24ITB008 BSL-3 Lab Construction
Addendum #1 Questions & Answers
Issued: 06/11/2024

Question Number	Date Received	Question	Answer
Q1-1	05/30/2024 9:39 AM	Do you have a Design Budget for this project for our Security company? They are requiring us to provide something in writing from SNHD.	*Allowance of $30K for Security*
Q1-2	05/30/2024 9:39 AM	Is there a liquidated damage clause to this project?	*To be answered via subsequent addendum.*
Q2-1	05/31/2024 2:00 PM	We are requesting to bid Siemens Critical Environment lab controls for the above lab project. Please let us know if we can be an approved bidder for Siemens Lab Controls for the Biosafety Level 3 Lab project.	*Siemens is an acceptable option for the lab controls. Please note that lab control supply and exhaust air terminal units will require shut-off capability for possible decontamination. SNHD to confirm whether they want to match existing.*
Q3-1	06/03/2024 4:19 PM	Please see attached RFI regarding the elevator.	*Elevator to be 3500 lbs capacity, MRL hydraulic. Acceptable manufacturers to be: Kone, Schindler, TK*
Q3-2	06/03/2024 4:38 PM	[Will there] be a Project Manual, Geotechnical Report, Fire Protection/Safety Drawings, Security Drawings being sent out?	*Allowance of $75K for FP* *Allowance of $75K for FA*
Q3-3	06/03/2024 4:39 PM	[Will there] be any Landscape Plans?	*Civil will document "match existing" for any landscape architecture items in CDs.*
Q4-1	06/04/2024 7:01 AM	Is there a Geotechnical report on record for this project?	*To be answered via subsequent addendum.*
Q4-2	06/04/2024 7:01 AM	No room finish schedule incorporated on plans. How will this issue be resolved ?	*See SNHD Interior Finishes PDF document included in this Q&A.*
Q4-3	06/04/2024 7:01 AM	No elevator specifications or manufacturer.	*Elevator to be 3500 lbs capacity, MRL hydraulic. Acceptable manufacturers to be: Kone, Schindler, TK*
Q4-4	06/04/2024 7:01 AM	What is the new Asphalt parking lot design (subbase base, base course and wearing course)?	*Proposed asphalt section is 4" AC Paving over 8" Type II Aggregate Based. Refer to geotech report for additional information.*

Q4-5	06/04/2024 7:01 AM	What specifications for the 3" insulated wall panels?	*Centria Formawall Dimension Series insulated wall panels, Kingspan, MBCI, Metl-Span LLC*
Q4-6	06/04/2024 7:01 AM	Is the roof to be TPO over rigid tapered board or other?	*Modified Bitumen Roofing (SBS)*
Q4-7	06/04/2024 7:01 AM	Cold room specifications.	*Use R.W. Smith & Co as basis of design. 4" thick insulated wall panels*
Q4-8	06/04/2024 7:01 AM	Is all equipment listed supplied and installed by general contractor?	*All BSCs, Fumehoods and Autoclave shall be CFCI. All benchtop equipment shall be OFOI. All freezers and*
Q4-9	06/04/2024 7:01 AM	Please supply additional information on a manufacture for card reader and facial recognition access.	*Allowance of $30K for Security* *Allowance of $80K for power operated door hardware and controls*
Q5-1	06/04/2024 11:18 AM	Are as-built drawings available for the existing facility? This will help coordinate the underground utilities and the existing easements.	*To be answered via subsequent addendum.*
Q5-2	06/04/2024 11:18 AM	Sheet C-102 shows vacating both the North CLV Drainage easement and the South Sanitary easement. Civil drawings do not show removal of any lines. Is there any relocation or demo work required to place the building in the area indicated?	*Existing Storm drain easement is for surface flow only, no infrastructure to remove. Existing Sewer easement has an abandoned pipe that was abandoned during the Project Neon MLK infrastructure improvements. Confirm pipe was slurry filled, if so, no pipe removal necessary.* *The north easement is a surface easement, the south easement has an abandonded pipe.*
Q5-3	06/04/2024 11:18 AM	A8.4.1, detail 2 shows spray fire resistive material on the steel I-beam under the stairs. Is this required, and is there other steel needing coating?	*Not required. Type V-B construction.*

Q5-4	06/04/2024 11:18 AM	What is the basis of design for the elevator? No electrical or plumbing provisions are shown for the elevator or sump.	*See answer to question Q4-3* *Elevator to be 3500 lbs capacity, MRL hydraulic. Acceptable manufacturers to be: Kone, Schindler, TK. Confirm power reqs per model.* *Elevator is for passenger service, only, and not intended for fire figher emergency operation, therefore does not require sump pump nor is groundwater an issue at this depth.* *Circuiting will be provided in CD. Provide allowance for power feeders and disconnecting means for elevator equipment.*
Q5-5	06/04/2024 11:18 AM	What are the requirements for the new generator and associated equipment? Reference ES1.1 and E3.3.3. Is this Owner furnished or contractor furnished?	*Provide allowance for 750kW Tier 4 diesel generator with sound attenuated enclosurse and DPF. Provide 24 hour dual walled belly tank with the unit.*
Q5-6	06/04/2024 11:18 AM	Sheet EG.1, note 20 – Is this to read Lightning Protection?	*Correct. Provide allowance for Lightning Protection.*
Q5-7	06/04/2024 11:18 AM	Plumbing does not show natural gas piped to the second floor or roof. Will it be required? If so, please provide design.	*Natural gas will be provided for domestic hot water heaters, in mech/DI room; mechanical (2) boilers in and mechanical yard; and roof top (2) humidifiers. Laboratory spaces will not require natural gas. See revised Nat.Gas Piping Scope PDF included in this Q&A.*
Q5-8	06/04/2024 11:18 AM	Civil drawings do not provide a grading plan. Please provide.	*Precise grading shown on sheet C-104. More detail will be provided in CDs*
Q5-9	06/04/2024 11:18 AM	A3.3.1 shows the roof screens 6'-3" above the top of roof. Structural drawings do not show a kicker support for the roof screen. Is a kicker required for the wind rating?	*Design for mech screen on roof does not include a kicker*

Q5-10	06/04/2024 11:18 AM	SG2.0 General Cost Estimate notes: #5 how much should the Allowance be? What design should be used to base the Allowance?	*Perimeter slab condition steel as noted.* *• Moment and bracing connections as shown on typical details on S5.3 and S6.1.* *• 3 tons.* *• See plans for framing at openings. For other openings see MEP drawings and detail 7/S5.2.* *• 14 tons allowance for curtainwall support.* *• 1 tons of steel for roof canopy at building entrance.* *• Support for mech equipment is shown on plan.* *• Support for architectural building skin is CFMF and delegated design. Provide cost for CFMF and delegated design engineering.* *• Roof top screen wall support is indicated on plans.* *• Provide allowance for a thermal break pad at all penetrations through the building insulated barrier by steel framing. These locations are shown on plan. Pads shall be minimum 1" thick and assumed to be 16" square at each location as manufactured by Fabreeka.*
Q5-11	06/04/2024 11:18 AM	SG2.0 General Cost Estimate notes: how much contingency should be carries for the design development mentioned in #8?	*Carry a 20% contingency.*
Q5-12	06/04/2024 11:18 AM	The detail page shows two types of wall angle trim – shadow molding and regular. Which should be bid? The shadow molding is significantly more expensive. See pic below.	*Bid the shadow moulding at all Administration areas and the regular moulding at all other areas.*
Q5-13	06/04/2024 11:18 AM	There is no finish schedule provided. The design specs have several tiles listed, but do not show room numbers. The reflected ceiling page calls out for A-1 and A-2 tiles, but does not indicate what these tile material types are. Please provide.	*See SNHD Interior Finishes PDF document included in this Q&A.*
Q6-1	06/04/2024 1:57 PM	DIV 01: PLEASE PROVIDE A RESPONSIBILITY MATRIX	*To be provided with issuance of specifications and construction douments*

