

AWWA/IAPMO Manual-2022



Manual of Recommended Practice for:
**The Safe Closure and Reopening of
Building Water Systems**



American Water Works Association (AWWA)

The American Water Works Association is an international, nonprofit, scientific and educational association dedicated to providing total water solutions assuring the effective management of water. Founded in 1881, the Association is the largest organization of water professionals in the world.

AWWA's membership includes over 4,300 utilities that supply roughly 80 percent of the nation's drinking water and treat almost half of the nation's wastewater. Our approximately 50,000 members represent the full spectrum of the water community: public water and wastewater systems, environmental advocates, scientists, academicians, and others who hold a genuine interest in water, our most important resource.

AWWA also takes great pride in helping establish two preeminent organizations dedicated to safe water, the Water Research Foundation in 1966 and Water For People in 1991. AWWA unites the diverse water community to advance public health, safety, the economy, and the environment.

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Contents

Foreword and Purpose

Working Group Roster

1 Scope

- 1.1 Applicability
- 1.2 Building Water Systems
- 1.3 Occupancy Types
- 1.4 Terminology
- 1.5 Units of Measurement

2 Reference Publications

3 Definitions

- 3.1 Definitions

4 General Requirements

- 4.1 Water Management Program
- 4.2 Utility Coordination
- 4.3 Microbiological Testing
- 4.4 Legionella Testing

5 Potable Water System

- 5.1 General
- 5.2 Preparations
- 5.3 Flushing
- 5.4 Maintaining Building Water System - Periods of Low or No Water Use
- 5.5 Restoring Water Quality – After Period of Low or No Water Use
- 5.6 Managing Water System During Normal Occupancy

6 Nonpotable Water System

- 6.1 Normal Operation
- 6.2 Interruption of Normal Operation (System Shutdown Process)
- 6.3 Reopening of Nonpotable Water Systems

7 Mechanical Systems

- 7.1 Normal Operation, Cooling Towers
- 7.2 Water Treatment and Filtration Equipment, Cooling Towers
- 7.3 Interruption of Operation (System Shutdown)
- 7.4 Shutdown
- 7.5 System Reopening (Including Seasonal Startup)

Foreword and Purpose

As the world emerges from the COVID-19 pandemic, there will be countless studies that will consider where proactive efforts could have reduced the health and safety and the economic related impacts that resulted. Indeed, as a society we have learned a great deal and we will be better prepared for the next time we will need to respond to a similar threat on a global or regional scale, but only if we take the time to capture the best practices that are identified and put them into practice.

This Manual of Recommended Practice is intended to provide expert guidance on building water system safety. It provides sound and effective risk management practices for preparing water systems when buildings must be shut down or put into low use modes, “exercising” building water systems during periods of no or low use, and evaluating and preparing water systems for reopening.

While this document is developed as a guidance document, it is written in mandatory language so building and health departments can more easily appropriate and codify these requirements.

The contents of this Manual were verified and checked by a Working Group of experts in their respective fields. On top of a thorough review by the Working Group, the Manual also underwent a Peer Review process for any comments.

Disclaimer

This document is an informal guide and not a specification or standard. This guide offers information and options but does not contain all relevant engineering and administrative information necessary for its practice and application. Publication of this guide does not constitute endorsement of any method, advice, information, product, product type, service, or vendor. The use of this guide is entirely voluntary, and the user assumes all responsibility for use and application of the information in this guide. This guide does not supersede or take precedence over, displace, or supplement any law, regulation, or codes of any governmental authority, or any industry standard.

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AWWA/IAPMO Manual-2022

Manual of Recommended Practice for: The Safe Closure and Reopening of Building Water Systems

1 Scope

1.1 Applicability

This Manual shall apply to risk management practices for all potable and non-potable water supply systems during normal operation, when closing, during interruptions to normal operation, and when reopening building water systems in specific occupancy types. Section 4 shall apply to potable water systems, nonpotable water systems, and mechanical systems. Section 5 shall apply to potable water systems. Section 6 shall apply to nonpotable water systems. Section 7 shall apply to mechanical systems.

1.2 Building Water Systems

This Manual shall be applicable to building water systems (potable and nonpotable) for plumbing systems including the following:

- (1) Potable water systems
- (2) Non-potable water systems shall include, but not limited to, the following:
 - (a) Alternate water systems for outdoor use, or for indoor water use (dual plumbing systems)
 - (b) Utility supplied reclaimed water
 - (c) Rainwater catchment
 - (d) Gray water
 - (e) Landscape irrigation
 - (f) Decorative features
 - (g) Mechanical systems including cooling towers

1.3 Occupancy Types

This Manual shall be applicable to the following occupancies:

- (1) Non-residential (low- and high-rise)
 - (a) Office buildings
 - (b) Mercantile (seasonal retail)
 - (c) Schools/dormitories
 - (d) Hotels/motel
 - (e) Assembly
 - (f) Healthcare
- (2) Residential

Exception: one- and two-family occupancies

1.4 Terminology

In this Manual,

- (a) “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy to comply with the Standard;
- (b) “should” is used to express a recommendation, but not a requirement.

1.5 Units of Measurement

Inch/pound units are the primary units of record in global commerce. In this Manual, the inch/pound units are shown in parentheses. The values stated in each measurement system are equivalent in application, but each unit system is to be used independently. All references to gallons are to U.S. gallons.

2 Reference Publications

This Manual refers to the following publications and, where such reference is made, it shall be to the current edition of those publications, including all amendments published thereto.

American Water Works Association (AWWA)/International Association of Plumbing and Mechanical Officials (IAPMO)

Responding to Water Stagnation in Buildings with Reduced or No Water Use

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ANSI/ASHRAE 188

Legionellosis: Risk Management for Building Water Systems

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE Guideline 12

Minimizing the Risk of Legionellosis Associated with Building Water Systems

American Rainwater Catchment Systems Associations (ARCSA)/American Society of Plumbing Engineers (ASPE)

ARCSA/ASPE 63

Rainwater Catchment Systems

Code of Federal Regulations

Title 29, Part 1910

Occupational Safety and Health Standards

International Association of Plumbing and Mechanical Officials (IAPMO)

IAPMO/ANSI UPC-1

Uniform Plumbing Code

3 Definitions

3.1 Definitions

The following definitions shall apply in this Standard:

Authority Having Jurisdiction. As defined in the Uniform Plumbing Code (UPC): *The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, installations, or procedures. The Authority Having Jurisdiction shall be a federal, state, local, or other regional department or an individual such as a plumbing official, mechanical official, labor department official, health department official, building official, or others having statutory authority. In the absence of statutory authority, the Authority Having Jurisdiction may be some other responsible party. This definition shall include the Authority Having Jurisdiction's duly authorized representative.*

Building Water. Water collected, conveyed, circulated, stored, drained, or discharged by building plumbing systems for use in and around buildings.

Building Water Systems. As defined in ASHRAE 188: *Hot and cold potable water system and non-potable water system in the building, or on site.*

Disinfectant. As defined in ASHRAE 188: *Chemical agent or physical treatments used to kill or inactivate microorganism.*

Disinfectant residual. As defined in ASHRAE 188: *The net amount of a chemical disinfectant remaining in treated water after chemical demand exerted by the water is satisfied.*

Disinfection. As defined in ASHRAE 188: *The process of killing or inactivating pathogens.*

Flushing. The action of moving water through the plumbing to improve water quality. The purpose is to distribute fresh water throughout the building water supply system with water of a quality similar to what is supplied at the building inlet. This action moves fresh water from the city water supply through the building and moves hot water from the water heater or boiler to the point of use.

Interruption of Normal Operations (System Shut Down Process). The set of actions that should be taken to ready a building for an extended period of no or limited operations.

Legionella. As defined in ASHRAE 188: *The name of the genus of bacteria that can cause a pneumonia called Legionnaires' disease or a flu-like illness called Pontiac fever when inhaled, aspirated, or directly introduced into the lungs of susceptible individuals. Legionella are common aquatic bacteria found in natural and building water systems, as well as in some soils.*

Legionellosis. As defined in ASHRAE 188: *The term used to describe Legionnaires' disease, Pontiac fever, and any illness caused by exposure to Legionella bacteria.*

Monitoring. As defined in ASHRAE 188: *Conducting a planned sequence of observations or measurements of the physical and chemical characteristics of control measures.*

Normal Operations The state of a building water system when the building is open and being used as intended. This includes the normal hours of operation and the number of people that occupy the building.

Occupancy.

Normal Occupancy. The building is being used as intended. This includes periods of reduced occupancy and closure for less than two weeks.

Limited-Occupancy. When there is a reduction in the number of people using a facility, resulting in significantly reduced water use for at least two weeks.

Partial-Shutdown. When a portion of the building is not in use, and can result in no water use in that part of the building for at least two weeks.

Complete Shutdown. When the entire building is not in use, resulting in no water use in the building for at least two weeks.

