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Toolkit for Controlling *Legionella* in Common Sources of Exposure (*Legionella* Control Toolkit)

INFORMATION ON CONTROLLING *LEGIONELLA* IN COMMONLY IMPLICATED SOURCES OF LEGIONNAIRES' DISEASE OUTBREAKS

U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

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Accessible Version: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html

Legionella Control Toolkit Glossary

Aerosolized water: Small droplets of water in the air (generally, 5 microns in diameter or less), which can contain *Legionella* or other bacteria and can be deeply inhaled into the lungs

Biocide: See disinfectant

Biofilm: Germs and the slime they secrete that stick to and grow on any continually moist surface; provides a stable growth surface and an environment with nutrients for many types of germs, including *Legionella*

Building water systems: Includes hot and cold water distribution systems and all devices that use water to which people can be exposed, such as hot tubs, decorative fountains, and cooling towers

Control: To manage conditions within the building according to a water management program or to maintain established criteria

Control limits: Maximum value, minimum value, or range of values acceptable for the control measures being monitored to reduce risk for *Legionella* growth and spread

Control measures: Actions that can be taken for building water systems to limit growth and spread of *Legionella*, such as heating, adding disinfectant, or cleaning; control measures enable maintenance of control limits

Control points: Locations in water systems where a control measure can be applied

Corrective action: Actions taken to reestablish control when monitoring values or measurements are outside control limits

Dead legs: Piping subject to low or no flow because of design or decreased water use; for example, capped pipes or unused faucets

Disinfectant: Chemical or physical treatment to kill germs; for example, chlorine, monochloramine, chlorine dioxide, bromine compounds, copper-silver ionization, ultraviolet light, or ozone

Disinfectant residual: Amount of disinfectant available in water to kill bacteria

Drift: Water mist or small droplets carried by air, which may include aerosols

Hazardous conditions: Any condition or factor that can contribute to the growth and spread of *Legionella* to a person if not controlled

Healthcare facility: Hospitals, long-term care facilities, clinics, or other settings where patients seek care, such as dental offices, pharmacies, or outpatient laboratories

***Legionella*:** Bacteria that can cause Legionnaires' disease

Legionnaires' disease: A serious type of pneumonia caused by *Legionella*

Make-up water: Water provided to a device to replace system water lost through evaporation, processing, or draining

Non-potable water: Water not intended for people to drink or ingest, such as water for industrial processes, irrigation, or equipment like cooling towers

Non-routine *Legionella* testing: Testing for *Legionella* to investigate potential sources of environmental exposure for persons with disease. Testing for public health investigations should always be performed in conjunction with the public health authority having jurisdiction

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People at increased risk for Legionnaires' disease: Includes people 50 years or older, current or former smokers, people with a chronic lung disease (like emphysema), people with weak immune systems or who take drugs that weaken the immune system, people with cancer, and people with underlying illnesses such as diabetes, kidney failure, or liver failure

Potable water: Hot or cold water intended for people to drink or ingest, such as drinking, bathing, food preparation, and dishwashing

Remediation: Response activities taken to reduce contamination in response to control measures, such as routine *Legionella* test results, that persistently exceed control limits or to events that pose an immediate risk to control of building water systems; required whenever Legionnaires' disease occurs; may also be appropriate for unexpected events such as equipment failure or acts of nature that disrupt the water system

Residual: See Disinfectant residual

Routine *Legionella* testing: Testing for *Legionella* to establish a baseline measurement for performance indicators or for validating a water management program or corrective action. Methods and objectives vary from those of non-routine *Legionella* testing

Sediment and scale: Mineral build-up in a water system that uses up disinfectant and supports growth or survival of bacteria

Stagnation: When water does not flow well; areas of stagnation encourage biofilm growth, ambient temperatures, and disinfectant residual reduction

Supplemental disinfection: Adding disinfectant to a water system on site; may require permitting for potable water systems

Validation: Activities to confirm the water management program is working as intended and is effective for *Legionella* control; testing for *Legionella* is one method for validation of a water management program

Verification: Activities to confirm the water management program procedures are occurring as intended; reviewing temperature logs to ensure temperature measurement is occurring at the intended frequency is one method for verification of a water management program

Water age: Amount of time it takes for water to reach a point of use or fixture/device from the point of entry; for example, slow moving water has a higher water age than water moving quickly through a building water system

Water management program (WMP): Multistep process to reduce *Legionella* growth and spread; includes establishing a team, describing building water systems, identifying areas or devices where *Legionella* might grow or spread to people, determining control measures, monitoring control measures, establishing remediation activities and interventions when control measures are not met, ensuring the program is running as designed and is effective, and documenting all program activities

CS321985-A

Controlling *Legionella* in Potable Water Systems

Purpose

Use this document to:

1. Help evaluate hazardous conditions associated with potable water systems
2. Implement *Legionella* control measures for potable water systems per ASHRAE Guideline 12-2020
3. Complement existing resources for water management programs (WMP)
4. Support environmental assessments conducted during public health investigations

Key Points

- **No single control measure ensures the control of *Legionella* in potable water systems.**
- **Thermal remediation is not recommended for potable water systems.**

Sediment and biofilm, Temperature, water Age, and disinfectant Residuals (STAR) are the key factors that affect Legionella growth in potable water systems

Design

Understanding potable water system design components is critical for *Legionella* control. The following considerations apply to hot and cold potable water systems. They should be evaluated from the point at which water enters a facility system to the point where it leaves the system through a fixture or device.

Design Recommendations

- Use pipe insulation to maintain hot and cold water temperatures throughout the water system.
- Eliminate sections of no- or low-water flow called dead legs.
- Install thermostatic mixing valves as close as possible to fixtures to prevent scalding while permitting circulating hot water temperatures above 120°F (49°C).
- Recognize that low-flow and mechanically complex fixtures (e.g., electronic sensor faucets) can increase the risk of *Legionella* growth.
- Identify water system components that speed the decay of disinfectant residuals (e.g., UV devices, water softeners, carbon filters, heaters).
- Use appropriately sized hot and cold water storage tanks fitted with recirculating pumps to maintain flow and avoid unfavorable temperature gradients.
- Consider installing sampling ports throughout your water system in locations to facilitate water parameter monitoring and WMP validation.