Q6-2	06/04/2024 1:57 PM	DIV 09: PLEASE PROVIDE A ROOM FINISH SCHEDULE (THE ARCHITECTURAL DESIGN SHEET FINISH SUMMARY DOES NOT ALIGN WITH THE ROOMS ON THE PRINT)	*See SNHD Interior Finishes PDF document included in this Q&A.*
Q6-3	06/04/2024 1:57 PM	DIV 11: PLEASE PROVIDE EQUIPMENT SPECIFICATIONS / VENDOR	*All BSCs, Fumehoods and Autoclave shall be CFCI. All benchtop equipment shall be OFOI. All freezers and refrigerators shall be OFCI.*
Q6-4	06/04/2024 1:57 PM	DIV 14: PLEASE PROVIDE ELEVATOR TYPE/SIZE/SPECIFICATIONS	*Elevator to be 3500 lbs capacity, MRL hydraulic. Acceptable manufacturers to be: Kone, Schindler, TK.*
Q6-5	06/04/2024 1:57 PM	DIV 09: ACT: DESIGN SPECS HAVE MANY TILES LISTED BUT DON'T SHOW ROOM NUMBERS. RCP CALLS OUT A-1 AND A-2 TILES; PLANS DON'T SHOW MATERIAL TYPES. PLEASE ADVISE.	*See SNHD Interior Finishes PDF document included in this Q&A.*
Q6-6	06/04/2024 1:57 PM	DIV 09: DETAIL PAGE SHOWS 2 TYPES OF WALL ANGLE TRIM, "SHADOW" AND "REGULAR" PLEASE ADVISE AS TO WHICH TO USE WHERE.	*Bid the shadow moulding at all Administration areas and the regular moulding at all other areas.*
Q6-7	06/04/2024 1:57 PM	DIV 07: PLEASE PROVIDE ROOFING SPECIFICATIONS.	*Modified Bitumen Roofing (SBS)*
Q6-8	06/04/2024 1:57 PM	PROJECT: PLEASE PROVIDE A SPECIFICATIONS MANUAL.	*To be provided with CD's*
Q6-9	06/04/2024 1:57 PM	ELECTRIC: EDS1.0 shows demo and removal of (2) existing parking lot light poles. However, ES1.1 does not show any relocation and/or new light poles for the new parking area. Please confirm that no site lighting is required.	*New site lighting will be included in CDs. Provide allowance for exterior building lights, parking lot lighting, landscape lighting and CCTV/Security design of $125K.*
Q6-10	06/04/2024 1:57 PM	ELECTRIC: EP2.1 and EP2.2 key notes call out wiremold. Please provide Series wiremold required.	*Provide Wiremold ALA4800 series.*
Q6-11	06/04/2024 1:57 PM	ELECTRIC: Will the new area be required to connect to the existing building fire alarm system, or will the new building be its own standalone fire alarm system?	*Fire alarm to be new system with connection back to existing building system.*

Q6-12	06/04/2024 1:57 PM	ELECTRIC: If connect to existing Fire Alarm Panel, please provide existing fire alarm panel manufacturer / monitoring company.	*Fire alarm to be new system with connection back to existing building system.*
Q6-13	06/04/2024 1:57 PM	ELECTRIC: Will the existing building tele/data, CCTV, Access controls, A/V. etc., need to connect to the new building?	*Yes.*
Q6-14	06/04/2024 1:57 PM	ELECTRIC: If not, are there any owner preferred vendors for low voltage systems?	*To be answered via subsequent addendum.*
Q6-15	06/04/2024 1:57 PM	ELECTRIC: Will all the low voltage systems need to be continuous conduit from the device to the IT room on the 1st floor?	*Provide conduit to accessible ceiling space then supported by cable tray or J-hooks; to be designed by LV designer.*
Q6-16	06/04/2024 1:57 PM	ELECTRIC: Will the new building require lightning protection?	*Provide allowance for Lightning Protection.*
Q6-17	06/04/2024 1:57 PM	ELECTRIC: NEC 700.3 (F) requires a generator quick connect tap box (docking station) and none is shown. Should this be included in the base bid?	*Docking station is not required since the generator is not an article 700 source. Article 701/702 generators do not require docking stations. Though not required, it is beneficial to include pending cost and approval of the client. Provide a separate line item allowance for a docking station.*
Q6-18	06/04/2024 1:57 PM	ELECTRIC: No roof receptacles are shown on EP2.3. Please clarify that they will not be required and be integral to the mechanical equipment.	*Roof receptacles locations will be provided in CD. Provide allowance for pedestal mounted roof receptacles.*
Q6-19	06/04/2024 1:57 PM	ELECTRIC: EL2.1 general note 1 states, all lighting control devices are low voltage unless otherwise indicated. Will a lighting control relay panel with integral time clock be required for zone controlling or is the lighting controls local within the areas shown?	*Local areas controls shall be used inside the building. A lighting control panel shall control the site lighting and the public spaces inside the building. All lighting controls shall be digitally networked controls. Provide allowance for digital lighting controls per the IECC.*
Q6-20	06/04/2024 1:57 PM	ELECTRIC: Can NEC compliant aluminum feeders be used for 100A or more and 1/0 or larger?	*Aluminum feeders not acceptable. Provide copper feeders.*

Q6-21	06/04/2024 1:57 PM	ELECTRIC: Can MC cable be used on concealed areas and walls?	*MC cable can only be used in concealed wall from the junction box located directly above the room. Provide EMT to junctions boxes throughtout the ceiling space. Specifications will be provided for the project, which will dictate installation requirements.*
Q6-22	06/04/2024 1:57 PM	ELECTRIC: E3.1.1 shows a new main distribution board (MSB-2B) with a meter main at the main breaker section and additional meters for distribution. NV Energy will not allow this installation the way it is drawn. Either the meters feeding the panels need to be removed or the meter in the main section needs to be removed. Please advise on which change is preferred.	*Provide only the meter/main in the exterior main board. Remove meter/main section from interor board.*
Q6-23	06/04/2024 1:57 PM	ELECTRIC: Please provide feeder schedule that matches feeder tags shown on E3.1.1.	*Feeder schedule will be provided in CD. Provide feeders based on the breaker sizes shown on the single line diagram.*
Q6-24	06/04/2024 1:57 PM	ELECTRIC: Please provide circuit, disconnect means, and panel location for roof top equipment. None shown on electrical drawings.	*Circuiting will be provided in CD. Provide quantity for power feeders and disconnecting means for all mechanical and plumbing equipment.*
Q6-25	06/04/2024 1:57 PM	ELECTRIC: Please provide circuit, disconnect means, and panel location for mechanical equipment in mechanical yard. None shown on electrical drawings.	*Circuiting will be provided in CD. Provide quantity for power feeders and disconnecting means for all mechanical and plumbing equipment.*
Q6-26	06/04/2024 1:57 PM	ELECTRIC: Will an outdoor panel be required for the mechanical yard?	*Panel for mechanical yard equipment will be located in the main electrical room.*
Q6-27	06/04/2024 1:57 PM	ELECTRIC: Please provide circuit, disconnect means, and panel location for exhaust air volume control boxes and supply air volume control boxes on first and second floors. None shown on electrical drawings.	*Circuiting will be provided in CD. Provide allowance for power feeders and disconnecting means for all mechanical and plumbing equipment.*
Q6-28	06/04/2024 1:57 PM	ELECTRIC: Please provide size for elevator control module disconnect.	*Circuiting will be provided in CD. Provide quantity for power feeders and disconnecting means for all mechanical and plumbing equipment.*

