: Natural or synthetic rubber.
d. Pressure Rating: 200 psig minimum.
e. Metal Component Finish: Corrosion-resistant coating or material.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. Ford Meter Box Company, Inc. (The).
d. Hays Fluid Controls.
e. JCM Industries, Inc.
f. Smith-Blair, Inc.
g. Or Equal.

C. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless steel hose covered with stainless steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

2.7 GATE VALVES

A. Gate Valves - AWWA, Cast Iron:

1. Gate valves, unless otherwise indicated, shall be the same size as the main in which they are installed. Gate valves shall be non-rising stem, counterclockwise opening and provided with a 2-inch square operating nut with the word open and an arrow cast in the metal to indicate direction to open. Valves shall be marked with raised lettering cast on the body indicating manufacturer and working pressure. Working pressure rating shall equal or exceed that of the pressure class of the adjoining pipe unless otherwise indicated. Gaskets shall conform to AWWA C111 and be full faced 0.0625-inch cloth inserted rubber with bolt holes pre-punched.

2. Gate Valves - Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

a. Standards: AWWA C509 or AWWA C515.
b. Minimum Pressure Rating: 200 psig.

c. End Connections: Mechanical joint, flanged, threaded, or push on.
d. Interior Coating: Complying with AWWA C550.

3. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, and bronze stem.

a. Standard: AWWA C509 or AWWA C515.
b. Minimum Pressure Rating: 200 psig.
c. End Connections: Mechanical joint, flanged, threaded, or push on.

B. Gate Valves - UL/FM Global, Cast Iron:

1. Gate Valves - UL/FM Global, Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with flange for indicator post, bronze seating material, and inside screw.

a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
b. Minimum Pressure Rating: 175 psig.
c. End Connections: Mechanical joint or flanged.
d. Interior Coating: Complying with AWWA C550.

2. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet and bronze seating material.

a. Standards: AWWA C509 or AWWA C515, UL listed and FM Global approved.
b. Minimum Pressure Rating: 175 psig.
c. End Connections: Mechanical joint or flanged.
d. Interior Coating: Complying with AWWA C550.

C. AWWA, Cast-Iron Gate Valves:

1. Manufacturers:

a. Mueller Co. A-2362-6
b. American Flow Control. Series 2500
c. CLOW RW2639

D. UL/FMG, Cast-Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Cast Iron Pipe Company.
b. Clow Valve Company; a subsidiary of McWane, Inc.
c. McWane, Inc.
d. Mueller Co.
e. NIBCO INC.
f. Or Equal.

2. UL/FMG, Nonrising-Stem Gate Valves:

a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.
3) End Connections: Flanged.

3. OS&Y, Rising-Stem Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 175 psig.

b. End Connections: Flanged

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies: Sleeve and valve compatible with drilling machine.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Cast Iron Pipe Company.
b. Clow Valve Company; a subsidiary of McWane, Inc.
c. EJ.
d. Flowserve Corporation.
e. McWane, Inc.
f. Mueller Co.
g. Or Equal.

2. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FM Global approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.9 CHECK VALVES

A. AWWA Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American AVK Co.
    b. American Cast Iron Pipe Company.
    c. McWane, Inc.
    d. Mueller Co.
    e. NIBCO INC.
    f. Or Equal.

2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.

    a. Standard: AWWA C508.
    b. Pressure Rating: 175 psig.

B. UL/FMG, Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Cast Iron Pipe Company.
    b. Matco-Norca.
    c. McWane, Inc.
    d. Mueller Co.
    e. NIBCO INC.
    f. Or Equal.

2. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.

    a. Standards: UL 312 and FMG approved.
    b. Pressure Rating: 250 psig.

2.10 DETECTOR CHECK VALVES

A. Detector Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Fire & Waterworks.
b. Badger Meter, Inc.
c. McWane, Inc.
d. Mueller Co.
e. Watts; a Watts Water Technologies company.
f. Or Equal.

2. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.
c. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

3. Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.

2.11 WATER METERS

A. Water Meter - Utility Company Furnished:

1. Utility Company: Las Vegas Valley Water District

B. Water Meters - Displacement Type:

1. Source Limitations: Obtain water meters - displacement type, from single manufacturer.
2. Standard: AWWA C700.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: Nutating disc; totalization meter.
5. Registration: Flow in cu. ft. as required by utility company.
6. Case: Bronze or Stainless steel.
7. End Connections: Threaded or flanged

C. Water Meters - Compound Type:

1. Source Limitations: Obtain water meters - compound type, from single manufacturer.
2. Standard: AWWA C702.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: With integral mainline and bypass meters; totalization meter.
5. Registration: Flow in cu. ft. as required by utility company.
6. Case: Bronze or Coated ductile iron.

7. End connections: Flanged

D. Remote Registration System, Direct-Reading Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Registration: Flow in cu. ft..

E. Remote Registration System, Encoder Type: Utility company standard. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Standard: AWWA C707.
2. Registration: Flow in cu. ft..
3. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
4. Visible Display Units: Comply with utility company requirements for type and quantity.