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Operation, Maintenance, and Control Limits

Use a WMP to protect building operators, staff, and visitors from exposure to *Legionella* in potable water systems. No single measure can ensure *Legionella* control. A comprehensive WMP allows water system operators to layer a series of complementary control measures to create environmental conditions that prevent bacterial intrusion, growth, and transmission. Develop or refine a WMP with the following guidelines in mind:

- Monitor temperature, disinfectant residuals, and pH frequently based on performance of water management program or *Legionella* performance indicators for control. Adjust measurement frequency according to the stability of performance indicator values. For example, the measurement frequency should be increased if there is a high degree of measurement variability.
- Store hot water at temperatures above 140°F (60°C) and ensure hot water in circulation does not fall below 120°F (49°C). Recirculate hot water continuously, if possible.
- Store and circulate cold water at temperatures below the favorable range for *Legionella* (77–113°F, 25–45°C); *Legionella* may grow at temperatures as low as 68°F (20°C).
- Ensure a disinfectant residual is detectable throughout the potable water system.
- Flush low-flow piping runs and dead legs at least weekly and flush infrequently used fixtures (e.g., eye wash stations, emergency showers) regularly as-needed to maintain water quality parameters within control limits.
- Clean and maintain water system components, such as thermostatic mixing valves, aerators, showerheads, hoses, filters, and storage tanks, regularly.
- Do not presume supplemental disinfection systems will control *Legionella* without an adequate WMP.
  - Selecting or operating a supplemental disinfection system inappropriately may result in system damage or health hazards (e.g., disinfectant byproducts). Consult with a water treatment professional regarding supplemental disinfection systems. They may require permitting.
- Recognize that point-of-use (POU) microbial filters with an effective pore size of 0.2-microns or less that comply with the requirements of ASTM F838 can provide immediate control at individual fixtures in a water system if integrated into a WMP.
  - POU filters protect only the connected fixture. Correct location selection is critical to *Legionella* exposure prevention across the water system.
  - Follow the manufacturer recommendations regarding frequency of replacement and appropriate operating conditions.
  - POU filters may need to be removed before performing an acute remediation procedure.
- Consider testing for *Legionella* in accordance with Routine Testing for *Legionella* (Page F1).

Remediation

If an outbreak or illness is suspected, test in conjunction with public health in order to:

- Confirm the presence of *Legionella* before performing remediation.
- Confirm elimination of *Legionella* after remediation activities.

If control measures are ineffective, if routine results indicate poor *Legionella* control, or if an outbreak or illness is suspected by the authority having jurisdiction (AHJ), consider the remediation options described below. Note: The public health AHJ determines whether there are associated illness(es) or an outbreak. Choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Consult with a water treatment professional as certain procedures should only be undertaken by a professional. **Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.**

- Chemical shock using an elevated level of a disinfectant, such as chlorine, for a limited duration can control *Legionella* in a potable water system. Consult scientific evidence and technical expertise before choosing a specific chemical shock procedure. In addition:
  - Consider which components of the water system need remediation.
  - Chemical shock of a hot water system may have improved efficacy if the temperature is lowered.
  - Chemical shock options may be impacted by regulations (e.g., chemicals allowed into sewer discharge) and may require permitting.
- Thermal shock of water systems is not recommended due to frequent failure and rapid recolonization of *Legionella*.

Table 1. *Legionella* Control Measures for Potable Water Systems

	Water Parameter	Control Measure	Recommendations
S	**S**ediment and Biofilm	Flushing, cleaning, and maintenance	• Flush after an intrusion event (e.g., water main break). • Clean and maintain water system components such as water heaters, mixing valves, aerators, showerheads, hoses, and filters regularly as indicated by water quality measurements.
T	**T**emperature	Control limits	• Store hot water above 140°F (60°C) and maintain circulating hot water above 120°F (49°C). • Store and maintain circulating cold water below the growth range most favorable to *Legionella* (77–113°F, 25–45°C). Note that *Legionella* may grow at temperatures as low as 68°F (20°C).
A	Water **A**ge	Flushing	• Flush low-flow pipe runs and dead legs at least weekly. • Flush infrequently used fixtures regularly.
R	Disinfectant **R**esidual*	Control limits	• Chlorine: Detectable residual as directed by WMP. • Monochloramine: Detectable residual as directed by WMP.

* Disinfectant residual recommendations apply to disinfectant delivered by the municipal water authority. Supplemental disinfection system control limits are not prescribed here and must be dictated by the water treatment professional and water management program.

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella

Controlling *Legionella* in Cooling Towers

Purpose

Use this document to:

1. Help evaluate hazardous conditions associated with all types of cooling towers and evaporative condensers
2. Implement *Legionella* control measures for cooling towers per ASHRAE Guideline 12-2020
3. Complement existing resources for water management programs
4. Support environmental assessments conducted during public health investigations

Key Points

- **Scale, corrosion, sediment controls, and system cleaning are critical for cooling tower operations and Legionnaires' disease prevention.**
- **Disinfectant residual should be monitored and adjusted by an automated system.**
- ***Legionella* risks are similar for open and closed-circuit cooling tower systems.**

Sediment and biofilm, temperature, water age, and disinfectant residual are the key factors that affect *Legionella* growth in cooling towers.