Point of entry (POE). Where the water from the city enters a building. Some buildings may have more than one point of entry (e.g., hospitals and other healthcare facilities that may have at least two points of entry).

Point of use (POU). The location where water is used in the building (e.g., faucet or water closet).

Potable Water System. A building water distribution system that provides hot or cold water intended for direct or indirect human contact or consumption.

Plumbing System. Includes all potable water, alternate water sources, building supply, and distribution pipes; all plumbing fixtures and traps; all drainage and vent pipes; and all building drains and building sewers, including their respective joints and connections, devices, receptors, and appurtenances within the property lines of the premises and shall include potable water piping, potable water treating or using equipment, medical gas and medical vacuum systems, liquid and fuel gas piping, and water heaters and vents for same. [2018-UPC Section 218.0]

Process flow diagram. As defined in ASHRAE 188: *A step by step drawing of a building water system that includes the location of all water processing steps – including, but not limited to, conditioning, storing, heating, cooling, recirculation, and distribution – that are part of the building water system.*

Program Team. The group or individual designated by the building owner or designee to be responsible for developing, implementing, and maintaining the program. [ASHRAE 188:3]

Registered Design Professional. As defined in the Uniform Plumbing Code (UPC): *An individual who is registered or licensed by the laws of the state to perform such design work in the jurisdiction.*

Remedial Flushing. The action of replacing or replenishing the water in the plumbing network with a one-time intervention to end a stagnation period.

Responsible Party. The people who will conduct work and are accountable for building water system operations (e.g., building owner, tenant, management company, contractor/operator, etc.).

Risk. The potential to cause harm resulting from exposure.

Risk management. As defined in ASHRAE 188: *Systematic activities to reduce risk.*

Routine Flushing. The action of moving water through the plumbing that is implemented to improve or maintain water quality in the building on a regular basis.

Stagnation. When water in the water supply piping (e.g., domestic water) of a building, or other built water system, does not move, or moves very slowly, causing water quality to deteriorate. This may occur due to seasonal changes in the occupancy of the building, during construction of a section of a building, or due to other conditions where water does not move normally through the plumbing.

System Reopening. The set of actions that should be taken to ready a building for normal operations after an extended period of no or limited operations.

Water Management Program (WMP). A risk management program to help building managers identify risks to water quality, including Legionella, and establish clear guidelines for managing these risks at various points in the building lifecycle, including start-up, normal operation, under occupancy, water system shutdown, and water system restart. The water management program includes a written plan, a team, and a feedback and review process to keep the plan and program current and synchronized.

4 General Requirements

4.1 Water Management Program

4.1.1 Application

Where a water management program is in-place, it shall be reviewed prior to applying this manual. Where a water management program is not in place, a water management program shall be developed to include at a minimum the following elements as covered in this Manual:

- (1) A program team shall be identified.
- (2) The potable and non-potable building water systems shall be described, and process flow diagrams created.
- (3) An analysis of the building water systems, including all engineering controls, shall be conducted and documented. Risk analysis should be conducted with priority given to previously designated high risk devices, or those which pose higher risk to building occupants within the particular building being evaluated.
- (4) A detailed description of all building water systems described in Section 1.2.
- (5) Identification of all the physical, chemical, and biological risks to the building water systems.
- (6) Description or procedures associated with the normal operation, shutdown, maintenance, and start-up of building water systems.

Note: *Building water systems, including water supply and sanitary drainage, can present many additional risks to water quality and human health that warrant careful management of physical, chemical, and biological characteristics through a water management program.*

Managing water quality can also improve the performance of building water systems and extend the life of plumbing system. Managing water in building plumbing systems further requires understanding and monitoring the interaction between supply water and premise plumbing systems, compelling coordination with water providers to ensure building managers are aware of upstream risks that may impact building water quality.

4.2 Utility Coordination

Information shall be obtained about the specific disinfection and corrosion control chemicals being used in the supply water to the building from the water utility, including the following:

- (1) General water quality information
- (2) Type and level of disinfectant residual
- (3) Corrosion control chemicals added to the water
- (4) Distribution system maintenance near the building
- (5) Expected water quality changes

Note: *It is important to notify the water utility of any sensitive water quality parameters for the building or facility, and to review/develop the notification protocol for significant water quality changes.*

4.3 Microbiological Testing

Microbiological testing shall be conducted by an accredited laboratory in accordance with the Authority Having Jurisdiction.

4.4 Legionella Testing

Legionella culture and qPCR testing shall be conducted by an accredited laboratory in accordance with the Authority Having Jurisdiction. *Legionella* testing may also be conducted on-site using a method validated by a third party to a nationally or internationally recognized standard.

4.4.1 Laboratory Testing

Laboratory testing should utilize a culture testing as the default methodology. However, in some instances, particularly when results need to be given more quickly, other methodologies such as qPCR may be considered, usually in conjunction with culture methods. The laboratory should be contacted to determine if the limit of detection (LOD) of the test method used is appropriate for the user's needs. The LOD may be for different processing methods and different water types (potable, non-potable, and mechanical systems) used by the laboratory. The Authority Having Jurisdiction should be consulted for the method LOD allowable by the Authority Having Jurisdiction. Samples determined to be positive for Legionella are defined as those containing at least 1 Colony Forming Unit per milliliter or 1 Most Probable Number per milliliter (CFU/mL or MPN/mL) greater than the limit of detection.

4.4.1.1 Culture Testing

Legionella culture testing shall be conducted by a laboratory:

- (1) Accredited to ISO/IEC 17025, "*General requirements for the competence of testing and calibration laboratories,*" or equivalent.
- (2) Using a culture method that conforms to ISO 11731, "*Water Quality — Enumeration of Legionella,*" or equivalent.

4.4.1.2 qPCR Testing

Legionella pneumophila qPCR testing shall be conducted by a laboratory:

- (1) Accredited to ISO/IEC 17025, “*General requirements for the competence of testing and calibration laboratories,*” or equivalent.

4.4.2 Rapid Testing Devices

Rapid testing devices, when utilized, shall be conducted on-site by equipment that is approved by the Authority Having Jurisdiction where the AHJ requires approval.

4.4.3 Legionella Testing

It is recommended to test at a minimum for all serogroups of Legionella pneumophila.

5 Potable Water Systems

5.1 General

5.1.1 Scope

This section focuses on potable water plumbing systems inside larger buildings and building campuses with complex plumbing. Refer to AWWA/IAPMO *Responding to Stagnation in Buildings with Reduced or No Water Use*, for additional guidance. Based on the outcome of the building survey and risk assessment, each building may require unique actions based on its plumbing systems, use patterns, and source of water supply. Buildings that have a WMP shall be exempt from these requirements. This section applies to, but is not limited to, the following occupancies:

- (1) Hotels, motels, and or other similar short-term stay, multi-room buildings.
- (2) Multi-family buildings of any height that have a central water heating system that delivers hot water to the units using circulation loops or heat traced supply piping. (e.g., condominiums, townhouses, apartments, etc.).
- (3) Office buildings and other facilities of any height that have a central water heating system that delivers hot water using circulation loops or heat traced supply piping.
- (4) K-12 schools and university dormitory and classroom buildings.
- (5) Industrial facilities and campuses with shared hot and cold-water supplies.
- (6) Healthcare, hospital, and long-term care facilities or other facilities with a higher risk level.

Responsible parties shall utilize Section 5.1, Section 5.2, and Section 5.3 to make the determination of whether to maintain the water systems during periods of low or no use (Section 5.4) or to restore the water systems after the periods of low or no use have ended (Section 5.5). They shall also use these three sections to determine how to manage the water systems after the building has been returned to normal occupancy (Section 5.6). Responsible parties shall refer to Figure 5.1.1 in accordance with the requirements of this Manual.