Q6-29	06/04/2024 1:57 PM	ELECTRIC: Please provide circuit and panel location for industrial and domestic hot water heaters.	*Circuiting will be provided in CD. Provide allowance for power feeders and disconnecting means for all mechanical and plumbing equipment.*
Q6-30	06/04/2024 1:57 PM	ELECTRIC: Please confirm (if any) electrical requirements, circuit, panel, disconnect means, and what is supplied by EC for: leak detection decontamination tank, purified water system, water softener, Ino exchange vessels, trap primer, self-regulating temperature maintenance cable, EWC-1, HE manifold, N2 manifold, environmental decontamination system, and air compressor shown on plumbing plans. Non shown on electrical drawings.	*Circuiting will be provided in CD. Provide quantity for power feeders and disconnecting means for all mechanical and plumbing equipment.*
Q6-31	06/04/2024 1:57 PM	PROJECT: PLEASE PROVIDE A LIST OF ALL OWNER PREFERRED / REQUIRED VENDORS.	*To be answered via subsequent addendum.*
Q6-32	06/04/2024 1:57 PM	DFH: PLEASE PROVIDE A DOOR, FRAME, HARDWARE / ACCESS CONTROL SCHEDULE	*Allowance of $80K for power operated door hardware and controls.*
Q6-33	06/04/2024 3:15 PM	Please provide points list, diagrams and sequence of operations for the BAS controls system. Clearly distinguishing between the BAS scope and the LAMS scope and their integration to one another.	*Controls diagrams, SOO, and points list will be provided with CD set. Roughly 240 points identified, to be confirmed. See draft of spec section 23 09 00 and 25 09 00 for general description of requirements for lab controls and building automation system included in this Q&A.*
Q6-34	06/04/2024 3:15 PM	Notes 1 thru 3 under the “Supply Air Volume Control Box Schedule” on drawing H4.1.3 indicate accessories and or data which are not applicable, available or options on a “Phoenix” lab valve. Confirm the accessories and requirements in notes 1 thru 3 are not valid nor required.	*New notes replacing the three are the following:* *1. BOX WIDE OPEN STATIC PRESSURE LOSS, IN. WG.* *2. FACTORY CONTROLLER WITH DDC (BACNET) COMMUNICATION*
Q6-35	06/04/2024 3:15 PM	The BOD requests all laboratory spaces to have laminar flow supply air diffusers, Titus Tri-Tec; however, none are scheduled for use on the drawings. Please provide the rooms, quantities and sizes of these devices.	*Titus Tritec will be added to the Air Device Schedule in CD set. All lab spaces will require a radial type diffusers (Tri-Tec).*

Q6-36	06/04/2024 3:15 PM	Drawing H4.1.2 schedules a “Storage Tank”. What system is this for CHW or HHW? What is the volume and	*The Storage tank is not required.*
Q6-37	06/04/2024 3:15 PM	BOD page 5-2 requests gas-tight dampers in the ductwork if decontamination is required. Will the phoenix valves meet this intent or will separate dampers be required. If separate dampers are required please provide the quantity, size and location of them and specify if they are manual operated or automatic via the BAS or LAMS.	*Phoenix valves are able to meet gas-tight requirements.*
Q6-38	06/04/2024 3:15 PM	Drawing H2.1.3 shows two pieces of equipment tagged H-1 and H-2 adjacent to AHU-2 and AHU-3. They are not included in the equipment schedule. Please complete equipment selection and design.	*These are humidifiers. Basis of Design: H-1 DriSteem GTS LX-400; H-2 DriSteem GTS LX-250. Equipment schedule will be shown in CD set. Dispersion tube assembly (Ultra-sorb MP) will be installed inside air handler.*
Q6-39	06/04/2024 3:15 PM	Drawing HP2.1.3 indicates CHW and HHW to be distributed to the AHU-1, 2 & 3 on top of the roof. Air handling units are specified with coil vestibules for piping to be routed up from the floor below. Confirm which is the intended	*This will be confirmed once AHUs are selected. However, to limit roof penetrations, pipe routing will resemble how it is currently shown. Since it will be routed on the roof, AHU vestibules will not be required.*
Q6-40	06/04/2024 3:15 PM	Taking a look at the BOD document, page 26 states that the basis of design is Automated Logic. Is this a hard requirement or will SNHD accept other VE options?	*The design intent was for the new mechanical controls to match existing. SNHD to confirm if they want to match existing or will accept other VE options.*
Q6-41	06/04/2024 3:15 PM	What is the contract type for sub-contractors. Lump Sum or GMP	*To be answered via subsequent addendum.*

1 LEVEL 1 REFERENCE PLAN
SCALE: 1/8" = 1'-0"

Mechanical Room / Electrical Room / MPOE / Fire Riser Room / Waste / Storage / Chem Storage / Gas Cyl. Storage / Jan. Closet :
Floor : Sealed Concrete
Walls: Painted GWB.
Ceiling: Open to structure / (ACT @ Storage & Gas Cyl. storage, Jan. Closet, Painted GWB @ Chem. Storage)

I.T. Server / Lockers / Corridors / Stair:
Floor: LVT (ESD Resilient Tile @ I.T. Server)
Base: Rubber
Walls : Painted GWB.
Ceiling : ACT per plans (except stair)

Restrooms
Floor: Porcelain Tile
Walls: Full height porcelain tile
Ceiling : Painted GWB.

Offices / Conference Room
Floor: Carpet
Base: Rubber
Walls: Painted GWB
Ceiling: ACT

Breakroom:
Floor: LVT
Base: Rubber
Walls: Painted GWB
Ceiling: ACT

Accessioning / Laboratories:
Floor: Poured Epoxy Flooring
Base: Integral w/ floor
Walls: Painted GWB; Level 4 Finish; Epoxy Paint
Ceiling: Clean Room Unperforated / square lay-in

Entry Lobby:
Floor: LVT w/ recessed aluminum walk-off mats
Walls: Painted GWB
Ceiling: ACT

Connecting Corridor:
Floor: LVT
Base: Rubber
Walls: Painted GWB
Ceiling: ACT

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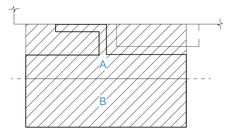
SNHD Southern Nevada Health District

KEY PLAN



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REVISIONS

NO.	BY	DESCRIPTION	DATE
B		DESIGN DEVELOPMENT	05.24.2024
A		50% DD SET	05.10.2024

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Las Vegas, NV 89106

DRAWN BY	RM	DATE	05.24.2024
PROJECT NO.	20230523	SCALE	1/8" = 1'-0"

DRAWING NAME
LEVEL 1 REFERENCE PLAN

FLOOR/SECTION	PHASE	DRAWING NO.
1	DD	A1.1

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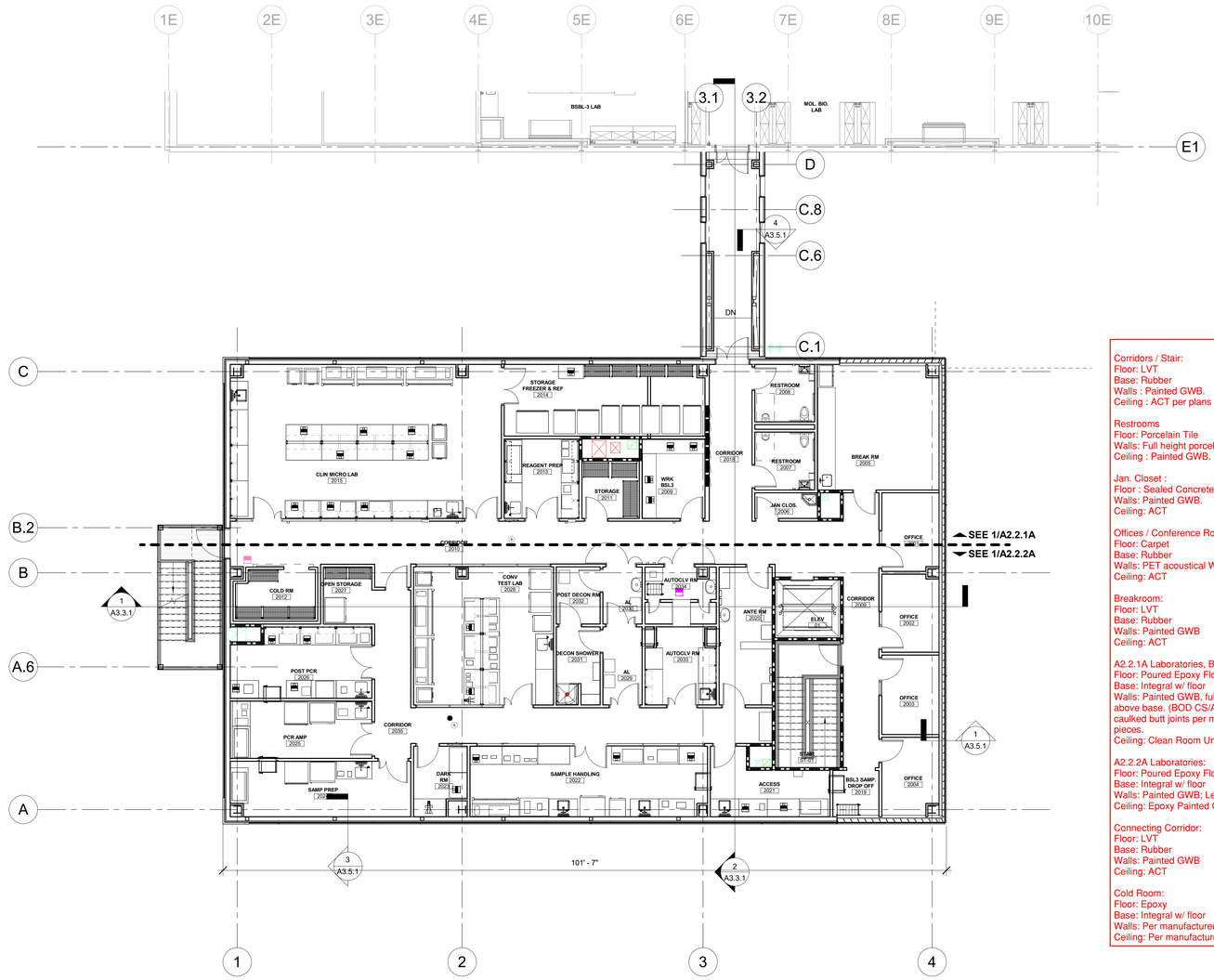