Design

Open- vs. Closed-Circuit Cooling Towers

All cooling towers use the evaporation of water to remove heat and release it into the atmosphere. Cooling towers use circulating water to cool chillers, heat pumps, compressors, condensers, heat exchangers, and other process devices. Both kinds of cooling towers, open- and closed-circuit, require the same basic operation and maintenance protocols. Both types of cooling towers can release aerosolized water to the atmosphere. If *Legionella* is present, the aerosolized water can spread the bacteria over miles. However, closed-circuit cooling towers have an additional, closed loop that can keep the fluid used in the cooling processes from being exposed to the atmosphere. Closed-circuit cooling towers can operate in cool temperatures in a "dry" mode that does not use water or generate aerosols.

Design Recommendations

Understanding cooling tower design components is critical for *Legionella* control.

- Use high-efficiency drift eliminators.
- Locate cooling towers at least 25 feet from building air intakes to ensure that the cooling tower's drift plume is not drawn into a ventilation system.
- Ensure system piping is designed to avoid stagnation or dead legs.
- Recirculate water during intermittent operation.
- Design and install an automated water treatment system.

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Operation, Maintenance, and Control Limits

Safe operation and regular cooling tower maintenance protect building operators, staff, visitors, and the adjacent community from exposure to *Legionella*. The necessary frequency of these activities depends on the cooling load, the environmental conditions present in the area where the cooling tower is located, and the cooling tower's design. Use a water management program to establish, track, and improve operation and maintenance activities. Operate and maintain cooling towers with the following guidelines in mind:

- Follow manufacturer recommendations for cleaning and disinfection prior to commissioning, before startup, when idling, and after shutdown.
- Operate cooling tower systems at the lowest possible water temperature, and below the most favorable *Legionella* growth range (77–113°F, 25–45°C), if possible.
- Automate anti-corrosion, anti-scale, and disinfectant addition and monitoring.
- Monitor water parameters, like disinfectant residual and pH, on a regular basis. Measurement frequency should be based on performance of the water management program or *Legionella* performance indicators for control. Adjust frequency according to the stability of performance indicator values. For example, the measurement frequency should be increased if there is a high degree of measurement variability.
- Flush low-flow pipe runs and dead legs at least weekly.
- Balance operating times among cooling towers to prevent stagnation when multiple cooling towers or cells exist.
- Implement automated blowdown (intentional discharge of system water and replacement with supply water) to maintain system water quality.
- Consider filtration to reduce the level of suspended solids in the cooling water based on system factors (e.g., cooling tower location, particle load).
- Perform an off-line disinfection and cleaning at least annually.
- Monitor cooling towers for water service disruptions and develop plans to respond accordingly.
- Consider testing for *Legionella* in accordance with Routine Testing for *Legionella* (Page F1).
- Maintain site-specific log sheets, test procedures, service reports, and test results on-site.

Remediation

If an outbreak or illness is suspected, test in conjunction with public health in order to:

- Confirm the presence of *Legionella* before performing remediation.
- Confirm elimination of *Legionella* after remediation activities.

Cleaning, disinfecting, and remediating cooling towers involves a hierarchy of protocols. Determine how the following response protocols fit into your water management program. The protocols are listed in order of increasing intensity from routine treatment to offline emergency disinfection. Consult ASHRAE Guideline 12-2020 for instructions for each response. These steps may require customization based on system components, operating conditions, or other factors.

- Online remedial treatment
- Online disinfection
- Offline cleaning and disinfection
- Offline emergency cleaning and disinfection

If an associated outbreak or illness is suspected by the public health authority having jurisdiction (AHJ), perform an offline emergency cleaning and disinfection using the procedures below. Note: The public health AHJ determines whether there are associated illness(es) or an outbreak.

Consult a water treatment professional for guidance on applying these procedures.

1. **Review** the current water treatment program (e.g., cleanliness, maintenance, disinfectant program).
2. **Remove** heat load from the cooling system. Shut off fans associated with the cooling tower. Disengage all automated chemical feed and control equipment.
3. **Shut off** system blowdown and keep make-up water valves open and operating.
4. **Close** building air intake vents near the cooling tower, especially those downwind, until after the cleaning procedure is complete.
5. **Circulate** water through all system equipment, including any bypass or standby components.
6. **Add** an oxidizing disinfectant sufficient to achieve a disinfectant residual of at least 20 ppm as free available oxidant.
7. **Add** an appropriate dispersant and apply antifoam, if needed. Apply appropriate corrosion inhibitors.
8. **Reduce** the cycles of concentration (if necessary) to achieve and maintain a pH of less than 8.0 for chlorine-based disinfectants or less than 8.5 for bromine-based disinfectants.
9. **Maintain** a free available oxidant residual of 10 ppm for a minimum of 24 hours. Shorter contact times can be effective at higher concentrations.
10. **Drain** the system after the disinfection period to the sanitary sewer, following all applicable rules, regulations, and permits that may be required.
11. **Physically clean** all accessible system equipment. Consideration should be given to all cooling tower equipment, including fill pack, drift eliminators, equalizer lines, remote sumps, basins, strainers, chillers, free cooling heat exchangers, and any bypass or standby components.
12. **Refill** the system and circulate water through all system equipment including any bypass or standby components.
13. **Add** an oxidizing disinfectant and maintain a free available oxidant residual of at least 10 ppm for one hour.
14. **Drain** the system after the disinfection period to the sanitary sewer following all applicable rules, regulations, and permits that may be required.
15. **Refill** the system and return all chemical feed and control equipment to normal operation.