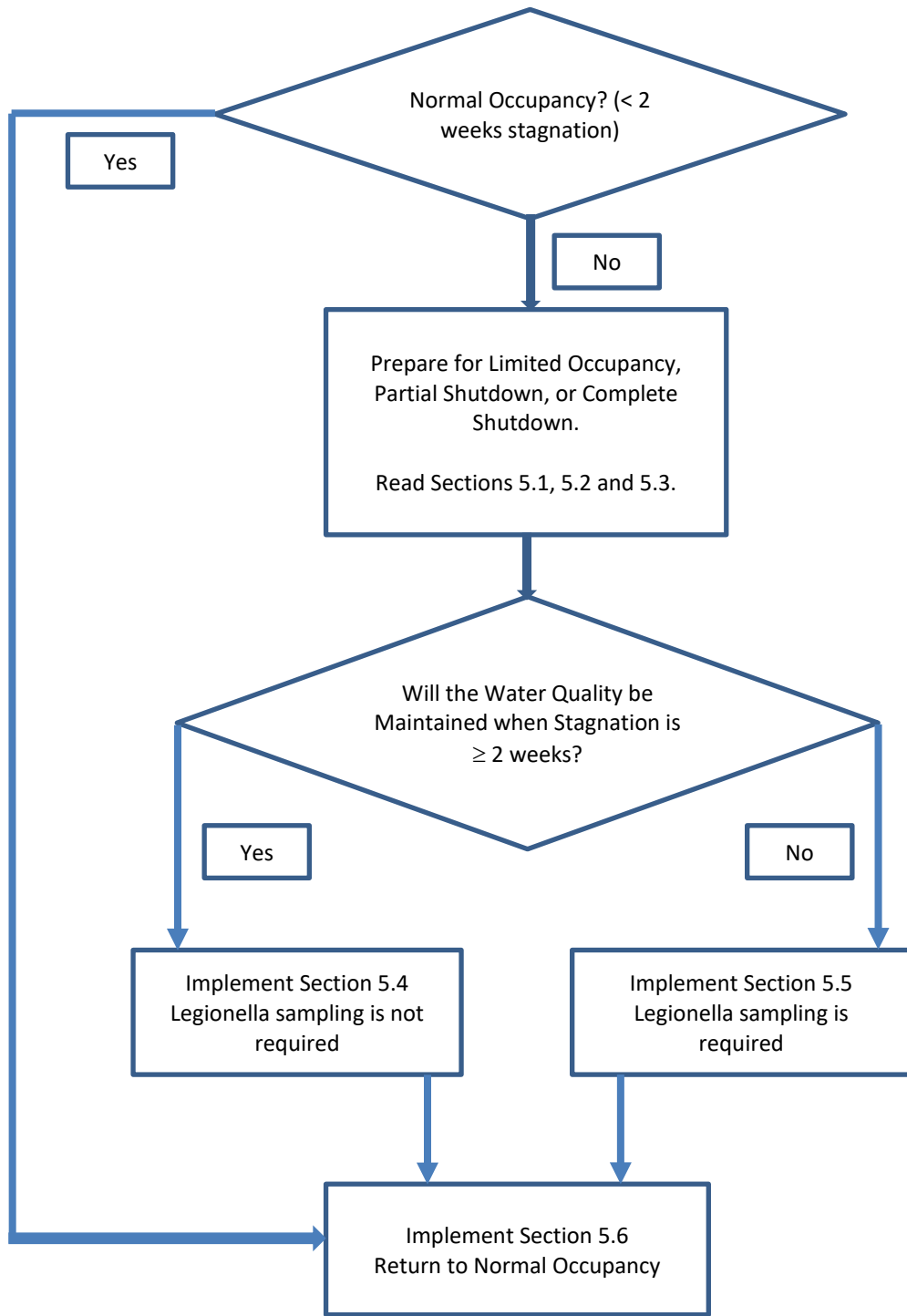


Figure 5.1.1
Potable Water Systems Flow Chart

5.1.2 Occupancy Status and Duration of Stagnation

Table 5.1.2 compares the open or closed status of the building to the duration of stagnation. Responsible parties shall use Table 5.1.2 to assist in their determination of risks and the steps they will take to address them.

Table 5.1.2
Occupancy Status and Duration of Water Stagnation

Open/Closed Status	<2 Weeks Stagnant	≥2 Weeks Stagnant
Normal	Normal Occupancy	N/A
Not Normal	Normal Occupancy	Limited Occupancy
Partially Closed	Normal Occupancy	Partial Shutdown
Completely Closed	Normal Occupancy	Complete Shutdown

5.2 Preparations

5.2.1 Communication

Building owners/operators shall work with the proper internal and external building operations individuals to assess risks and determining appropriate responses. These might be the same persons listed on the WMP Program Team. Depending on the building and based on the knowledge of the owner/operator, individuals that shall be helpful in development of the flushing plan include the following:

- (1) **Custodial managers and staff.**
- (2) **Contractors and consultants with on-site knowledge.** Persons who typically support building operations or staff activities in operating or maintaining the potable water system (e.g., mechanical systems contractors, professional plumbers, consulting engineers).
- (3) **Additional contractors.** Contractors or consultants that specialize in building water management or environmental monitoring. These contractors assist in developing a plan, providing professional expertise to review remedial activities, and guiding the building team to meet potential regulatory requirements.
- (4) **Regulatory or compliance entities.** Authorities with jurisdiction over various aspects of building operations (e.g., environmental health and safety officers, code enforcement officials, and the local health department agency).
- (5) **Occupants.** Communicate to all tenants, users, and staff what actions will be taken by the building management to maintain water quality during limited occupancy conditions. Enlist their assistance in reporting any issues that they notice with the water.
- (6) **Install proper signage and communications.** Upon the onset of periods of low or no water use, install proper signage throughout the building at all water taps to indicate the procedures being taken to protect water quality and public health. The building owner/operator shall consider all available forms of communication available to them (e.g., local signage, electronic mail, electronic messaging systems, web pages) that allow information to be conveyed to building occupants whether they are in the building or not.

5.2.2 Water Quality and Risk Concepts and Knowing the System

Treated drinking water is provided to buildings by their water purveyor (usually the city). Even though the water is treated, it is not sterile. Water purveyors typically treat water near the source and then add a secondary disinfectant, chlorine, or chloramine, to prevent the growth or regrowth of bacteria in the distribution system. Once water enters a building, this secondary disinfectant dissipates. Additionally, if water temperatures also increase, an environment for potentially harmful bacteria to grow can be created. The following are things to consider when assessing the risk in the building:

- (1) **Time without secondary disinfectant residual.** Long periods of stagnation in building water systems reduce drinking water secondary disinfectant levels and low disinfectant levels can allow *Legionella* and/or other opportunistic pathogens to grow.
- (2) **Environmental conditions.** Microbial disease risk increases due to the potential of some pathogens (such as *Legionella*) to replicate under favorable environmental conditions including temperature and nutrients in the water.
- (3) **Inhalation exposure pathway.** Microbial risk to people in building water systems can be through inhalation (as from *Legionella*) but can also include other pathogens and exposure pathways. Inhalation risks can occur whenever water is aerosolized, such as from showers, water misters/foggers, and many other uses that significantly increase humidity and/or cause airborne water droplets/mist.

Methods described in this Manual are provided as tools for the responsible party to improve potable water plumbing system disinfectant residuals, maintain proper water temperature (both hot and cold), reduce water stagnation, and thereby reduce the risk from many opportunistic pathogens that shall regrow in building water systems and cause infection. For additional information, see Section 2.

5.2.3 Equipment

Responsible parties shall obtain the equipment needed to measure and document the water quality in their building(s).

- (1) **Notebook/Logbook.** All actions taken to maintain water quality shall be documented. This shall include chlorine and temperature monitoring results, and any other actions taken to maintain water quality.
- (2) **Digital chlorine residual analyzer.** Chlorine analyzers shall be required to monitor the level of disinfectant inside the building.
 - (a) When measuring disinfectant residuals, it is necessary to measure free chlorine for buildings supplied with water with a free chlorine residual and total chlorine for buildings supplied with chloramine residual.
 - (b) USEPA-accepted field test methods (shall be used as part of this guidance) are colorimetric based using N, N-diethyl-p-phenylenediamine (DPD) reagents. Digital DPD-based meters are available that provide rapid and consistent analytical results. The manufacturer's directions for the DPD meter used shall be carefully reviewed with the staff responsible for completing disinfectant residual measurements prior to testing. Based on whether the building water system has chlorine or chloramine select from the following:
 - i. "Total" chlorine analyzer instruments/kits are used to measure for either free chlorine residual or chloramine residual.
 - ii. "Free" chlorine analyzer instruments/kits are used to measure free chlorine residual (it will not detect chloramine residual).
 - (c) Test strips for chlorine residual are not sufficiently accurate for the tasks described in this document.

- (3) **Digital thermometer.** A digital thermometer with rapid response shall be used for accurate documentation of temperature while complying with the time of flushing required to achieve target water temperatures.
- (4) **Sampling supplies.** If collecting samples, including for testing Legionella, the following documentation, and supplies shall be provided:
 - (a) Chain of custody
 - (b) Bottles
 - (c) Ice
 - (d) Cooler
 - (e) Any additional equipment needed by the Legionella testing laboratory.
- (5) **Provide appropriate personal protective equipment (PPE).** In addition to any business-or situation- specific PPE (e.g., pandemic-related guidance), responsible parties shall determine what additional PPE is necessary for tasks described in this Section. The activities include working within enclosed spaces, working with hot/scalding water, and generation of aerosols that pose a health risk. Relevant PPE shall include:
 - (a) Safety glasses
 - (b) Gloves (e.g., when scald or burn risks are present)
 - (c) N-95 respirators with appropriate medical clearance, fit-testing, and training. PPE (29 CFR 1910.132) and Respiratory Protection (29 CFR 1910.134) standards apply. Additional local requirements that are identified by Occupational Safety and Health Administration (OSHA) or health and safety officers.
 - (d) Alternative water supply (workers shall not consume water that is being flushed).
 - (e) Training in the proper use of provided PPE.