Corridors / Stair:
Floor: LVT
Base: Rubber
Walls : Painted GWB.
Ceiling : ACT per plans (except stair)

Restrooms
Floor: Porcelain Tile
Walls: Full height porcelain tile
Ceiling : Painted GWB.

Jan. Closet :
Floor : Sealed Concrete
Walls: Painted GWB.
Ceiling: ACT

Offices / Conference Room
Floor: Carpet
Base: Rubber
Walls: PET acoustical Wall Panels
Ceiling: ACT

Breakroom:
Floor: LVT
Base: Rubber
Walls: Painted GWB
Ceiling: ACT

A2.2.1A Laboratories, BSL3 Workroom & Storage:
Floor: Poured Epoxy Flooring
Base: Integral w/ floor
Walls: Painted GWB, full height wall protection above base. (BOD CS/Acrovyn), install with caulked butt joints per mfr instructions. No trim pieces.
Ceiling: Clean Room Unperforated / square lay-in

A2.2.2A Laboratories:
Floor: Poured Epoxy Flooring
Base: Integral w/ floor
Walls: Painted GWB; Level 4 Finish; Epoxy Paint
Ceiling: Epoxy Painted GWB

Connecting Corridor:
Floor: LVT
Base: Rubber
Walls: Painted GWB
Ceiling: ACT

Cold Room:
Floor: Epoxy
Base: Integral w/ floor
Walls: Per manufacturer
Ceiling: Per manufacturer

1 LEVEL 2 REFERENCE PLAN
SCALE: 1/8" = 1'-0"

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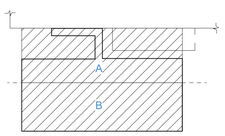
KEY PLAN



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B		DESIGN DEVELOPMENT	05.24.2024
A		50% DD SET	05.10.2024

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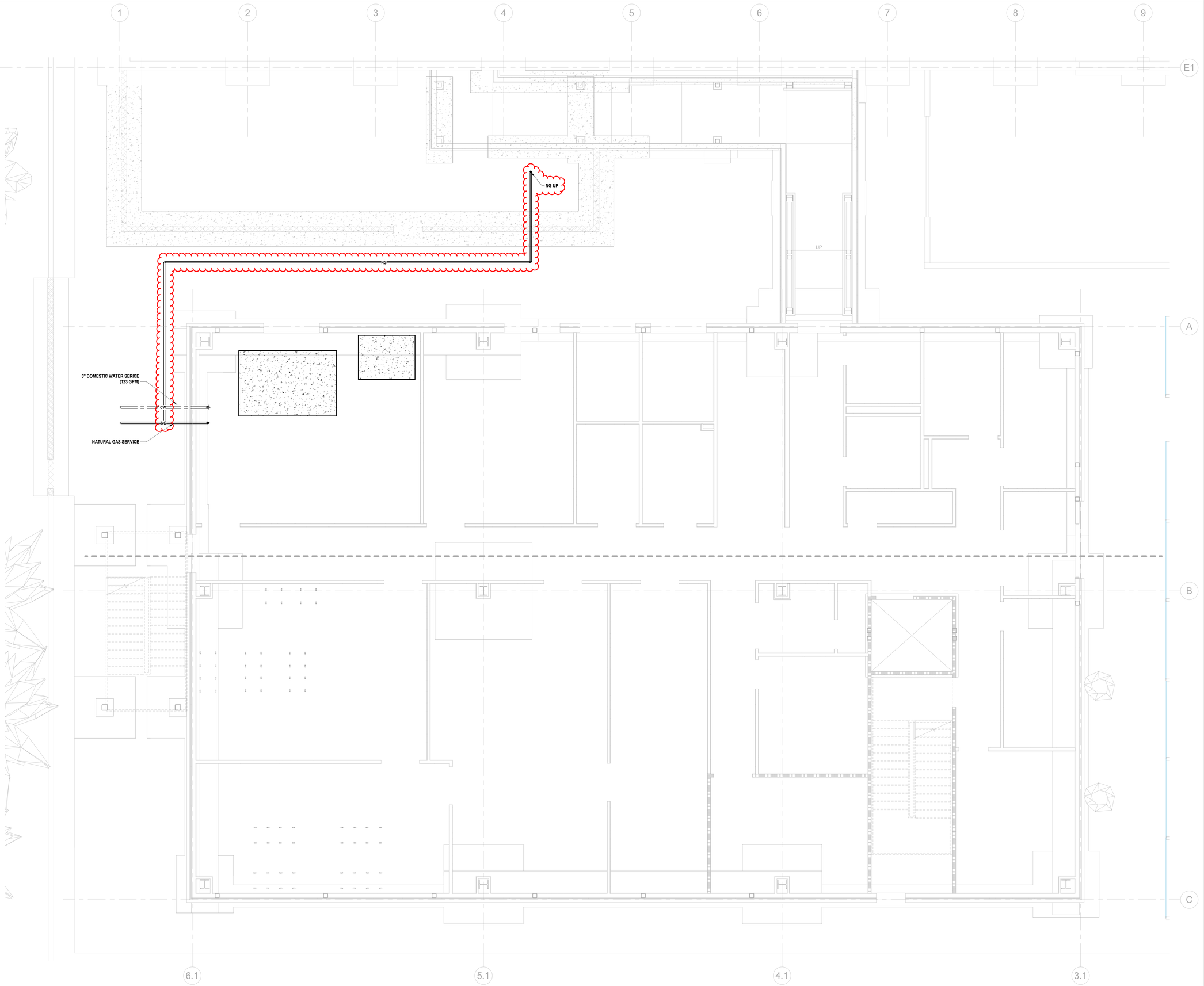
DRAWING NAME
LEVEL 2 REFERENCE PLAN

FLOOR/SECTION	PHASE	DRAWING NO.
2	DD	A1.2



1 UNDERGROUND - PIPING PLAN
SCALE: 1/4" = 1'-0"

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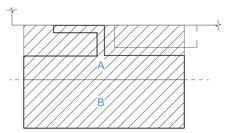
KEY PLAN