Table 1. *Legionella* Control Measures for Cooling Towers

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Cleaning frequency, scale and corrosion inhibitors	• Cleaning frequency varies based on operational factors. • Remove from service, clean, and disinfect at least annually. • Monitor scale and corrosion inhibitor levels frequently as indicated by water quality measurements.
Temperature	Control limits	• Operate at the lowest possible water temperature outside the favorable growth range for *Legionella* (77–113°F, 25–45°C).
Water Age	Make-up water quality and turnover frequency	• Flush low-flow pipe runs and dead legs at least weekly. • During wet system standby (water remains in system and shutdown for less than 5 days), maintain water treatment program and circulate water 3 times a week through the open loop of a closed-circuit cooling tower and entire open-circuit cooling system. Ensure system water quality is managed through automated system blow down. • Use potable water for system make-up water or ensure reclaimed or condensate sources are appropriately managed.
Disinfectant Residual	Control limits	• pH: Maintain based on type of disinfectant used and manufacturer recommendations to prevent corrosion. • Oxidizing disinfectants (e.g., chlorine & bromine): Maintain measurable residuals throughout each day. Consult manufacturer recommendations. • Non-oxidizing disinfectants: Maintain based on product label concentration and contact time.

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella
- Cooling Technology Institute Guideline 159(20): https://www.coolingtechnology.org/shop

CS321985-A

Controlling *Legionella* in Hot Tubs

Purpose

Use this document to:

1. Help evaluate hazardous conditions associated with all types of hot tubs and whirlpool spas (including display models)
2. Implement *Legionella* control measures for hot tubs per ASHRAE Guideline 12-2020
3. Complement existing resources for water management programs
4. Support environmental assessments conducted during public health investigations

Key Points

- **Hot tubs have been associated with Legionnaires' disease outbreaks.**
- **All hot tubs—including display models—should be operated with proper disinfectant residuals and pH.**
- **Public hot tubs should use automatic feed and control systems for disinfectant and pH.**

Sediment and biofilm, temperature, water age, and disinfectant residual are the key factors that affect *Legionella* growth in hot tubs.

Design

Hot tubs maintain water temperatures within the most favorable range for *Legionella* growth (77–113°F, 25–45°C), create aerosols, and accelerate the decay of disinfectants. These conditions make the following design recommendations critically important for preventing disease:

- Use automatic feed and control systems to maintain proper disinfectant residual and pH.
- Ensure easy access to all mechanical and filtration components for routine and preventive maintenance and service.
- Ensure the hot tub basin can be easily, quickly, and completely drained and refilled and is suitable for regular scrubbing and cleaning.
- Consider locating indoor hot tubs in rooms with isolated air handlers and dehumidifiers.
- Locate building air-handing system outlets and returns to reduce the potential for transmission of aerosols.
- Post signage warning of increased health risks to individuals who are immune compromised or who have chronic lung disease.

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Operation, Maintenance, and Control Limits

Safe operation and regular hot tub maintenance protect staff, bathers, and bystanders from exposure to *Legionella*. Use a water management program to establish, track, and improve operation and maintenance activities. Operate and maintain hot tubs of all types and sizes with the following guidelines in mind:

- Follow manufacturer recommendations and requirements of the authority having jurisdiction; areas without local regulations can use CDC's *Model Aquatic Health Code* (MAHC).
- Monitor and maintain a chlorine or bromine disinfectant residual and pH according to Table 1.
- Test disinfectant residual and pH at least twice per day (as often as hourly when in heavy use).
- Backwash sand and diatomaceous earth filters routinely per manufacturer recommendations.
- Replace cartridge filters on a regular basis per manufacturer recommendations.
- Ensure steady water flow across the filter 24 hours per day.
- Clearly post the maximum bather load (CDC's MAHC recommends 10 ft^2 per bather) and rules for appropriate use.
- Remove hot tubs from service daily to carry out disinfection with a higher than normal disinfectant residual. For example, a free residual of 10 mg/L or 10 times the combined chlorine level, whichever is greater, for at least one to four hours is commonly used.
- Drain, scrub, clean, and fill hot tubs according to Table 1.
- Ensure all staff involved in hot tub operation and maintenance are trained appropriately.
- Maintain complete operating records for hot tubs and review trends of disinfectant residuals, pH, and maintenance activities.
- Consider testing for *Legionella* in accordance with Routine Testing for *Legionella* (Page F1).

Private Hot Tubs

- **All hot tubs have potential for *Legionella* growth if control measures are not taken.**
- **Monitor and maintain proper disinfectant residuals and pH, even when not in use.**
- **Follow manufacturer recommendations for cleaning, filter replacement, and all other maintenance activities.**

Remediation

If an outbreak or illness is suspected, test in conjunction with public health in order to:

- Confirm the presence of *Legionella* before performing remediation.
- Confirm *Legionella* elimination after remediation activities.

If control measures are ineffective or if routine test results indicate poor *Legionella* control, and there are NO illnesses, then consider the following remediation steps:

1. **Remove** the hot tub from service.
2. **Increase** disinfection by adding disinfectant and maintaining 10 ppm free chlorine for 1 hour.
3. **Drain** the water.
4. **Scrub,** clean, and rinse all hot tub surfaces with fresh potable water and drain as needed.
5. **Clean** and service filters according to manufacturer recommendations.
6. **Refill** with fresh potable water.
7. **Return** the hot tub to the routine disinfectant residual level.
8. **Resume** service once performance indicators are consistent with *Legionella* control and are within control limits.

If an outbreak or illness is suspected by the public health authority having jurisdiction (AHJ), do the following. Note: The public health AHJ determines whether there are associated illness(es) or an outbreak.

1. **Remove** the hot tub from service.
2. **Drain** the hot tub after collection of samples per public health instructions.
3. **Scrub** and clean all surfaces, including skimming devices and weirs, using water with a minimum free chlorine concentration of 5 ppm.
4. **Rinse** all hot tub surfaces with fresh potable water and drain as needed.
5. **Replace** filters or filter media (if applicable).
6. **Repair** parts as needed.
7. **Refill** the hot tub with fresh potable water.
8. **Hyperchlorinate** the water to 20 ppm free chlorine. Circulate hyperchlorinated water with jets off for 1 hour. Circulate hyperchlorinated water with jets on for 9 additional hours. Maintain a minimum free chlorine residual of 20 ppm for a total of 10 hours.
9. **Flush** the entire system with fresh potable water and refill.
10. **Return** the hot tub to the routine disinfectant residual level.
11. **Resume** service in coordination with public health authority.