2.12 WATER METER BOXES

A. Description: 2-inch meter box, precast concrete meter box 9-1/2 in. x 16 in., with #9 gauge welded wire loop.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

a. Associated Concrete Products, Inc.
b. Brooks Products, Inc.
c. Or Equal.

B. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

C. Verify, with authorities having jurisdiction, whether AWWA, UL-listed, or FM Global-approved backflow preventers are required.

2.13 BACKFLOW PREVENTERS

A. Backflow Preventers - Reduced Pressure Principle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Colt Series
b. Watts; a Watts Water Technologies company.
c. Wilkins.
d. Or Equal.

2. Standard: ASSE 1013 or AWWA C511.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle one-third of flow range.
5. Size: Size per plan
6. Design Flow Rate: Per Plan
7. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
9. Configuration: Designed for horizontal, straight through flow.
10. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Backflow Preventers - Double-Check Assembly:

1. Standard: ASSE 1015 or AWWA C510.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
4. Size: Size per plan
5. Design Flow Rate: Rate per plan
6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

C. Backflow Preventer Test Kits: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO.
    c. Flowmatic Corporation.
    d. Watts; a Watts Water Technologies company.
    e. Wilkins.

2. Source Limitations: Obtain backflow preventer test kits from single manufacturer.

2.14 CONCRETE VAULTS

A. Concrete Vault - Precast, Reinforced Concrete: Designed for A-16 load designation in accordance with ASTM C857 and made in accordance with ASTM C858.

1. Ladder: ASTM A36/A36M, steel or PE-encased steel steps.

2. Manhole:

   a. ASTM A48/A48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.

      1) Dimension: 24-inch minimum diameter unless otherwise indicated.

   b. ASTM A536, Grade 60-40-18, ductile-iron traffic frame and cover.

      1) Dimension: 24-inch minimum diameter unless otherwise indicated.

3. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.15 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire End & Croker Corporation.
   c. Guardian Fire Equipment, Inc.
   d. Kidde Fire Fighting; A UTC Business Unit.
   e. Potter Roemer LLC.
   f. Or Equal.

2. Source Limitations: Obtain fire department connections from single manufacturer.
3. Standard: UL 405.
4. Configuration: Freestanding, with cast-bronze body, thread inlets in accordance with NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high, brass sleeve; and round escutcheon plate.
5. Connections:

   a. Two NPS 2-1/2 inlets and one NPS 6 outlet.
   b. Three NPS 2-1/2 inlets and one NPS 6 outlet.
   c. Six NPS 2-1/2 inlets and one NPS 6 outlet.

6. Inlet Alignment: Inline, horizontal
7. Finish Including Sleeve: Polished chrome-plated
8. Escutcheon Plate Marking: "AUTO SPKR”

2.16 ALARM DEVICES

A. Alarm Devices: UL 753 and FM Global approved, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250 psig working pressure; designed for horizontal or vertical installation; with 2 SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: SPDT; designed to signal valve in other than fully open position.

D. Pressure Switches: SPDT; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

A. Transition couplings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.

B. Do not use flanges or unions for underground piping.

C. Flanges, unions, and grooved-end-pipe couplings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping NPS 3/4 to NPS 3 to be any of the following:

1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

E. Underground water-service piping NPS 4 to NPS 8 to be any of the following:

1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

F. Water Meter Box Water-Service Piping: NPS 3/4 to NPS 2 to be same as underground water-service piping.

G. Underground fire-service-main piping NPS 4 to NPS 12 to be any of the following:

1. Ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, high-pressure, resilient-seated gate valves with valve box.
2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FM Global, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:

    a. Gate Valves, NPS 2 and Smaller: Bronze, rising stem.
    b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated
    c. Check Valves: AWWA C508 swing type.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Comply with Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

B. Provide a continuous bare copper or aluminum tracer wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

3.5 INSTALLATION OF PIPING

A. Water-Main Connection:

1. Arrange with utility company for tap of size and in location indicated in water main.
2. Tap water main in accordance with requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve in accordance with MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install copper tube and fittings in accordance with CDA's "Copper Tube Handbook."

E. Install ductile-iron, water-service piping in accordance with AWWA C600 and AWWA M41.

F. Bury piping with depth of cover over top at least 36 inches with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches of cover over top.
2. In Loose Gravelly Soil and Rock: With at least 24 inches of additional cover.

G. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

H. Extend water-service and fire-suppression water-service piping and connect to water-supply source and building water-piping and fire-suppression piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service and fire-suppression water-service piping at building wall until building water-piping and fire-suppression piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water-piping and fire-suppression piping systems when those systems are installed.

I. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

J. Comply with Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for fire-suppression-water piping inside the building.

K. Comply with Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts in accordance with coupling manufacturer's written instructions.