5.2.4 Water Supply

Responsible parties shall understand the water supply coming into their building(s). Responsible parties shall:

- (1) Determine how much water their building uses under conditions of normal occupancy. This includes weekdays, weekends, holidays, etc., whatever is normal. Begin this determination by analyzing the billing records from the water supplier. Augment the data obtained from the billing records as needed to better understand shorter periods of time.
- (2) Ask the water supplier:
 - (a) If more frequent water usage data are available to assist with the understanding of water usage.
 - (b) What type of disinfectant is being used, typically either free chlorine or chloramine.
 - (c) What the typical disinfectant residual (or goal) is in the portion of the water delivery system that supplies the building for all four seasons of the year.
 - (d) How to learn when changes to the levels and types of disinfectant are made.
 - (e) How to learn when flushing activities in the portion of the water delivery system that supplies the building are planned or underway.
- (3) Measure the disinfectant residual at the POE to the building.
 - (a) If the disinfectant residual levels are low or not-detectable (approximately <0.05 mg/L of either free chlorine or total chlorine), ask the water supplier if it is possible to increase the disinfectant residual in the portion of the water delivery system that supplies the building.
- (4) Stay informed regarding any announcements from the local water utility/supplier (e.g., boil water orders, do not use orders, and other notifications regarding water quality).

- (5) Understand if their building(s) are using on-site water treatment (adding supplemental disinfectant, adding corrosion scale inhibitors, etc.).
 - (a) Consider specific impacts to their building(s) due to the on-site treatment.
 - (b) Determine how to apply the procedures in this Section to their facility.

Note: *Nearly all buildings have water meters owned and monitored by water suppliers that track total water usage. Billing for water service is typically based upon the amount of water used in a month or quarter. The type and level of disinfectant (free chlorine or chloramine), vary in the portion of the water delivery system that supplies your building(s) seasonally or due to other factors. These changes will impact building operations (e.g., a change in disinfectant measurement equipment/supplies will be needed). Periodically, the water supplier flushes all or portions of the water delivery system. Like flushing in a building, flushing distribution system main pipelines is used to improve water quality. It can also affect the water quality that is supplied to your building(s).*

5.2.5 Water Quality

The provisions in this section shall be implemented as part of Section 5.4, Section 5.5, and Section 5.6.

- (1) **Scheduling and Frequency of Sampling.** Water quality samples shall be obtained before, during, and after flushing activities.
- (2) **Minimum Water Quality Parameters to be Monitored.** Sampling shall take place to characterize both cold and hot water depending on the sample being analyzed, as follows:
 - (a) Disinfectant residual: Cold water (and possibly hot water, see below).
 - (b) Temperature: Cold and hot water.
 - (c) Legionella: Depends on location, but may include hot water (or warmed water, such as at the temperature that is normally used during operating a shower).
- (3) **Procedure for Monitoring Water Quality.** Conduct an initial assessment of disinfectant residuals and water temperatures. The water usage and occupancy levels at the time shall be documented. The purpose of this initial assessment is to identify several critical locations representative of both worst case and best-case disinfectant residuals and water temperatures that can be used in the future to determine the effectiveness of temperature set-points and flushing. Consider repeating this type of assessment in different seasons and for different levels of occupancy.
 - (a) Critical control sampling locations for disinfectant residuals, water temperature and Legionella include:
 - i. **Worst and Best Cases.** Identify several critical sampling locations that represent both worst case and best-case conditions for the different parameters. Some of these control sampling sites may differ for the three different parameters.
 - ii. **High risk locations.** These are sites where water is used by people that have greater risk for contracting an infection, such as those with increased age or compromised immune systems. Legionella exposure is influenced by fixtures and devices that are known to aerosolize water. These include showers, misters, and foggers.
 - iii. **Hot and Cold Water.** Measurements shall include hot and cold-water locations.
 - (b) Disinfectant residuals.
 - i. Conduct an initial assessment of disinfectant residuals throughout the building:
 - (1) Measure and record incoming disinfectant residual at the POE.
 - (2) Measure and record disinfectant residual at locations entering the hot water system after the water heater, and in recirculating systems.
 - (3) Measure and record disinfectant residual at hot and cold water sites throughout the building. Include sites that are hydraulically distant from the POE.

- ii. This data shall be used to identify and select critical control sampling locations that reflect locations in the plumbing system that have the lowest disinfectant residual and any other key locations (e.g., sites that are tied to microbial sampling).
 - iii. Repeat measurement of disinfectant residuals at these disinfectant-based critical control sampling locations frequently enough to understand variations resulting from changing occupancy and usage. All monitoring results shall be recorded and reviewed.
 - iv. After flushing, measure, and record disinfectant residual at the disinfectant-based critical control sampling locations.
- (c) Cold and hot water temperatures.
- i. Conduct an initial temperature assessment of hot and cold water throughout the building.
 - (1) Measure and record incoming cold-water temperature at the POE.
 - (2) Measure and record water temperature at locations entering the hot water system after the water heater, and in recirculating systems.
 - (3) Measure and record water temperature at the critical control locations selected based on disinfectant residual.
 - (4) Measure and record cold and hot water temperatures at all taps that are flushed for both cold and hot water (this does not include where end-use devices are installed such as water closets, urinals, ice machines, or other mechanical equipment) and after flushing at critical control locations.
 - ii. If needed, modify the list of critical control sampling locations based on the results of the temperature assessment.
 - iii. Repeat temperature measurements at these temperature-based critical control sampling locations frequently enough to understand variations resulting from changing occupancy and usage. All monitoring results shall be recorded and reviewed.
 - iv. After flushing, measure and record temperature at the temperature-based critical control sampling locations.
- (d) Legionella.
- i. (Optional) Collect water samples to test for Legionella after flushing has been completed and disinfectant residual and water temperature levels are acceptable. Sampling for Legionella is optional when following Section 5.4. When following Section 5.5, sampling for Legionella is required and should be conducted within two weeks of returning the building water system to normal usage.
 - (1) When choosing a lab, ensure that the lab is accredited to perform Legionella analyses and that the method of testing for Legionella is included in the laboratory's scope of accreditation.
Note: *It is recommended that culture-based samples are analyzed by a laboratory accredited or National Environmental Laboratory Accreditation (NELAC) Institute (<https://lams.nelac-institute.org/>) or in accordance with ISO/IEC 17025.*
 - ii. As part of the WMP development, sampling sites for testing of Legionella shall be identified. The number and location of sites will depend upon both the vulnerability of building users and upon degree of building plumbing risks. Ideally, some Legionella sampling sites shall overlap with disinfectant residual and temperature sampling sites.
 - iii. Collect and test water samples at least once per year. Initial monitoring shall be done more frequently to establish a baseline of results. (Remember to measure and

record both disinfectant residual levels and water temperatures with each Legionella test sample and record these results).

Note: Legionella testing results shall reflect both the concentration of organisms at individual sites and may show organism detections at a few or many sample locations. Refer to Table 5.2.5 for recommended actions required based on US CDC guidance.

Table 5.2.5
Legionella Testing Criteria

Legionella CFU/Liter	Action Required
Not Detected	Acceptable – continue monitoring
< 100 to 1,000	Refer to responsible person and assure water quality values are within target
> 1,000 to < 10,000	<ul style="list-style-type: none"> i) Resample if small percentage (10-20%) are positive; review control measures ii) If >20% positive may indicate low level colonization, disinfection of system, and risk assessment to determine additional actions
≥ 10,000	Resample, immediate review of control measures, disinfection of whole system

Source: EU (2017).

The EU guidelines emphasize the goal to achieve no cultural *Legionella*, but acknowledge that occasional detection (<20%) of low levels of *Legionella* (< 1,000 CFU/L) may be acceptable provided that other water quality values (e.g., temperature, disinfectant) and operational parameters are within the water management plan guidelines. Intermediate levels (> 1,000 to < 10,000 CFU/L) and high levels (≥ 10,000 CFU/L) trigger a series of actions including resampling, remedial measures such as disinfection, and overall review of the water management plan program.

Note: Test results may be expressed in CFU/mL or MPN/mL, consult the testing laboratory or test manufacturer for the appropriate interpretation of results.

5.3 Flushing

5.3.1 Manage Risk Related to Flushing

The provisions in this section shall be implemented as part of Section 5.4, Section 5.5, and Section 5.6.