Managing *Legionella* Risk in Display Hot Tubs

- A hot tub on display that contains water also requires disinfectant.
- Residual disinfectant (free chlorine: 3–10 ppm, bromine: 4–8 ppm) and pH (7.2–7.8) should be monitored twice a day.[†]
- Maintain complete operating records for display hot tubs, including disinfectant residual levels, pH, and maintenance activities.

Table 1. *Legionella* Control Measures for Hot Tubs and Whirlpool Spas*

Water Parameter	Control Measure	Recommendations**
Sediment and Biofilm	Cleaning frequency	• Vigorously scrub all surfaces each time tub is drained.
Temperature	Control limits unlikely met due to operating conditions	• Hot tubs operate within the favorable growth range for *Legionella* (77–113°F, 25–45°C). • Additional measures are required to control *Legionella*. • Water should not exceed 104°F (40°C) to prevent scalding.
Water Age	Bather load, frequency of use	• Water replacement frequency in days = (Spa volume in gallons/3)/average # users per day.[†]
Disinfectant Residual[‡]	Control limits	• pH: 7.2–7.8[†] • Free chlorine: 3–10 ppm[†] • Bromine: 4–8 ppm[†]

* The listed control measures were last updated according to ASHRAE Guideline 12-2020 and CDC's 2018 MAHC. View the current versions of ASHRAE Guideline 12 and MAHC for the most up-to-date recommendations.

** See Managing *Legionella* Risk in Display Hot Tubs section for recommendations for controlling *Legionella* in display hot tubs.

[†] Recommendation based on guidance from MAHC, accessible at: https://www.cdc.gov/mahc/editions/current.html.

[‡] Cyanuric acid or stabilized chlorine products should not be used in hot tubs as they slow disinfection.

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- Display Hot Tub Fact Sheet: https://www.cdc.gov/nceh/ehs/docs/factsheets/hot-tub-displays-ld-risk-p.pdf
- Operating Public Hot Tubs Fact Sheet: https://www.cdc.gov/healthywater/pdf/swimming/resources/operating-public-hot-tubs-factsheet.pdf
- Model Aquatic Health Code: https://www.cdc.gov/mahc/
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella

CS321985-F

Controlling *Legionella* in Decorative Fountains

Purpose

Use this document to:

1. Help evaluate hazardous conditions associated with decorative or ornamental fountains ("decorative fountains")
2. Implement *Legionella* control measures for decorative fountains per ASHRAE Guideline 12-2020
3. Complement existing resources for water management programs
4. Support environmental assessments conducted during public health investigations

Key Points

- **All decorative fountains produce aerosols.**
- **Do not place decorative fountains in areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities.**
- **Cleaning and disinfection are a regular part of decorative fountain operation and maintenance.**

Sediment and biofilm, temperature, water age, and disinfectant residual are the key factors that affect *Legionella* growth in decorative fountains.

Design

Understanding the decorative fountain design components are critical for *Legionella* control. Consider how each of the following impacts factors for *Legionella* growth: size, pumps, lighting, filtration, water treatment systems, and features (e.g., cascades, sprays, water walls). Decorative fountains should be supplied with a cold potable water make-up source at temperatures below the favorable range for *Legionella* (77–113°F, 25–45°C).

Operation, Maintenance, and Control Limits

All decorative fountains produce aerosols. Safe operation and regular decorative fountain maintenance protect building owners, employees, and visitors from exposure to *Legionella*. The frequency of these activities depends on the environmental conditions present in the area where the decorative fountain is located and its design. Use a water management program to establish, track, and improve operation and maintenance activities. Operate and maintain decorative fountains of all types and sizes with the following guidelines in mind:

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- Follow manufacturer recommendations and any requirements of the authority having jurisdiction.
- Do not operate decorative fountains in areas intended for use by persons at increased risk of Legionnaires' disease, such as healthcare facilities.
- Monitor critical water parameters, like temperature and disinfectant residual, at least weekly.
- Automate disinfectant feed and monitoring systems, if possible.
- Apply algaecide as needed.
- Avoid prolonged idle periods and run decorative fountains at least daily.
- Immediately clean and disinfect if cloudy water, visible debris, algae, biofilm, or foul odor are present.
- Consider testing for *Legionella* in accordance with Routine Testing for *Legionella* (Page F1).

Remediation

If an outbreak or illness is suspected, test in conjunction with public health in order to:

- Confirm the presence of *Legionella* before performing remediation.
- Confirm elimination of *Legionella* after remediation activities.

ASHRAE Guideline 12-2020 does not define remedial treatment procedures for decorative fountains. The following procedures are adapted from the ASHRAE Guideline 12-2020 heated whirlpool and spa/hot tub remedial treatment procedure.

If control measures are ineffective or if routine test results indicate poor *Legionella* control, and there are NO illnesses, then consider the following remediation steps:

1. **Remove** the decorative fountain from service.
2. **Hyperchlorinate,** maintaining 10 ppm free chlorine for one hour.
3. **Drain** the water once shock disinfection is completed.
4. **Scrub** all surfaces.
5. **Clean** and service filters (if applicable).
6. **Refill** with fresh potable water.
7. **Return** the decorative fountain to the routine disinfectant residual level outlined in Table 1 before use.

If an associated outbreak or illness is suspected by the public health authority having jurisdiction (AHJ), do the following. Note: The public health AHJ determines whether there are associated illness(es) or an outbreak.

1. **Remove** the decorative fountain from service.
2. **Drain** the decorative fountain.
3. **Scrub** all surfaces.
4. **Replace** filters or filter media (if applicable).
5. **Repair** parts as needed.
6. **Refill** the decorative fountain.
7. **Hyperchlorinate,** maintaining a minimum of 20 ppm free chlorine for 10 hours.
8. **Drain** and rinse all components of the decorative fountain.
9. **Refill** with fresh potable water.
10. **Return** the decorative fountain to the routine disinfectant residual level outlined in Table 1 before use.