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Project Model Lead

REVISIONS

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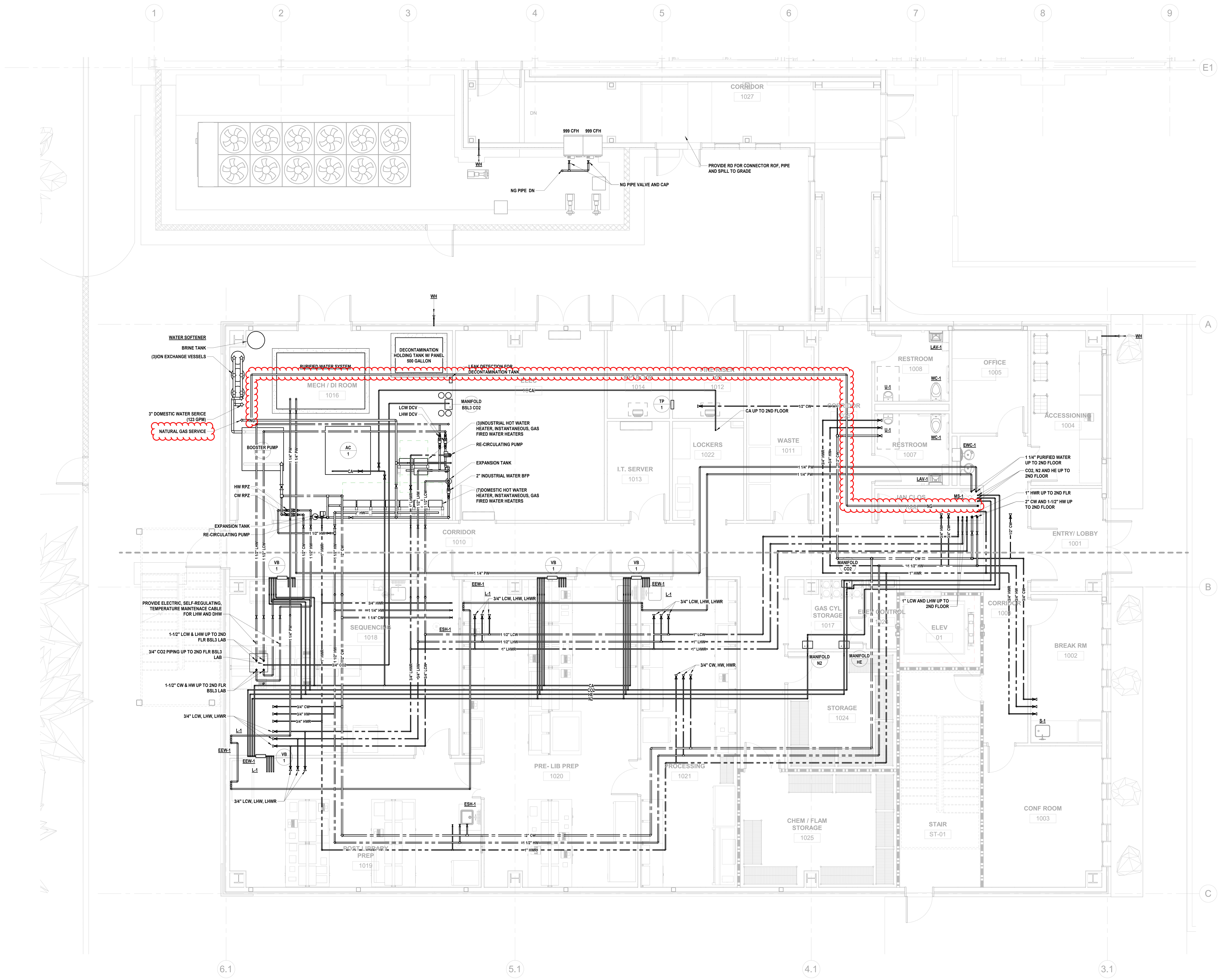
DRAWN BY		DATE	02.08.2024
PROJECT NO.	20230523	SCALE	1/4" = 1'-0"

DRAWING NAME

UNDERGROUND - PIPING PLAN

FLOOR/SECTION	PHASE	DRAWING NO.
	DD	PS1.0



1 LEVEL 1 PIPING PLAN - NEW BUILDING - Dependent 1
SCALE: 1/4" = 1'-0"

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KEY PLAN

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Project Model Lead

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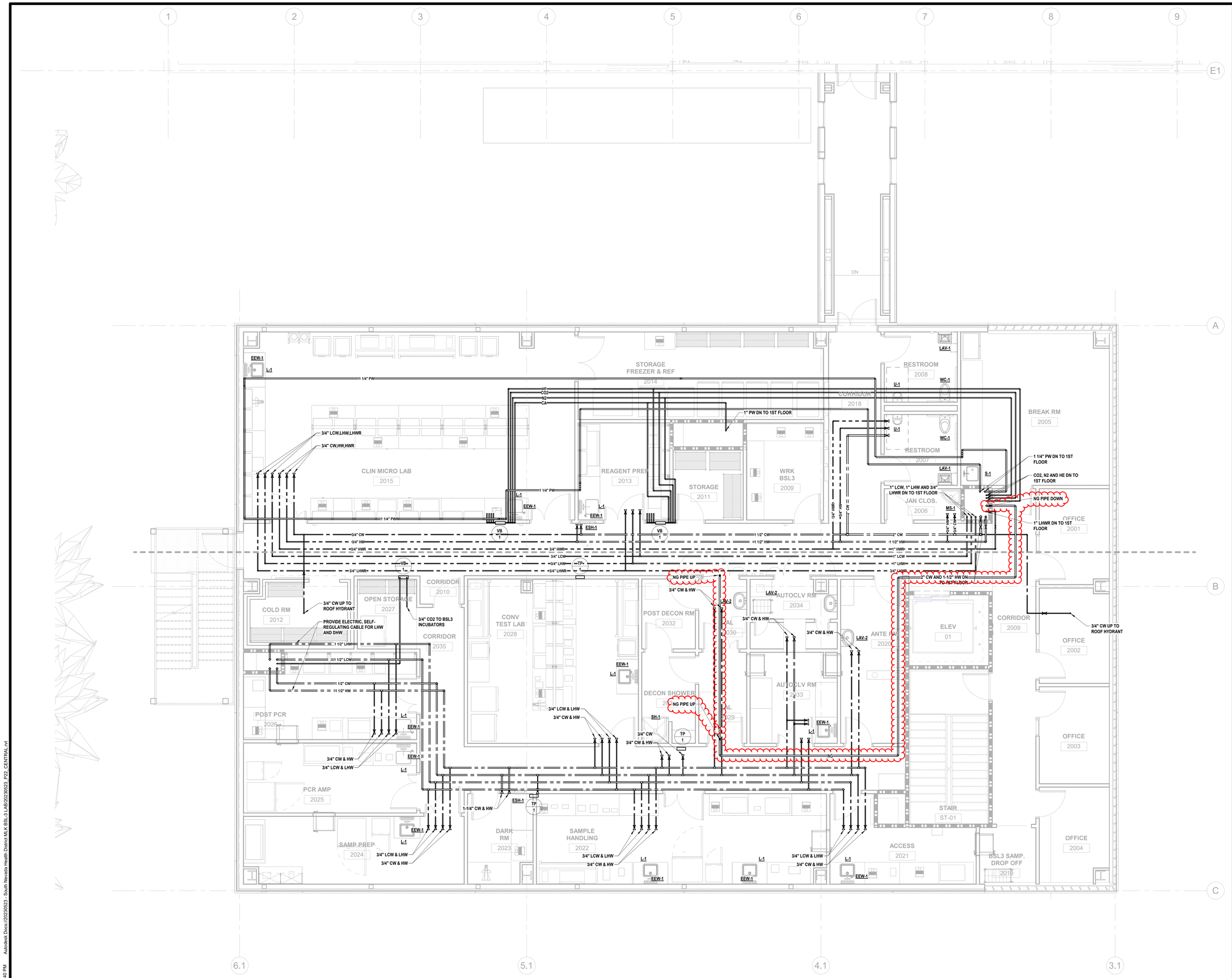
DRAWING NAME
LEVEL 1 - PIPING PLAN