- (1) Flushing activities have several considerations, including managing potential health risks to workers and building occupants during flushing:
 - (a) Scald risk: Exposure to high water temperatures; outlets with water >130°F pose a risk for scalding.
 - (b) Inhalation risk: Exposure to aerosols generated during flushing activities; outlets that generate the most aerosols (e.g., showerheads, sprayer attachments, urinals, flushometer water closets, etc.) and outlets that have low flow or tempered water

- <120°F (e.g., outlets with low flow aerators, point of use thermostatic mixing valves) pose the highest risk for exposure to pathogens that grow in stagnated conditions.
- (c) Ingestion risk: Exposure to metals outlets that are used for drinking and food preparation have the highest potential for exposure to metal.
 - (d) Electrocuting risk: releasing large volumes of water within a building in spaces that also have electrical wiring poses the risk of electric shock.
 - (e) Risks associated with confined space entry.
- (2) There is less potential for exposure for building occupants if flushing shall occur when the building is not occupied. The following are measures that shall be taken to manage risks to workers. Note that these measures assist in risk management, but do not provide risk elimination.
- (a) Implement engineering controls. A specific concern is exposure of workers to aerosols that contain pathogens such as Legionella. This is especially a concern during flushing and in enclosed spaces with inadequate ventilation. Controls include:
 - i. Fill water drain and vent systems with water by slowly pouring water down the drain of all outlets and floor drains prior to increasing ventilation
 - ii. Increase HVAC system outdoor air make-up during major flushing activities (**Note: fill drain traps first**)
 - iii. Turn on vent fans, close windows and eliminate the use of other devices that might stir up air (**Note: fill drain traps first**)
 - iv. Remove aerators, showerheads, and other sprayer devices that create aerosols during flushing activities (**Note: if removed, they need to be cleaned, rinsed, and replaced after flushing. Special tools are required to remove some aerators.**)
 - v. Take steps to reduce aerosol generation during flushing activities appropriate to the outlet while maintaining flushing flow rates. Measures used shall not create backflow hazards. Use of dedicated equipment and adequate cleaning between uses reduces potential for inadvertent contamination of outlets.
 - (b) **Implement Administrative controls.** This pertains to adhering to state and federal worker safety regulations. Overall, periodically reviewing safety procedures with workers is a useful strategy to assess exposures and revise procedures to reduce risks, as necessary. “After action” debriefings shall also be used to collect information to improve the safety and efficiency of flushing procedures. In general, the following processes shall be in place, along with other potential local safety requirements or regulations that impact the building:
 - i. Inform workers of potential health risks.
 - ii. Describe how workers are exposed to those risks during flushing activities, including advising workers not to drink the water from their flushing activities.
 - iii. Encourage workers to discuss their personal risk factors and if they shall engage in flushing related tasks with a medical professional prior to engaging in this activity.
 - iv. Provide relevant training, personal protective equipment (PPE), and implement practices to reduce exposure.

5.3.2 Develop a Flushing Plan

A flushing plan shall be established that includes the following:

- (1) Developing an effective flushing plan requires the owner/operator to:
 - (a) Understand the building water system(s) plumbing and affiliated plumbing devices.
 - (b) Recognize which portions of the water system are impacted by low use or no use conditions.
 - (c) Be prepared to refresh the stagnant and inoperative systems while not harming building components or end use devices and without harming the building occupants.
- (2) Identify and locate key system locations such as:
 - (a) All water service lines from the municipal water supply to a building point of entry.
 - (b) Water storage tanks (e.g., water heaters, pressure tanks).
 - (c) Mechanical equipment supplied by potable water.
 - (d) Devices in the building water system (e.g., backflow preventers, filters, disinfection systems, water softeners, etc.).
- (3) Review the potable water plumbing design with maintenance and management personnel. Consult as-built drawings if available. If as-built drawings are not available, then consult construction drawings. If no drawings are available, conduct a site survey to determine the design. Conduct a limited site survey to confirm the teams understanding of any drawings.
 - (a) Identify POE devices (e.g., strainers) to conduct service line flushing.
 - (b) Identify cold and hot water supply pipes including mains, branches, risers, and manifolds (headers).
 - (c) Identify outlets furthest away from the point of entry (the longest plumbing runs).
 - (d) Separate outlets into different service “zones,” (e.g., systems, risers, floors) organized by proximity to the source(s) of water supply to that zone.
 - (e) Identify locations at which plumbing is to be flushed efficiently (e.g., service sinks, riser drains, hot water return pipes, industrial kitchen faucets, water closets, etc.).
 - (f) Identify drain locations for flushed water capable of accepting anticipated flows without creating a backflow or flooding hazard.
 - (g) Reconcile available drawings with staff knowledge and experience.
- (4) Specialty devices plumbed into the building water system (e.g., ice/coffee/soda machines, drinking fountains, dishwashers, eye-wash stations, safety showers, medical equipment, salon chairs, or other devices serviced by potable water) shall be identified, located, and organized by zones.
- (5) Establish protocols to prevent:
 - (a) Water hammer (e.g., slowly opening and closing valves during flushing activities)
 - (b) Back-siphonage
 - (c) Flooding
- (6) Confirm the critical control sampling locations identified in Section 5.2.5 that will be used to assess the effectiveness of flushing.

Note: *Building managers must evaluate the water use and occupancy patterns of their buildings, health risks, and the resources available to design an appropriate flushing plan. The amount of flushing necessary to prevent water quality issues will vary by building.*

5.3.3 Flushing the System

Flushing shall be conducted from the entry points to the points of use at the hydraulic extremities of the building. The purpose of flushing is to bring in fresh water from the municipal supply pipe to the POE, from the POE through the building to the POU locations, and then through any end-use devices. This allows disinfectant and corrosion inhibitors from the city water supply to flow through the building's plumbing.

5.3.3.1 Flushing Protocol

The following flushing protocol shall be implemented:

- (1) Measure water quality prior to flushing. Work with water purveyor to flush hydrants if necessary.
- (2) Flush the service main to the point(s) of entry (POE) to obtain representative temperature and disinfectant residual entering the building.
- (3) Flush mechanical room cold water mains.
- (4) Flush mechanical room potable service water heating equipment and piping.
- (5) Flush all end points throughout the building:
 - (a) Cold water (first)
 - i. until temperatures at all POU locations are similar to that entering the building.
 - ii. until disinfectant residual at all cold water POU locations are similar to that entering the building.
 - (b) Hot water
 - i. until temperatures at all POU locations reach operating setpoints.
 - ii. obtain disinfectant residual at all hot water POU locations to be similar to where they start in the service water heating system.
 - (c) Ensure that all other end-use devices are brought on-line and flushed after the building has fresh water.
- (6) Water discoloration that occurs due to flushing. If discoloration appears, flush until the water runs clear.
- (7) Consider automating flushing at key locations.
- (8) Where possible, consider bypassing mixing valves to increase flow rates during flushing.
- (9) Water quality shall be assessed in accordance with Section 5.2.5.

Note: *The goal of flushing is for the cold-water disinfectant levels at the POU to be at least 80 percent of the incoming disinfectant at the POE. Lower percentages are indicative of something in the building's water distribution system that is reacting with the disinfectant and needs to be addressed.*

5.4 Maintaining Building Water Systems - Periods of Low or No Water Use

5.4.1 Application

Where the decision has been made to maintain water quality during periods of limited occupancy, partial shutdown and complete shutdown, responsible parties shall follow the WMP or implement the provisions of Section 5.4.

The key to maintaining safe, good water quality in the building's plumbing systems is to create water flow (replace water within the building plumbing with fresh water from the water supplier) to maintain sufficient disinfectant residuals and proper water temperatures to prevent the growth of microbial pathogens. Consistent water flows in the building plumbing shall be maintained to prevent plumbing material corrosion caused by variable water quality conditions in accordance with the following:

- (1) The water quality of the building water system shall be maintained during periods of limited occupancy and partial shutdown.
- (2) It is permissible to maintain the water quality of the building water system during periods of complete shutdown.
- (3) Where the building water systems have not been maintained during periods of limited occupancy, partial shutdown and complete shutdown, responsible parties shall implement the provisions in Section 5.5.

5.4.2 Preparation for Maintaining System

Where a water quality baseline has not yet been established, conduct an initial assessment in accordance with the procedures in Section 5.2.5.

5.4.3 Preparation for Maintaining System

The following actions shall be taken during system maintenance:

- (1) Signage and Communications. Post signs indicating the status of the system as being maintained. If building or portion of building is shut down, provide additional signage indicating this status and that water shall not be used.
- (2) Records & Documentation. All actions taken to maintain water quality in the building shall be documented. All disinfectant residual, water usage, and temperature measurements shall be recorded and saved.
- (3) Maintenance Flushing. Conduct flushing activities in accordance with Section 5.3.
- (4) Water Quality Sampling. Conduct water quality sampling activities in accordance with Section 5.2.5. Legionella testing is not required but recommended.

5.4.4 Returning to Service-After System Maintenance

The following shall be implemented when returning to service:

- (1) Before returning a building to service, the following conditions shall be achieved:
 - (a) Cold-water disinfectant residual levels at the POU shall be at least 80 percent of the incoming disinfectant residual at the POE.
 - (b) Cold-water temperatures at the POU shall be similar to the water temperature at the POE.
 - (c) Hot water temperatures measured at the POU shall reach operating setpoints. Where applicable, thermal mixing valves shall be adjusted to reach these setpoints.
 - (d) (Optional) Legionella test results shall meet the conditions referenced in Section 5.2.5.
- (2) Post signage that states the building water systems are ready for use.