Table 1. *Legionella* Control Measures for Decorative Fountains by Volume in US Gallons

Water Parameter	Control Measure	Recommendations		
		< 5 gallons	5–25 gallons	> 25 gallons
Sediment and Biofilm	Cleaning frequency	Weekly	Monthly	Routinely to remove scale and deposits as indicated by water quality measurements.
		Any time there is visible biofilm or debris (in addition to above routine cleaning)		
Temperature	Control limits	Maintain water temperature below 77°F (25°C).*		
Water Age	Water turnover, flow, replacement	Water turnover and flow are needed to maintain water treatment applied for microbial control. Avoid idle periods. Run at least daily.		
Disinfectant Residual	Control limits	3–5 ppm free chlorine for at least 1 hour per day	3–5 ppm free chlorine for at least 1 hour per day	0.5 ppm free chlorine for at least 6 hours/day

* Exposure to warm air, heat-generating submerged lights, or other factors that elevate water temperature into the favorable growth range (77–113°F, 25–45°C) will require additional mitigation strategies.

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella

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Controlling *Legionella* in Other Devices

Purpose

Use this document to:

1. Help evaluate hazardous conditions associated with devices that use water
2. Implement *Legionella* control measures for devices that use water per ASHRAE Guideline 12-2020
3. Complement existing resources for water management programs (WMP)
4. Support environmental assessments conducted during public health investigations

Key Points

- **Any system or equipment containing nonsterile water can grow *Legionella.***
- **Keep all plumbed devices clean and well maintained.**

Sediment and biofilm, temperature, water age, and disinfectant residual are the key factors that affect *Legionella* growth in devices that use water.

Any Device that Contains Nonsterile Water Can Grow *Legionella*

In the absence of control, *Legionella* can grow in almost any system or equipment containing nonsterile water, such as tap water, at temperatures favorable to *Legionella* growth. Devices that may grow *Legionella* in the absence of control include the following:

- All types of secondary water collection, storage, and use for recycled water, gray water, rainwater, and groundwater
- Water storage for high-demand or emergency use and expansion tanks
- Lawn sprinklers and irrigation systems
- Solar water heating systems
- Fire suppression systems
- Safety showers and eyewash stations
- Produce and recreational misters
- Evaporative air coolers
- Spray and pressure washing equipment
- Machine/metal working lubrication and coolant systems
- Dental and medical equipment (e.g., scalers, CPAP, bronchoscopes, heater-cooler units)
- Ice machines
- Humidifiers

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Operation, Maintenance, and Control Limits

Use control methods to protect building operators, staff, and visitors from exposure to *Legionella* in devices that use nonsterile water. Certain devices that use water can generate aerosolized water droplets or otherwise present a unique risk and should have specific control measures in place to prevent exposure. These are highlighted below and are followed by general guidelines for *Legionella* control in a wide variety of devices.

Produce and Recreational Misters

- Insulate pipes to maintain water temperatures outside the *Legionella* growth range.
- Avoid stagnation by running regularly or draining when not in use.
- If recreational misting equipment has a reservoir, drain and clean it regularly; consider using a disinfectant appropriate for the system.

Ice Machines

- Clean regularly and replace filters per manufacturer recommendations.
- Consider routine *Legionella* testing of ice machines in settings that serve people at increased risk of Legionnaires' disease.

Humidifiers

- Tanks on humidifiers should be emptied and cleaned daily.

Sprinklers and Irrigation Equipment

- Operate these devices outside of normal business hours to limit bystanders' exposure.

Dental and Medical Equipment

- Clean regularly per manufacturer recommendations.
- Use sterile water in respiratory equipment such as CPAP, heater-cooler units, and bronchoscopes.

General Guidelines:

- Regularly clean and maintain all water system components, such as spray nozzles, sprinkler heads, and hoses.
- Ensure evaporative coolers are functioning properly with managed airflow across condensate pans.
- Store and maintain water at temperatures outside the favorable growth range for *Legionella* (77–113°F, 25–45°C); note that *Legionella* may grow at temperatures as low as 68°F (20°C).
- Keep collection basins, condensate pans, cooling coils, and other components clean and free from dirt, debris, corrosion, and biofilm.
- Flush low-flow piping runs, dead legs, and low-use fixtures regularly.
- Consider testing for *Legionella* in accordance with Routine Testing for *Legionella* (Page F1) or if indicated by a WMP.

Remediation

If an outbreak or illness is suspected, test in conjunction with public health in order to:

- Confirm the presence of *Legionella* before performing remediation.
- Confirm elimination of *Legionella* after remediation activities.

If control measures are ineffective, if routine test results indicate poor *Legionella* control, or if an outbreak or illness is suspected by the authority having jurisdiction (AHJ), consider remediation options. Note: The public health AHJ determines whether there are associated illness(es) or an outbreak. Water system managers should choose a remedial treatment procedure after considering the system infrastructure, water quality parameters, and available sampling results. Certain procedures should only be undertaken in consultation with a water treatment professional. **Following a successful *Legionella* remediation procedure, recolonization of the water system is likely unless the underlying conditions supporting *Legionella* growth are addressed.**

Table 1. *Legionella* Control Measures for Other Devices

Water Parameter	Control Measure	Recommendations
Sediment and Biofilm	Flushing, cleaning, and maintenance	• Clean and maintain water system components regularly in accordance with manufacturer recommendations.
Temperature	Control limits	• Store and maintain water at temperatures outside the favorable growth range for *Legionella* (77–113°F, 25–45°C); ▸ Note that *Legionella* may grow at temperatures as low as 68°F (20°C).
Water Age	Flushing and water replacement	• Flush and replace water according to manufacturer recommendations.
Disinfectant Residual	Control limits	• Consider using a disinfectant appropriate for the system and in accordance with manufacturer recommendations.