FLOOR/SECTION PHASE: DD
DRAWING NO.: PS1.1



1 LEVEL 2 PIPING PLAN - NEW BUILDING - Dependent 1
SCALE: 1/4" = 1'-0"

NOT FOR CONSTRUCTION

EC NEVADA
401 West A Street, Suite 320
San Diego, CA 92101
Tel: 949-417-7550

CONSULTANTS

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SNHD Southern Nevada Health District

KEY PLAN

PRINCIPAL

RESEARCH PLANNER

Project Engineer

Project Model Lead

REVISIONS

NO.	BY	DESCRIPTION	DATE

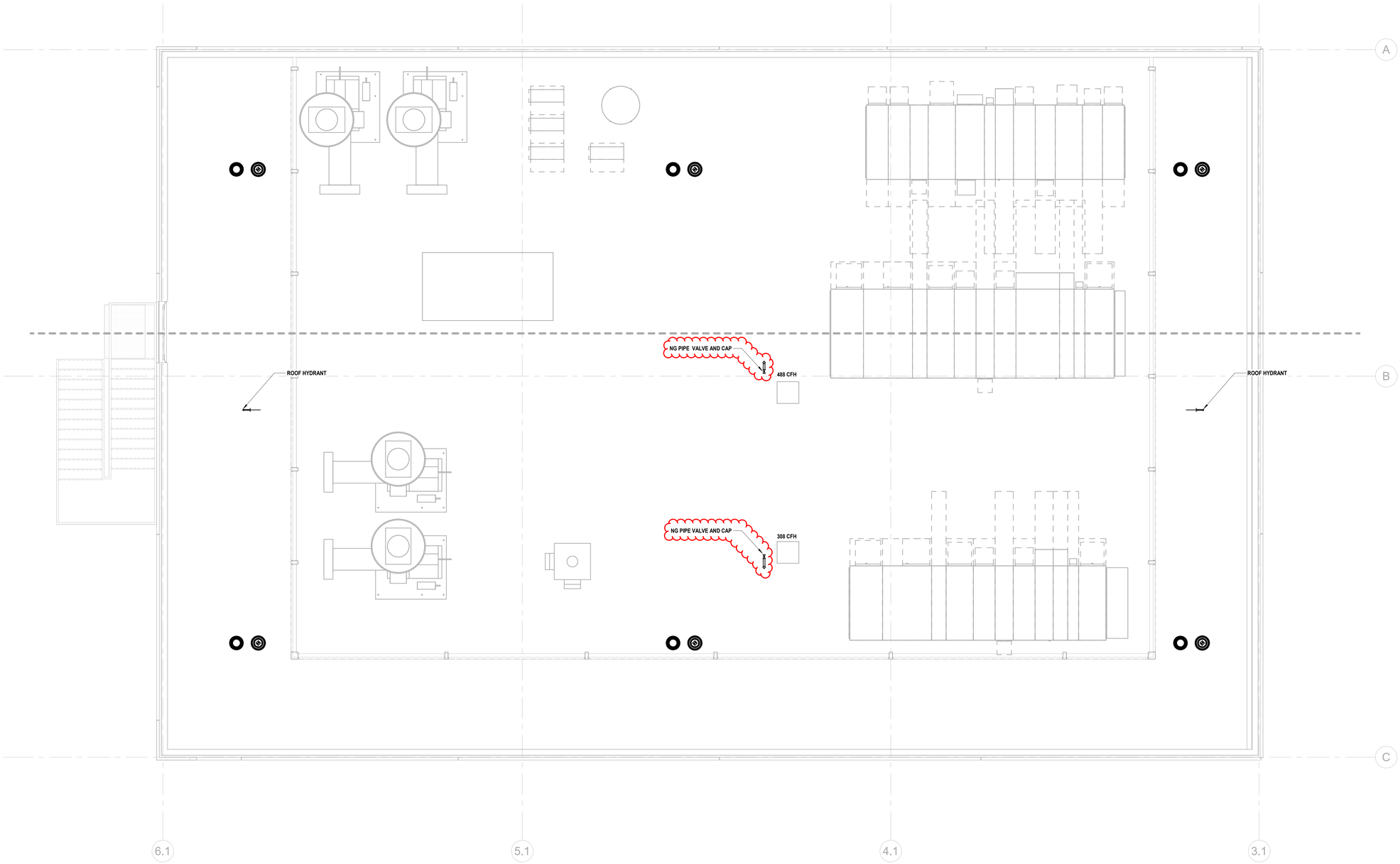
Southern Nevada Health District
700 South M.L.K. Blvd
Las Vegas, NV 89106
Enter address here

DRAWN BY		DATE	02.08.2024
PROJECT NO.	20230523	SCALE	1/4" = 1'-0"

DRAWING NAME

LEVEL 2 - PIPING PLAN

FLOOR/SECTION PHASE	DRAWING NO.
DD	PS1.2



1 ROOF - PIPING PLAN
SCALE: 1/4" = 1'-0"

NOT FOR CONSTRUCTION

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San Diego, CA 92101
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CONSULTANTS

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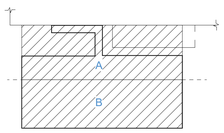
SNHD Southern Nevada Health District

KEY PLAN



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DRAWN BY | DATE 02.08.2024

PROJECT NO. 20230523 | SCALE 1/4" = 1'-0"

DRAWING NAME

ROOF - PIPING PLAN

FLOOR/SECTION PHASE: DD | DRAWING NO.: PS1.3

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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. Division 25 “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 135-2001: 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 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.

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 ANSI/ASHRAE Standard 135, BACnet functionality to assure interoperability between all system components. Native support for the BACnet protocols are required to assure that the project is fully supported by the BAS. Provide associated certification as part of submittal (BTL for BACnet). 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
2. Accutrol
3. Siemens

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 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 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 use 24 VAC power ± 15%, the industry standard.
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 complete with pressure pick-up ports for space and reference locations.
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)

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 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 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, which will be required for humidity control.

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

2.5 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. Note that auto-zero recalibration of transducers is not acceptable as a substitute for semi-annual recalibration.

END OF SECTION 23 09 00

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 "Flow Meters" for flow measuring devices that relates to this Section.
4. Refer to Section 23 09 00 "Laboratory Airflow Control System" for interface requirements related to this Section.
5. Refer to Section 23 09 20 "Gas Detection Systems" for interface requirements related to this Section.
6. Refer to Division 25 Section “Sequence of Operations for HVAC Controls” for requirements that relates 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) controlled thru the new Building Automation System (BAS), except the following:

1. Boilers (B), Chiller (CH) shall be provided with factory microprocessor controls. These systems shall be provided with a BACnet/IP interface. This interface will provide functionality for start/stop, setpoint reset and monitoring of all operational data and alarms through the DDC system.

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

available on at least 64 client computers, 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. SNHD presently has an existing Automated Logic (ALC) 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. 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. BAS: Building Automation System (Synonymous with BMS)

B. BMS: Building Management System (Synonymous with BAS)

C. Control Contractor: Contractor for this section

D. DDC: Direct digital control

E. I/O: Input/output

F. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

G. MS/TP: Master slave/token passing

H. NIST: National Institute of Standards and Technology

I. PC: Personal computer

J. PID: Proportional plus integral plus derivative

K. OWS: Operator Work Station

L. RTD: Resistance temperature detector

1.4 SYSTEM PERFORMANCE

A. The system shall comply with the following performance requirements:

1. Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of 20 dynamic points per graphic. All current data shall be displayed within 10 seconds of the request.
2. Graphic Refresh: They system shall update all dynamic points with current data within 8 seconds. Data refresh shall be automatic, without operator intervention.
3. Object Command: the maximum time between the command of a binary object by the operator and the reaction by the device shall be two seconds. Analog objects shall start to adjust within two seconds.
4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior six seconds.
5. Alarm Response Time: the maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed ten seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every five seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within five seconds of each other.
8. Performance: Programmable controllers shall be able to execute DDC PID control loops as a selectable frequency from at least once every one second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
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. Space Temperature: Plus or minus 0.5 deg F
    e. Ducted Air Temperature: Plus or minus 0.5 deg F
    f. Outside Air Temperature: Plus or minus 0.5 deg F
    g. Dew Point Temperature: Plus or minus 3 deg F
    h. Temperature Differential: Plus or minus 0.25 deg F
    i. Relative Humidity: Critical Areas plus or minus 1 percent
    j. Relative Humidity: Non-critical Areas plus or minus 3 percent
    k. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale
    l. Airflow (Measuring Stations): Plus or minus 2 percent of full scale
    m. Airflow (Terminal): Plus or minus 10 percent of full scale
    n. Air Pressure (Space): Plus or minus 0.01-inch wg
    o. Air Pressure (Ducts): Plus or minus 0.1-inch wg
    p. Carbon Dioxide: Plus or minus 50 ppm
    q. 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. System Integration Mock-up: A mock-up of the BAS to demonstrate system performance and integration with the lab airflow control system. Provide labor, equipment, materials and service as necessary to support 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.