- (3) Responsible parties shall implement Section 5.6.1(5) activities to ensure that water does not stagnate prior to occupancy.
- (4) After the building has been returned to service, responsible parties shall check in with occupants over the next several weeks to determine if problems have been identified and shall address those that have arisen.

5.5 Restoring Water Quality – After Period of Low or No Water Use

5.5.1 Application

Where the decision has been made not to maintain water quality during periods of limited occupancy, partial shutdown and complete shutdown, responsible parties shall follow the WMP or implement the provisions of Section 5.5.

5.5.2 Actions During Complete Shutdown

Actions during complete shutdown shall be in accordance with the following:

- (1) **Signage and Communications.** Post signs stating the building water system has been shut down and that water shall not be used. Where possible, include an estimate of the expected duration of the shutdown period.
 - (a) Occupants or visitors that come into building shall be prohibited from using or engaging with the building water systems.
 - (b) Maintenance personnel shall wear PPE when engaging with the building water system.
- (2) **Records & Documentation.** Document all actions taken to shut down the building water system.
- (3) **Water treatment devices.** The responsible parties shall:
 - (a) Understand the operational requirements of any treatment devices in their building during no use periods. Water treatments include dosing a liquid or dry chemical for disinfection or corrosion control, operating a passive treatment conditioning device such as a copper-silver system or a water softener, etc.
 - (b) Where these devices will be operating a rate below their recommended treatment capacities either adjust their operation accordingly or shut them down.
- (4) **Water heating system.** Where the duration of the downtime for the potable water supply is expected to be extensive the responsible parties shall consider turning off the water heating equipment including the circulation pumps and controls.
- (5) **Drain the potable water system.** Where the duration of the downtime for the potable water supply is expected to be extensive the responsible parties shall consider completely draining the water from the cold and hot water systems.
- (6) **Other devices connected to the potable water.** These devices include water storage tanks, pressure and expansion tanks, treatment devices, pools/spas/hot tubs and related features, decorative features, safety devices (eyewash, shower), hot water tempering devices, showerheads, ice machines, bottle filling devices, water drinking stations, secondary/under-the-sink water heaters, drink/coffee/tea machines, etc. The responsible parties shall:
 - (a) Follow manufacturer recommendations concerning long periods of no use.
 - (b) Post signage that water is shut until further notice for all equipment that is taken off-line.

5.5.3 Restoring the System

The actions in this section shall occur toward the end of the low/no use period and prior to returning the building to normal operations. The responsible parties shall:

- (1) Refill. Where the building water systems have been drained, refill them with water.

- (2) Conduct Remedial Flushing. Remedial flushing shall be conducted in accordance with Section 5.3 and the following:
 - (a) Flush all water heaters primary and secondary.
 - (b) Flush all devices that are part of the building water distribution systems.
 - (c) Where applicable, disinfect the building water system in accordance with local codes.
- (3) Restore Operations. In the appropriate sequence per manufacturer instructions, re-start all primary potable water mechanical equipment, treatment devices, storage tanks, and pressure and expansion tanks and water heating systems.
- (4) POU Devices. Clean and disinfect all end point devices after water sampling has verified that the flushing is complete. Restart these devices.
- (5) Water Quality Sampling. Conduct water quality sampling activities in accordance with Section 5.2.5. Legionella testing is required.
- (6) Signage and Communications. Post new signage indicating the status of the system is being restored. Include an estimated timeline for restoring the system and state that 'ready for use' signage will be installed when appropriate.

Note: *The purpose of remedial flushing is to refresh the building water system and transition the potable water pipelines from off-line or stagnant conditions to fresh water with the proper disinfectant residual level and temperature. It is likely that remedial flushing will take longer than routine flushing because the water will have been sitting stagnant (or plumbing will have been sitting empty/drained) for an extended period.*

5.5.4 Returning to Service After Restoring the System

- (1) Before returning a building to service, the following conditions shall be achieved:
 - (a) Cold-water disinfectant residual levels at the POU shall be at least 80 percent of the incoming disinfectant residual at the POE.
 - (b) Cold-water temperatures at the POU shall be similar to the water temperature at the POE.
 - (c) Hot water temperatures measured at the POU shall reach operating setpoints. Where applicable, thermal mixing valves shall be adjusted to reach these setpoints.
 - (d) Legionella test results, shall meet the conditions referenced in Section 5.2.5.
- (2) Responsible parties shall implement Section 5.6.1(5) activities to ensure that water does not stagnate prior to occupancy.
- (3) Post signage that states the building water systems are ready for use.
- (4) After the building has been returned to service, responsible parties shall check in with occupants over the next several weeks to determine if problems have been identified and shall address those that have arisen.

5.6 Managing Water System During Normal Occupancy

5.6.1 Returning to Normal Occupancy

After the building is returned to normal occupancy, the responsible parties shall:

- (1) Create a WMP for the potable water systems in accordance with Section 4.
- (2) Establish a new baseline once the building has been reopened. Conduct an initial assessment of disinfection residuals and water temperatures from the water supplier point(s) of entry and at the critical control sampling locations identified in Section 5.2.5 after the building has returned to normal occupancy and water usage. Water usage and occupancy levels shall be recorded during this assessment.
- (3) Monitor and record total water use and occupancy levels on a regular basis either monthly or more frequently. Daily monitoring is recommended to better understand daily fluctuations and enables owners to identify leaks or constantly running fixtures.
- (4) Monitor and record water quality in accordance with Section 5.2.5.
- (5) Manage water system stagnation
 - (a) Implement routine outlet flushing.
 - (b) Guide the frequency and duration of routine flushing by reduction of potable water stagnation that results in adequate disinfectant residual, hot and cold-water temperature, and microorganism levels at POU locations.

Note: Routine outlet flushing is a preventative action performed during periods of low water use during otherwise normal occupancy throughout a building or at specific unused outlets. There are no default recommendations with respect to duration, location, or frequency of routine outlet flushing that will reduce or eliminate risks in all settings. Incomplete flushing increases the risk levels of some contaminants by not thoroughly removing stagnant water or renewing water frequently enough.

6 Nonpotable Water Systems

6.1 Normal Operation

6.1.1 General

Non-potable water shall include, but not be limited to gray water, on-site treated non-potable water, rainwater, process water and reclaimed water. Section 6.1.1 shall apply to alternate water source other than rainwater catchment system. Rainwater catchment systems shall comply with Section 6.1.2. For the purpose of this document, alternate water sources apply to non-potable water applications. For the purposes of Section 6 of this manual, alternate water sources apply to non-potable water applications. Closed systems shall be systems that are not open to atmosphere and does not require a supply or replenishment of water. Open systems shall be systems that are open to atmosphere or requires a supply or replenishment of water.

6.1.1.1 Equipment Inspection

Equipment shall be checked for physical integrity and general function. Maintenance records shall be checked to confirm maintenance activities are up to date. Service contracts shall be checked to determine that regular service is being performed and that contractor recommendations are implemented. When maintenance is out of date, or specific issue is identified, the equipment shall be maintained in accordance with the manufacturer's

instructions or the registered design professional's requirements. Where the manufacturer's instructions do not provide inspection and maintenance frequency, the non-potable water systems and components shall be inspected and maintained. The alternate water source testing, inspection and maintenance frequency shall be performed per Table 6.1.1.1.

Table 6.1.1.1
Minimum Alternate Water Source Testing, Inspection,
and Maintenance Frequency

Description	Minimum Frequency-Open System	Minimum Frequency-Closed System
Inspect and clean filters and screens, and replace (if necessary)	Monthly	Every 3 months
Inspect and verify that disinfection, filters and water quality treatment devices and systems are operational and maintaining minimum water quality requirements as determined by the Authority Having Jurisdiction	In accordance with manufacturer's instructions, and the Authority Having Jurisdiction	In accordance with manufacturer's instructions, and the Authority Having Jurisdiction
Inspect pumps and verify operation	After initial installation and every 3 months thereafter	After initial installation and every 12 months thereafter
Inspect valves and verify operation	After initial installation and every 3 months thereafter	After initial installation and every 12 months thereafter
Clear debris from and inspect storage tanks, locking devices, and verify operation	Monthly	After initial installation and every 12 months thereafter
Inspect caution labels and marking	After initial installation and every 12 months thereafter	After initial installation and every 12 months thereafter
Inspect and maintain mulch basins for gray water irrigation systems	As needed to maintain mulch depth and prevent ponding and runoff	As needed to maintain mulch depth and prevent ponding and runoff
Cross-connection inspection and test*	After initial installation and every 12 months thereafter	After initial installation and every 12 months thereafter

*The cross-connection test shall be performed in the presence of the Authority Having Jurisdiction in accordance with the requirements of the plumbing code.

6.1.1.2 Water Quality Monitoring

The maintenance procedures shall be followed to maintain the minimum water quality of the nonpotable water system. The minimum water quality for non-potable water systems shall meet the applicable water quality requirements for the intended application as determined by the Authority Having Jurisdiction or the registered design professional's requirements approved by the Authority Having Jurisdiction.