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella
- Reduce Risk for Water: https://www.cdc.gov/hai/prevent/environment/water.html
- Dental Unit Water Quality: https://www.cdc.gov/oralhealth/infectioncontrol/summary-infection-prevention-practices/dental-unit-water-quality.html

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Routine Testing for *Legionella*

Purpose

Use this document to:

1. Help analyze hazards and establish *Legionella* control measures per ASHRAE Guideline 12-2020
2. Complement existing resources for testing, sampling, and water management programs (WMPs)
3. Support environmental assessment during public health investigations

Testing for public health investigations must always be performed in conjunction with the authority having jurisdiction (AHJ). The below guidance is for routine testing only.

Testing Objectives

Testing may be useful for routine and non-routine purposes, such as:

- Establishing a baseline measurement for performance indicators
- Validating a WMP
- Evaluating potential growth and transmission sources
- Confirming success or failure of remedial treatment
- Investigating potential sources of environmental exposure for persons with disease

Routine testing may be particularly beneficial for certain types of facilities, such as:

- Facilities that house or treat individuals at increased risk for Legionnaires' disease (e.g., senior communities, outpatient clinics)
- Facilities unable to meet control limits consistently
- Facilities with a history of associated Legionnaires' disease cases

Sample Collection

1. Perform an environmental assessment to identify areas with increased risk of *Legionella* growth and spread. Consider the key factors for *Legionella* growth (i.e., sediment and biofilm, temperature, water age, and disinfectant residual) when assessing risk.

Before sampling, consider how results will be used in the broader context of a water management program.

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2. Create a sampling plan that represents the entire building water system. Sampling location recommendations are included in the CDC Sampling Procedure and Potential Sampling Sites.
3. The volume of water you collect may depend on the source type (potable vs. non-potable) or condition (detectable disinfectant residual vs. visible debris and no detectable disinfectant residual). Typically, a 250 mL sample is sufficient for routine testing. Larger sample volumes and other sample types, such as swabs or ice, may provide additional information for at-risk facilities.
4. Reference CDC Sampling Procedure and Potential Sampling Sites for step-by-step instructions on selecting sites and collecting samples.

Test Methods and Laboratory Considerations

Some test methods may be performed onsite by the user or a qualified technician, while other methods may require contracting with a commercial laboratory. Regardless of the test method, be sure that you understand the performance characteristics of the test such as sensitivity, specificity, and limitations. For best results, follow instructions from the manufacturer or testing laboratory closely.

Consider testing for all *Legionella* species as all are supported by similar environmental conditions.

Considerations when working with laboratories testing for Legionella:

- Accreditation by a regional, national, or international accrediting body to a recognized standard for routine *Legionella* test methods, such as ISO/IEC 17025
- Capability of retaining *Legionella* isolates from samples for additional characterization
- Capacity to perform additional *Legionella* characterization as needed by the submitter

Test Methods

Traditional Culture (spread plate)	PCR	Alternative and Novel Methods
• Detects viable bacteria • Detects all *Legionella* species • Results typically reported in colony forming units (CFU) per volume with limit of detection ~10 CFU/mL • Yields isolate for additional characterization • Results typically reported in 7–14 days • Is subject to skill, experience, and procedural rigor of the laboratory • May be preferred for evaluating growth trends	• Detects *Legionella*-specific DNA or RNA • May not differentiate between live and dead bacteria • Results typically reported in genomic units (GU) which is not directly equivalent to CFU • Results typically reported in 2–48 hours • Is useful for negative screening • May be preferred for evaluating whether remediation was successful	• Should be validated against a standard method by a third party (e.g., ISO/IEC 17025) • Should have equal or improved accuracy and precision compared to the standard method • May detect only a subset of *Legionella* species or serogroups • Results may be reported in hours or days • Results may be expressed in a variety of units or only qualitatively • May be useful for repeated measurements when quick turnaround time is preferred

Note: Test method may vary by the type of water system and the reason for testing.

Sample volumes processed, plate types, resuspension procedures, and result reporting vary by lab even when using standard operating procedures such as CDC methods or ISO 11731 from the International Organization of Standardization.

Test Results for WMP Performance

Results of *Legionella* testing alone do not provide a measure of health risk and are not predictive of disease. **There is no "safe" amount or type of *Legionella*.** Additional considerations for results are:

- Results indicate the presence of *Legionella* within the sample only, as there is variability across water systems.
- Sample handling, transport, and lab processing can affect results.
- Results have been interpreted based on concentration (e.g., CFU/mL), extent of colonization (e.g., % positive), and type of *Legionella* (e.g., *Legionella pneumophila* serogroup 1 vs other species, serogroups, or sequence types). **See Figure 1 for a multifactorial approach to interpreting *Legionella* test results as performance indicators.**
- The presence of any *Legionella* should trigger response activities (see "Suggested Response Activities").

Performance Indicators and Suggested Response for Routine *Legionella* Test Results

If test results are expressed in units other than CFU/mL, consult the testing laboratory or test manufacturer for appropriate result interpretation.