L. 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.
14. 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 monitor and control the facility's building automation system remotely. 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 100 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 components.

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. System Software: Update to latest version of software 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. 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. Laboratory Airflow Control System (ACS) equipment to be provided as indicated in 23 09 00 and interface with Division 25.

L. Combination fire/smoke and smoke dampers in ducts with electric motors will be provided by Contractor for Section 23 30 00. Control Contractor shall wire electric motors.

M. 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.

N. Furnish TAB Contractor (Spec Section 01 91 00) and Commissioning Agent (Spec Section 01 91 13) 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.

O. Furnish duct mounted airflow measuring stations and static probes to Contractor for Section 23 30 00 for installation.

P. 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.

Q. Provide all power wiring and devices required for electric/electronic operators/actuators.

R. 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 factory installation. Furnish control valve for field installation and provide all additional wiring and tubing as required for a complete installation.

S. 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.

T. All mechanical equipment sent with loose controls shall be mounted and wired by Division 25.

U. Control Contractor shall provide all conduit, trays, etc. required for power and control wiring to his devices.

V. Control Contractor shall include time in his bid required to meet with specialty equipment manufacturers (boilers, chiller, cold room, etc.) and program their equipment to fully interface with the BAS.

W. Control Contractor shall interlock fans or pumps through hard wiring where indicated on contract documents; software interlocks shall not be acceptable.

X. Provide BACnet IP communication cards or ports to interface with equipment such as variable frequency drives, chillers, boilers, etc. as required by the contract documents.

Y. Coordinate equipment with Division 26 "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

Z. Electronic communication with drives shall be used for monitoring. System functions such as start/stop and status shall be hard wiring for reliability.

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.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Acceptable Manufacturers:

1. Automated Logic Corporation (match existing).

B. 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.

C. Provide extension of existing control system consisting of sensors, controllers, indicating devices, interface equipment, other apparatus, and accessories to operate mechanical equipment and to perform functions as specified.] [Update all existing data bases and incorporate new graphics.

D. To the maximum extent possible, the control system shall consist of IP-based controllers and interfaces. Non-IP controllers and interfaces are only permitted where an IP option does not exist. Provide MS/TP network(s) as required to communicate with non-IP devices.

E. Provide all materials and field work necessary for a complete system.

F. Provide electric operator for each damper and valve to be controlled, unless one is specified elsewhere.

G. Unless specified otherwise, provide fully modulating components.

H. 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.

I. Motors that respond to incremental "pulse" signals or do not fail to the specified position shall not be acceptable.

J. 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.

K. 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.

L. Graphic User Interface (GUI): New global graphics to provide a user friendly interface to the new detail graphics.

1. 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, and humidity, and differential pressure input available on the DDC system shall be interactively displayed on the floor plan. Provide sub-area graphics as required to fit all temperatures.

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 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.

2.5 DDC EQUIPMENT

A. Operator Work Station: One PC-based microcomputer(s) with minimum configuration as follows:

1. Motherboard: With minimum of 4 integrated USB 2.0 ports, Network Interface Card (NIC), integrated audio, bios, and hardware monitoring.
2. Processor: AMD A 8.
3. RAM: 8GB.
4. Video Card: With 64 MB RAM capable of supporting 1280 x 1024 resolution with 32 bit color.

5. Monitor: Non-reflective 22-inch flat panel LCD and shall support a display resolution of 1280 x 1024 pixels. Separate controls shall be provided for color, contrast and brightness.
6. Keyboard: QWERTY, 105 keys.
7. Hard-Disk Drive: 1 TB.
8. CD RW Drive: 48x24x48
9. DVD-ROM Drive.
10. Mouse: Three button, optical.
11. Uninterruptible Power Supply: 1 kVa, to provide 1 minute switchover.
12. Operating System: Microsoft Windows
13. Printer: Color, ink-jet type as follows:

    a. Print Head: 4800 x 1200 dpi optimized color resolution.
    b. Paper Handling: Minimum of 100 sheets.
    c. Print Speed: Minimum of 17 ppm in black and 12 ppm in color.
14. 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.
    q. Automatic restart of field equipment on restoration of power.

15. 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. Custom Application Software:

1. English language oriented.
2. Full-screen character editor/programming environment.
3. Allow development of independently executing program modules with debugging/simulation capability.
4. Support conditional statements.
5. Support floating-point arithmetic with mathematic functions.
6. Contains predefined time variables.

C. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. The diagnostic terminal unit shall conform to the BACnet B-OD device profile.
2. System: With two integrated USB 2.0 ports, 10/100 NIC, integrated audio, bios, and hardware monitoring.
3. Processor: Intel Pentium.
4. Random-Access Memory: 8 GB.
5. Hard-Disk Drive: 500 GB.
6. CD-ROM Read/Write Drive: 48x24x48.

D. 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.

E. 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.

F. 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- to 10-V dc), 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, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
6. Universal I/Os: Provide software selectable binary or analog outputs.
7. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators. Floating type actuators are allowed on terminal devices such as reheat coils, VAV boxes, fan coil units and unit heaters. Floating type actuators are not permitted on air handling units or central plant controls.

G. 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.

H. Power Line Filtering: Internal or external transient voltage and surge suppression for work stations 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

2.6 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 scheduling with real-time clock. 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. The operator shall have the ability to manually override automatic or centrally executed commands at the Networked DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
6. 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.
7. 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.
8. 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.
9. 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.

10. 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.
    a. 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

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.

1. Application Specific Controllers shall conform to the BACnet B-ASC device profile.
2. Provide for control of each piece of equipment, including, but not limited to, the following:

    a. Air Volume Control Boxes (AVCB)
    b. Fan Coil Units

2.7 CONTROL PANELS

A. Provide panels of unitized cabinet type for each system.

B. Enclosure: Fabricate panels from 12-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 layouts 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.

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.

F. Control Panels located outdoors: provide NEMA 3R panels with integral air conditioning unit to maintain the required environmental conditions of all equipment within the panel.

2.8 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Acceptable Manufacturers:

1. APC
2. Eaton
3. Liebert

B. Provide an uninterruptible power supply at workstations, servers, gateways, specified DDC panels and elsewhere as specified to protect from power surges, spikes, blackouts and brownouts. Provide immunity from electrical sags, surges, transients, noise and outages. UPS unit shall provide continuous, regulated output power without using their batteries. Equipment and associated factory-installed controls, field-installed controls, electrical equipment and power supply connected to building normal and backup power systems and UPS shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when either normal or backup power is restored.

C. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.

D. Performance:

1. Battery Reserve: 15 minute typical at full load for DDC controllers; 10-15 minutes with a typical OWS load.
2. EMI/RFI: Comply with FCC Part 15J, Class A.

E. Electrical:

1. Input Voltage: 120 volt single phase, two-wire plus ground.
2. Input Frequency: 60 Hz, plus or minus1 percent.

F. Environmental:

1. Operating Temperature: 35 deg F to 95 deg F.
2. Relative Humidity: 0 % to 90 % RH noncondensing.

G. Battery: Internal, sealed, captive electrolyte, noncorrosive, and no flammable gases.

H. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure). These points shall be wired to the DDC system.