Water quality shall be checked at the following:

- (1) At the most distant point in the non-potable water distribution system
- (2) In areas that are known to be low or no-use
- (3) Before and after any water treatment and filtration system
- (4) Storage tanks or vessels

6.1.1.3 Routine Flushing

The nonpotable water system shall be routinely flushed as required by the Authority Having Jurisdiction for bacterial control and to meet the water quality as stated in Section 6.3.1.2.

6.1.2 Debris Removal

The rainwater catchment conveyance system shall be equipped with a debris excluder or other approved means to prevent the accumulation of leaves, needles, other debris, and sediment from entering the storage tank. Devices or methods used to remove debris or sediment shall be accessible and sized and installed in accordance with manufacturer's installation instructions.

6.1.2.1 Water Treatment and Filtration Equipment. A filter permitting the passage of particulates not larger than 100 microns (100 μm) shall be provided for rainwater supplied to water closets, urinals, trap primers, and drip irrigation system. The water treatment and filtration shall be maintained in accordance with the manufacturer's installation instructions.

6.1.2.2 Water Quality Monitoring.

The minimum water quality for harvested rainwater shall meet the applicable water quality requirements for the intended applications as determined by the Authority Having Jurisdiction. In the absence of water quality requirements determined by the Authority Having Jurisdiction, the minimum treatment and water quality shall be in accordance with Table 6.1.2.

Exception: No treatment is required for rainwater used for subsurface or nonsprinkled surface irrigation where the maximum storage volume is less than 360 gallons (gal) (1363 L).

6.1.2.3 Minimum Water Quality.

Where the water quality is not acceptable as required in Section 6.3.2.2, determine whether routine flushing is needed. When routine flushing will suffice, the routine flushing shall be done in accordance with Section 6.3.2.5. Where the water quality of the tested water cannot consistently be maintained at the minimum levels specified in Table 6.1.2, then the system shall be equipped with an appropriate treatment device meeting applicable NSF standards or equivalent.

Water quality shall be checked at the following:

- (1) At the most distant point in the rainwater catchment distribution system,
- (2) In areas that are known to be low or no-use,
- (3) Before and after any water treatment and filtration system, and
- (4) Storage tanks or vessels.

Table 6.1.2
Minimum Water Quality
for Rainwater Catchment Systems

Application	Minimum Treatment	Minimum Water Quality
Car washing	Debris excluder or other approved means in accordance with Section 6.1.2, and 100 μ m in accordance with Section 6.1.2.1 for drip irrigation.	N/A
Subsurface and drip irrigation	Debris excluder or other approved means in accordance with Section 6.1.2, and 100 μ m in accordance with Section 6.1.2.1 for drip irrigation.	N/A
Spray irrigation where the maximum storage volume is less than 360 gal (1363 L)	Debris excluder or other approved means in accordance with Section 6.1.2, and disinfection in accordance with Section 6.1.2.4.	N/A
Spray irrigation where the maximum storage volume is equal to or more than 360 gal (1363 L)	Debris excluder or other approved means in accordance with Section 6.1.2.	Escherichia coli: < 1 CFU/mL or 1MPN/mL, and Turbidity: < 10 NTU
Urinal and water closet flushing, clothes washing, and trap priming	Debris excluder or other approved means in accordance with Section 6.1.2, and 100 μ m in accordance with Section 6.1.2.1.	Escherichia coli: <1 CFU/mL or 1MPN/mL, and Turbidity: < 10 NTU
Ornamental fountains and other water features	Debris excluder or other approved means in accordance with Section 6.1.2.	Escherichia coli: <1 CFU/mL or 1MPN/mL, and Turbidity: < 10 NTU
Cooling tower make-up water	Debris excluder or other approved means in accordance with Section 6.1.2, and 100 μ m in accordance with Section 6.1.2.1.	Escherichia coli: <1 CFU/mL or 1MPN/mL, and Turbidity: < 10 NTU

6.1.2.4 Water Quality Devices and Equipment

Devices and equipment used to treat rainwater to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

6.1.2.5 Routine Flushing

The rainwater catchment system shall be routinely flushed as required by the Authority Having Jurisdiction for bacterial control and to meet the water quality as stated in Table 6.1.2.

6.2 Interruption of Normal Operation (System Shutdown Process)

This section applies to the closure strategies of the building water system for nonpotable water systems when the normal operation is interrupted. The required inspection prior to shutting down the system shall be in accordance with Table 6.2.1.

Note: *These procedures are general guidelines intended to supplement the requirements set forth by the registered design professional and the Authority Having Jurisdiction.*

6.2.1 General Systems

6.2.1.1 Shutting Down Without Draining (See Section 6.2.2 for Rainwater Catchment Systems)

The following shall be done when shutting down system when the system is not drained:

- (1) Prior to system shutdown verify operation of bypass system.
- (2) Inspect bypass system and verify proper operation at a minimum of every three months.
- (3) If applicable, implement procedures to prevent pipes from freeze damage.
- (4) Use proper lockout/tagout procedures and follow manufacturer's instructions to remove stored energy from equipment.

6.2.1.2 Shutting Down with System Draining (See Section 6.2.2 for Rainwater Catchment Systems)

The following shall be done when shutting down system when the system is drained:

- (1) Shut off water supply and drain the tank.
- (2) Drain the system following the manufacturer's instructions, the water management plan, and the registered design professional or the Authority Having Jurisdiction.
- (3) Close supply valves to storage water tanks and drain the tanks until the water runs clear.
- (4) Shutoff and drain the water supply system.

Note: *Unless the system can be physically dried, it is likely that pockets of water and condensation will remain even after the system is drained. These remaining pockets of water may be sufficient to allow waterborne pathogens to grow including Legionella.*

6.2.2 Rainwater Catchment Systems

Per Section 4.8.2.2 of ARCSA/ASPE 63, *Rainwater Catchment Systems*, rainwater harvesting systems shall be maintained in functioning order for the life of the system. Failure to properly maintain such a system requires the owner to abandon the system. Refer to Section 6.1.2 for continuous maintenance procedures during normal operation.

6.2.2.1 System Bypass

Rainwater Harvesting Systems shall be place in bypass mode and not be completely shutdown even while the primary water supply system is shutdown during low use or building closure.

Table 6.2.1
Required Inspection Prior to System Interruption

Description	Open System	Closed System
Inspect and clean filters and screens, and replace (if necessary)	☑	☑
Inspect and verify that disinfection, filters and water quality treatment devices and systems are operational and maintaining minimum water quality requirements as determined by the Authority Having Jurisdiction	☑	☑
Inspect pumps and verify proper operation (for bypass systems)	☑	☑
Inspect valves and verify proper operation	☑ Including system by-pass valves	☑
Clear debris from and inspect storage tanks, locking devices, and verify operation	☑	☑
Inspect caution labels and markings	☑	☑
Inspect and maintain mulch basins for gray water irrigation systems	☑	☑
Inspect flushing system and verify proper operation	☑	☑
Cross-connection inspection and test*	☑	☑

*The cross-connection test shall be performed in the presence of the Authority Having Jurisdiction in accordance with the requirements of the plumbing code.

6.3 Reopening of Nonpotable Water Systems

6.3.1 General Systems

6.3.1.1 Equipment Inspection

Equipment shall be checked for physical integrity and general function. Equipment shall be inspected in accordance with the manufacturer's start up procedures. The alternate water source testing, inspection and maintenance frequency shall be performed per Table 6.1.1.

6.3.1.2 Water Quality Testing

The water quality shall be tested until it meets the minimum water quality parameters of the nonpotable water system. The minimum water quality for non-potable water systems shall meet the applicable water quality requirements for the intended application as determined by the Authority Having Jurisdiction or the registered design professional's requirements approved by the Authority Having Jurisdiction.

The water quality shall be checked at the following:

- (1) At the most distant point in the non-potable water distribution system,
- (2) In areas that are known to be low or no-use,
- (3) Before and after any water treatment and filtration system,
- (4) Storage tanks or vessels.

6.3.1.3 System Flushing

The nonpotable water system shall be flushed as required by the Authority Having Jurisdiction for bacterial control and to meet the water quality as stated in Section 6.3.1.2.

6.3.2 Rainwater Catchment Systems

The rainwater catchment conveyance system shall be equipped with a debris excluder or other approved means to prevent the accumulation of leaves, needles, other debris and sediment from entering the storage tank. Devices or methods used to remove debris or sediment shall be accessible and sized and installed in accordance with manufacturer's installation instructions.

6.3.2.1 Water Treatment and Filtration Equipment

A filter permitting the passage of particulates not larger than 100 μm shall be provided for rainwater supplied to water closets, urinals, trap primers, and drip irrigation system. The water treatment and filtration shall be maintained in accordance with the manufacturer's installation instructions.