- If ≤1 CFU/mL for potable water or If ≤10 CFU/mL for cooling towers, *Legionella* growth appears well controlled
  - Continue Program
- If >1 CFU/mL for potable water or if >10 CFU/mL for cooling towers, conditions may allow for *Legionella* growth
  - Implement Suggested Response Activities
- If 10 to 100-fold increase for potable water or cooling towers, *Legionella* growth appears to be poorly controlled
  - Implement Suggested Response Activities
- If >100-fold increase, *Legionella* growth appears to be uncontrolled
  - Implement Suggested Response Activities

Suggested Response Activities

Suggested activities to be implemented when *Legionella* laboratory results are not indicative of well-controlled growth per performance indicators above:

1. Review sample collection, handling, and testing for potential errors.
2. Confirm that system equipment is in good working order and functioning as intended.
3. Review records to confirm that the WMP was implemented as designed (verification).
4. Review assumptions about operating conditions, such as physical and chemical characteristics of incoming water.
5. Re-evaluate fundamental aspects of the WMP, including analysis of hazardous conditions, cleaning, maintenance procedures, chemical treatment, and other aspects that could affect *Legionella* testing.
6. Adjust WMP as necessary to address any deficiencies identified.
7. Consider whether remedial treatment is needed only after completion of the above.
8. If remedial treatment was performed, wait at least 48 hours after the system returns to normal operating conditions and retest a set of representative samples to confirm the effectiveness of the response

If *Legionella* growth does not appear well controlled in healthcare facilities or facilities with populations at increased risk for Legionnaires' disease, consider implementing immediate control measures to protect people from exposure to water aerosols while implementing the guidance above. Note, if the root causes of *Legionella* growth are not identified and controlled, *Legionella* growth is likely to reoccur.

Whenever a case of disease is associated with a water system as determined by the public health AHJ, always:

- Review WMP verification and validation activities
  - Verification: Are the WMP activities occurring as intended?
  - Validation: Are the WMP activities working as intended and effective for *Legionella* control?
- Re-evaluate and revise WMP if needed

Resources

- Toolkit for Controlling *Legionella* in Common Sources of Exposure: https://www.cdc.gov/legionella/wmp/control-toolkit/index.html
- Toolkit: Developing a Water Management Program to Reduce *Legionella* Growth and Spread in Buildings: https://www.cdc.gov/legionella/wmp/toolkit/index.html
- *Legionella* Environmental Assessment Form: https://www.cdc.gov/legionella/downloads/legionella-environmental-assessment.pdf
- PreventLD Training: https://www.cdc.gov/nceh/ehs/elearn/prevent-LD-training.html
- ASHRAE Guideline 12-2020: https://www.ashrae.org/technical-resources/standards-and-guidelines/guidance-on-reducing-the-risk-of-legionella
- Sampling Procedure and Potential Sampling Sites: https://www.cdc.gov/legionella/downloads/cdc-sampling-procedure.pdf
- Immediate Control Measures for Healthcare Facilities: https://www.cdc.gov/legionella/health-depts/healthcare-resources/cases-outbreaks.html#measures-facilities

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Figure 1. Routine *Legionella* testing: A multifactorial approach to performance indicator interpretation*°Δ

Concentration indicates that *Legionella* growth appears:

Uncontrolled	Poorly Controlled	Well Controlled			
≥10 CFU/mL† in potable water **OR** ≥100 CFU/mL in non-potable water	1.0–9.9 CFU/mL in potable water **OR** 10–99 CFU/mL in non-potable water	Detectable to 0.9 CFU/mL in potable water **OR** Detectable to 9 CFU/mL in non-potable water	No *Legionella* detected in a single round of testing	No *Legionella* detected in multiple rounds of testing	No *Legionella* detected in multiple rounds of testing with methods that detect viable and non-viable bacteria of any *Legionella* species

Change in concentration over time indicates that *Legionella* growth appears:

Uncontrolled	Poorly Controlled	Well Controlled			
100-fold or greater increase in concentration (e.g., 0.05 to 5 CFU/mL)	10-fold increase in concentration (e.g., 0.05 to 0.5 CFU/mL)	*Legionella* concentration steady (e.g., 0.5 CFU/mL for two consecutive sampling rounds)	No *Legionella* detected in a single round of testing	No *Legionella* detected in multiple rounds of testing	No *Legionella* detected in multiple rounds of testing with methods that detect viable and non-viable bacteria of any *Legionella* species

Extent indicates that *Legionella* growth appears:

Uncontrolled	Poorly Controlled	Well Controlled			
Detection in multiple locations AND a common source location‡ **OR** Detection across many locations within a water system	Detection in a common source location that serves multiple areas **OR** Detection in more than one location within a water system	Detection in a few of many tested locations within a water system	No *Legionella* detected in a single round of testing	No *Legionella* detected in multiple rounds of testing	No *Legionella* detected in multiple rounds of testing with methods that detect viable and non-viable bacteria of any *Legionella* species

Type¥ of *Legionella* (species and serogroup) associated with Legionnaires' disease:

Highly Associated	Less Associated
L. pneumophila serogroup 1; Non-Lp1 *L. pneumophila*; Presence of multiple different *Legionella* species or serogroups	Any non-*pneumophila* *Legionella* species including "blue-white" fluorescent *Legionella*

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*This figure is intended for use during routine testing only. Test results are performance indicators and are not a measure of risk of human illness. This figure is not intended for use if a building or device is associated with Legionnaires' disease (LD) cases or an outbreak.

°See "Routine testing for *Legionella*" for guidance regarding suggested response activities. Comparable results may lead to different suggested response activities when other factors are considered (e.g., if there is evidence of poorly controlled growth at a healthcare facility).

ΔConsidering the type of *Legionella* identified along with other *Legionella* testing performance indicators provides a clearer picture of water system control than the results of any single indicator. For example, facility owners and operators may consider implementing immediate interventions for a healthcare facility with: A. detectable but <10 colony-forming units per milliliter (CFU/mL), B. non-Lp1 *Legionella pneumophila*, C. observed at steady concentrations, but D. detected at multiple distal locations including a central water heater.

†Concentrations expressed as CFU/mL are for test results generated by traditional spread plate culture methods. If other test methods are used, consult testing lab or manufacturer instructions for appropriate interpretation.

‡Common source location examples include water heaters, hot water returns, storage tanks, and cooling tower basins.

¥If a facility has a history of associated LD cases, then sequencing isolates obtained during routine testing may provide performance indicators regarding outbreak strain persistence (if that strain is detected).

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