2.9 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.

2.10 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Temperature Sensors:

1. For all temperature sensors that are wired to the controller inputs for measuring space temperature in laboratory areas, provide thermistor NTC temperature sensors with a minimum accuracy of ±0.5 °F. Calibration of these sensors in the controllers shall be possible. For other areas, standard temperature sensing utilizing thermistors or RTDs can be used. Temperature and humidity sensors that use digital communication with the DDC controller for areas other than offices shall not be used with approval from Architect.

C. 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. Minimum accuracy of ±1.2 °F.
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.

    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Temperature Indication: Digital Display.
    d. Color: Standard
    e. Orientation: Vertical.

6. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. 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. Minimum accuracy of ±1.2 °F.
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.

    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Temperature Indication: Digital Display.
    d. Color: Standard.
    e. Orientation: Vertical.

6. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

E. Humidity Sensors: Bulk polymer sensor element on Humidicap ®.

1. Acceptable Manufacturers:

    a. ROTRONIC Instrument Corp.
    b. Vaisala
    c. General Eastern

2. Accuracy: Critical areas (Polymer Labs and Cleanroom Areas humidity sensors) 1 percent full range with linear output; non-critical areas 3 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed
    b. Color: Standard.
    c. Orientation: Vertical

5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 1% accuracy from 0-90% RH and 1.7% accuracy from 90-100% RH. A temperature sensor shall be incorporated into the device with a range of -40F to 140F. Vaisala HMT310 or equal. Provide an outside air enclosure Vaisala DTR500 or equal. .
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

F. Pressure Transmitters/Transducers:

1. Acceptable Manufacturers: Ashcroft (Basis of Design).

    a. Veltron (High Accuracy)
    b. Fisher-Rosemount (High Accuracy)
    c. AutoTran (Mid Range)
    d. Setra (Low Range)

2. Differential Pressure Transmitter (Room Differential Pressure Monitoring):

    a. Bi-directional.
    b. Range selected for no more than 3 times the expected measurement value unless specified differently or approved by the Architect.
    c. 0.25% FS accuracy.
    d. Provide LEDs for visual indication of diagnostics (zero pressure, in range, out of range), XDL Option.
    e. Provide capability for in-place calibration (XPV Option).
    f. Aschroft Model DXLdp

3. Differential Pressure Transmitter:

    a. Range selected for no more than 3 times expected measurement value unless specified differently or approved by the Architect.
    b. 0.4% FS accuracy.
    c. Ashcroft Model CXLdp

4. Water Pressure Transducers (Liquid/Steam): Provide a transmitter that utilizes capacitive or thin film strain gauge sensing. Provide for an analog gauge piped in parallel with the transducer. Gauge shall meet specifications as specified in Division 23. Coordinate with Mechanical Contractor to provide and install this gauge. For differential pressure applications provide with bypass valve manifold assembly with valved venting capability.

    a. Accuracy (including non-linearity and hysteris): 0.5% FS.
    b. Compensated Temperature Range: 32 to 150 °F.
    c. Temperature Effect (over compensated range): 0.03%/°F.
    d. Output 4-20mA
    e. Load Impedance (smallest maximum acceptable) 600 °F.
    f. Operating Temperature: 0 to 175 °F.
    g. Hysteresis: 0.75% of span.

5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

2.11 STATUS SENSORS

A. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

B. Current Switches

1. The current switch shall be a Veris Industries Hawkeye Current Sensor.
2. The current sensor shall be induce powered from the monitored load.
3. The current sensor shall provide on/off status indication of electrical loads from 1.5 to 200 amperes.
4. The selected switch shall match current VFD System output requirements.
5. The current sensor shall be capable of providing accurate status at temperatures from -15º to 60º C.
6. The current sensor shall be isolated to 600 VAC rms.
7. The current sensor output shall be N.O. solid-state 1.0 ampere at 30 VAC/DC.
8. The current sensor shall be a self-gripping split-core type.
9. The current sensor shall detect drive belts slipping, breaking, or pump couplings shearing.

C. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

D. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.12 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.

2.13 INDOOR AIR QUALITY ROOM SENSORS

A. Acceptable Manufacturers:

1. Siemens
2. Honeywell International Inc.
3. 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.

2.14 THERMOSTATS

A. Electric, Low-Limit Duct Thermostat (Low Temperature Limit Thermostat): Two sets of contacts, snap-acting, single-pole, single-throw, manual-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

2.15 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.

2.16 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."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators (standard): Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Acceptable Manufacturers:

a. Belimo Aircontrols (USA), Inc.
b. Siemens
c. Johnson Controls, Inc.
d. Schneider Electric

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 with Edge Seals: 7 inch-lb/sq. ft. of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
f. 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: 40 to 104 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 60 seconds.

C. Electronic Actuators (for chiller valves):

1. Acceptable Manufacturers:

   a. Bray
   b. Belimo Aircontrols (USA), Inc.

2. Valves: 90-degree stroke time to be 30 seconds at 6,500 lb-in torque
3. Power Requirements (On/Off) 120V, 1-phase
4. Temperature Rating: Minus 20 to plus 150 deg F.
5. Enclosure: NEMA 4
6. Bray Model 70-0651 or equal

2.17 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. Limit minimum size of globe valve to 1.5 Cv and minimum size of ball valve to 1.0 Cv.
   c. Three-Way Modulating: Line size; globe, ball or butterfly valve.
   d. Differential Pressure: Typically 50% of pump head with full pump flow.
   e. Valves which are sized 6 inches 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. Terminal Unit Control Valves: Globe Valve, bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.18 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 nylon 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 Class 1 leakage at less

than 8 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 TS-475.

2.19 AIR FLOW MEASURING STATION

A. Acceptable Manufacturers:

1. Air Monitor Corporation: Multipoint, self-averaging pitot tube airflow measurement technology.
2. Ebtron: Thermal dispersion airflow measurement technology.

B. Duct Airflow Station:

1. Furnish unit containing parallel air straightener, 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. Outside Airflow Measurement (Duct Mounted):

1. Thermal Dispersion Airflow Measurement Technology:

a. A single manufacturer shall provide both the airflow/temperature measuring probes and a compatible transmitter at a given measurement location.
b. Each sensor housing shall utilize two hermetically sealed, bead in glass thermistor probes to determine airflow rate and ambient temperature
c. Standard size ranges: 11 inches to 64 inches with adjustable mounting brackets
d. Construction:

1) Sensor Mounting Block and Mounting Feet: 304 stainless steel
2) Rod Construction: Adjustable length cadmium plated rods

e. Transmitter:

1) The transmitter shall be capable of communicating with the BAS using a linear output signal, field selectable fuse protected and isolated, 0-10 VDC and 4-20 mA (4-wire).

D. 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 product 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.

E. 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.

2.20 DUCT STATIC PROBE

A. Furnish duct static pressure probe and place for static pressure sensing 2/3 of way downstream in system ductwork where static pressure sensing and control of variable volume system is shown or specified.

B. Construct with multiple static pressure sensors located along exterior surface of cylindrical probe, of extruded aluminum and (except for ¾-inch dia. probes with lengths of 24 inches or less) complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. Produce steady, nonpulsating signal of standard static pressure, without need for correction factors, with instrument accuracy of 0.5%.

2.21 STACK LIGHTS

A. Light stack shall be Allen Bradley 855W wall mount signal light or approved equal.

B. Quantity and color configuration as indicated on drawings and specification 25 09 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and operator work station.

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 at the height above finished floor to be level with light switches and other devices.
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 at the height above finished floor to match temperature sensors, light switches, etc.
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 nonferrous 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.
2. Damper End Switches: Damper position switches shall be installed to prove the direction driven, not normal position.

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.

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.

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. 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 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 supply and return air fans, exhaust fans, coil circulating pumps, chilled water pumps, 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. Connect all normal power DDC/ATC panels to the nearest normal 208/120V power panelboard within the electrical circuit zone.
2. 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.
3. 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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