3.7 INSTALLATION OF ANCHORAGE

A. Anchorage: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: In accordance with AWWA C600.
2. Fire-Service-Main Piping: In accordance with NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 INSTALLATION OF VALVES

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

3.9 INSTALLATION OF WATER METERS

A. Install water meters, piping, and specialties in accordance with utility company's written instructions.

B. Water Meters:

1. Install displacement-type water meters, NPS 2 and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
2. Install compound-type water meters, NPS 3 and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

C. Support water meters and piping NPS 3 and larger on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.10 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation in accordance with utility company's written instructions.

3.11 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.12 DETECTOR-CHECK VALVE INSTALLATION

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.13 INSTALLATION OF WATER METER BOXES

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.14 WATER METER INSTALLATION

A. Factory test in accordance with AWWA M6.

B. Install water meters, piping, and specialties according to utility company's written instructions.

C. Install meter bypass and valves in a precast vault in accordance with the manufacturer's instructions. Water meter and strainer shall have a minimum of five pipe diameters of straight run of pipe or equivalent full-open components upstream of the meter. Do not install elbows, bends, nonconcentric reducers, check valves and/or pressure reducing devices within ten pipe diameters upstream or three pipe diameters downstream of the meter. Do not install butterfly valves within five pipe diameters upstream of the meter.

D. the meter.

E. Water Meters: Install turbine-type water meters, NPS 2 and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

F. Water Meters: Install compound-type water meters, NPS 3 and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

G. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers. Install with meter manufacturer's recommended straight pipe diameters on each side of meter.

H. Install one inch conduit from water meter location to the location of the electrical meter inside of the building. Furnish and install 18/3 wire to connect water meter to building electrical meter.

3.15 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.16 INSTALLATION OF CONCRETE VAULTS

A. Install precast concrete vaults in accordance with ASTM C891.

3.17 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install ball drip valves at each check valve for fire department connection to mains.

B. Install protective pipe bollards on three sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.18 INSTALLATION OF ALARM DEVICES

A. Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

3.19 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 2 inches above grade.

B. Install protective metal enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.20 CONNECTIONS

A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to utility water main. Use [tapping sleeve and tapping valve] [service clamp and corporation valve].

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

D. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer piping.

E. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.21 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50 psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.22 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.23 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 14 15

SECTION 33 42 00 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile-iron culvert pipe and fittings.
2. PE pipe and fittings.
3. PVC pipe and fittings.
4. Concrete pipe and fittings.
5. Non-pressure transition couplings.
6. Expansion joints.
7. Cleanouts.
8. Encasement for piping.
9. Manholes.
10. Polymer-concrete, channel drainage systems.
11. Catch basins.
12. Stormwater inlets.
13. Stormwater detention structures.
14. Pipe outlets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

B. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

2.2 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
2. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.3 CLEANOUTS

A. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: Cross-laminated HDPE film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural

2.5 CONCRETE

A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: [1] [2] percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: [4] [8] percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

E. Drainage Specialties: Precast, polymer-concrete units.

1. Large Catch Basins:

a. 24-by-12-inch polymer-concrete body, with outlets in quantities and sizes indicated.
b. Gray-iron slotted grate.
c. Frame: Include gray-iron or steel frame for grate.

2. Small Catch Basins:

a. 19- to 24-inch by approximately 6-inch polymer-concrete body, with outlets in quantities and sizes indicated.
b. Gray-iron slotted grate.
c. Frame: Include gray-iron or steel frame for grate.

3. Sediment Interceptors:

a. 27-inch-square, polymer-concrete body, with outlets in quantities and sizes indicated.
b. 24-inch-square, gray-iron frame and slotted grate.

2.6 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C990, bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
8. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or

anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.

9. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

C. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange, and 26-inch-diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

2.7 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions in accordance with utility standards.

B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions in accordance with utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions in accordance with utility standards. Include heavy-duty frames and grates.

D. Frames and Grates: Heavy duty, in accordance with utility standards.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves,

and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install piping [NPS 6] <Insert value> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with [36-] [48-] [60-] [72-] <Insert dimension> inch-minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
7. Install PE corrugated sewer piping in accordance with ASTM D2321.
8. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
9. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
10. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install corrosion-protection piping encasement over the following underground metal piping in accordance with ASTM A674 or AWWA C105/A21.5:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.

3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
6. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
7. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
8. Join nonreinforced-concrete sewer piping in accordance with ASTM C14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
9. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
10. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Join force-main pressure piping in accordance with the following:

1. Join PVC pressure piping in accordance with AWWA M23 for gasketed joints.
2. Join dissimilar pipe materials with pressure-type couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic or landscaping areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch(es above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.6 STORMWATER INLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance with ACI 318.

3.8 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, flush with finished surface.

B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.

C. Embed channel sections and drainage specialties in 4 inch-minimum concrete around bottom and sides.

D. Fasten grates to channel sections if indicated.

E. Assemble channel sections with flanged or interlocking joints.

F. Embed channel sections in 4 inch-minimum concrete around bottom and sides.

3.9 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe,

manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Shielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.10 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8 inch-thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.11 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping in accordance with ASTM F1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

A. Clean interior of piping of dirt and superfluous materials Flush with water.

END OF SECTION 33 42 00