6.3.2.2 Water Quality Monitoring

The minimum water quality for harvested rainwater shall meet the applicable water quality requirements for the intended applications as determined by the Authority Having Jurisdiction. In the absence of water quality requirements determined by the Authority Having Jurisdiction, the minimum treatment and water quality shall be in accordance with Table 6.1.2.

Exception: No treatment is required for rainwater used for subsurface or nonsprinkled surface irrigation where the maximum storage volume is less than 360 gal (1363 L).

6.3.2.3 Minimum Water Quality

Where the water quality is not acceptable as required in Section 6.3.2.2, determine whether routine flushing is needed. When routine flushing will suffice, flushing shall be done in accordance with Section 6.3.2.5. Where the water quality of the tested water cannot consistently be maintained at the minimum levels specified in Table 6.1.2, then the system shall be equipped with an appropriate treatment device meeting applicable NSF standards, or equivalent.

Water quality shall be checked in accordance with the following:

- (1) At the most distant point in the rainwater catchment distribution system,
- (2) In areas that are known to be low or no-use,
- (3) Before and after any water treatment and filtration system, and
- (4) Storage tanks or vessels.

6.3.2.4 Water Quality Devices and Equipment

Devices and equipment used to treat rainwater to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

6.3.2.5 Routine Flushing

The rainwater catchment system shall be routinely flushed as required by the Authority Having Jurisdiction for bacterial control and to meet the water quality as stated in Table 6.1.2.

7 Mechanical Systems

7.1 Normal Operation, Cooling Towers

7.1.1 General Legionella

Water based mechanical systems are generally closed and pressurized and have no potential to affect the health of occupants, except at the cooling tower. Cooling towers can carry Legionella in aerosolized water droplets and infect occupants in and outside of the building. Section 7.1.2 through Section 7.2.4.2 shall apply to cooling towers under normal operation.

7.1.2 Water Management Program, Cooling Towers

For each cooling tower system, the owner shall have a maintenance program and plan prepared by a qualified person in accordance with Section 5, Section 6, and Section 7.2 of ANSI/ASHRAE 188, *ASHRAE Guideline 12*, the manufacturer's instructions, and the requirements of Section 7 of this Manual.

The plan shall be kept current and amended by a qualified person or building owner designee as needed to reflect any changes in the management and maintenance team, system design, operation, or system control requirements for the cooling tower system. The plan shall be kept in the building where a cooling tower or cooling tower system is located, or in an adjacent building or structure on the same campus, complex, lot, mall, or on-site central engineering division, and shall be made available to the Authority Having Jurisdiction for inspection upon and at the time of a request.

The maintenance Program and Plan shall include not less than the following:

- (1) **Management and maintenance team.** Identification, including names and contact information (such as mail and email addresses and telephone numbers) and description of the function of each person on the cooling tower system management and maintenance team, including:
 - (a) The owner of the building where each cooling tower system is located, and any manager or other person designated by the owner as responsible for compliance with the requirements of the Authority Having Jurisdiction and this section.
 - (b) Any person designated by the owner as a responsible person, as defined by the Authority Having Jurisdiction and this section.
 - (c) Every consultant, service company and qualified person who cleans, disinfects, delivers chemicals, or services the cooling tower system.
- (2) **Cooling tower system.** Identification, specifications and description of each cooling tower system and all components located at a specific address, including:
 - (a) The number of cooling towers in the cooling tower system.
 - (b) The location of each cooling tower in relation to the building and the building address, block and lot number.

- (c) The dimensions and characteristics of the cooling tower system including total recirculating water volume, cooling tower tonnage, biocide delivery method, flow rate and other key characteristics.
 - (d) The purpose of the cooling tower system and seasonal or year-round operation including start and end date, if applicable. For systems with multiple cooling towers, conditional operation, such as cycling or scaling related to cooling demand, shall also be noted.
 - (e) The identification and/or registration number for each cooling tower where required by the Authority Having Jurisdiction.
 - (f) The cooling tower manufacturer, model number and serial number, if applicable.
 - (g) A flow diagram or schematic of the cooling tower system, identifying all of the principal components and appurtenances of the cooling tower system including makeup water, water treatment and filtration equipment, and waste stream plumbing locations.
 - (h) Sources of makeup water, including potable and non-potable.
- (3) **Risk management assessment.** The assessment shall identify risk factors for Legionella proliferation and specify risk management procedures for all or parts of each cooling tower system, and anticipated conditions including:
- (a) Any dead legs or stagnant water in the recirculation system.
 - (b) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than 3 days, including idling or low circulation while not being fully drained.
 - (c) System parts that require continual operation throughout the year making regular, periodic offline cleaning and disinfection difficult.
 - (d) Any components that may add additional risk factors for organic material buildup and microbial growth such as strainers and out-of-use filters.
 - (e) Sources of elevated organic contamination, including, but not limited to windblown debris, bird waste and plant material.
 - (f) Design configurations that present risk of direct sun exposure on basin, deck, or fill.
 - (g) Ventilation intakes or other routes for human exposure to cooling tower aerosols.
 - (h) System components adversely affecting water quality management procedures.
 - (i) Other risk or limiting factors or constraints in the cooling tower system's design and functioning.
- (4) **Cooling tower operation**
- (a) Control measures, corrective actions, documentation, including a written checklist for routine monitoring, and reporting as required by the Authority Having Jurisdiction, and any routine maintenance activities recommended by the manufacturer's instructions, including performance measures, which may sufficiently demonstrate adequate implementation of the operation requirements described in the maintenance program and plan. Where there is a conflict between the requirements of this Section and the manufacturer's instructions, the maintenance program and plan shall reflect the most stringent requirement.
 - (b) Specific, detailed seasonal and temporary shutdown and start-up procedures.
 - (c) Notification and communication strategies among management and maintenance team members regarding the required corrective actions in response to process control activities, monitoring, sampling results and other actions taken to maintain the cooling tower system.

7.2 Water Treatment and Filtration Equipment, Cooling Towers

7.2.1 Water Treatment

Water treatment shall be provided to control microbiological activity, scale, corrosion, sediment, and solids in the system, and shall be in accordance with the following:

- (1) All equipment and chemicals used shall be specified for the purpose of treating the open recirculating loop.
- (2) The required schedule for inspection, maintenance, cleaning, and monitoring, and a corrective action plan.
- (3) The requirements for documenting system water treatment.
- (4) Any pre-treatment needs for non-potable water used as makeup water.

7.2.2 Disinfection

The responsible person for initiating disinfection shall be identified in the water management program documents and the disinfection process shall include the following:

- (1) Online disinfection
- (2) Emergency disinfection

7.2.3 Water Treatment Chemicals

Water treatment chemicals, such as biocides, shall be applied using an automated dosing system, where possible, at regular intervals. The frequency and quantity of chemical dosing shall be defined in the water management program, and performed accordingly, based on the microbial activity of the system and the chemical parameters of the circulating water.

Prior to changing an existing chemical treatment system or introducing a new chemical treatment agent, cooling tower design, installation, operation, and maintenance shall be evaluated by a qualified person or building owner designee to ensure compatibility between the chemicals and the cooling tower system's materials, and to minimize microbial growth and the release of aerosols.

The evaluation shall describe the optimum level of chemicals to achieve the desired result in a manner which can be used as a system performance measure.

- (1) **Daily automatic treatment while in operation.** Water in a cooling tower system shall be treated at least once a day when the system is in operation and such treatment shall be automated, unless the water management program and plan explicitly states how manual or less frequent biocide additions will provide effective control of Legionella growth.
- (2) **Recirculating system.** A cooling tower system shall be operated and programmed to continually recirculate the water, irrespective of the building's cooling demand of the system, unless the water management program specifies in detail how the intended water treatment schedule will be carried out, and how effective biofilm and microorganism control will be achieved when the whole or a part of the system is idle during the scheduled chemical injection.
- (3) **Chemicals and biocides.** Chemicals and biocides shall be used in quantities and combinations sufficient to control the presence of Legionella, minimize biofilms, and prevent scaling and corrosion that may facilitate microbial growth. It is recommended that oxidizing chemicals be used as the primary biocide control. For systems where oxidizing chemicals cannot be used as the primary biocide to control the presence of Legionella, building owners shall submit an alternative plan for effective bacteriological control for approval by the Authority Having Jurisdiction.

- (a) **Biocide applications.** Any person who performs cleaning and disinfection or applies biocides in a cooling tower system shall be a certified person as required by the Authority Having Jurisdiction.
- (b) **Registered biocides.** Only biocide products registered with the Authority Having Jurisdiction may be used to meet the disinfection requirements of this Section.
- (c) **Records.** Water treatment records shall be kept for all chemicals and biocides added, noting the purpose of their use, the manufacturer's name, the brand name, the safety data sheet, the date and time of each addition, and the amount added each week.
- (d) **Chemical and biocide additions.** Chemicals and biocides shall be added in accordance with this section and the procedures described in the maintenance program and plan addressing, as applicable, feeding mechanism, feeding location, frequency, set timer, duration, triggering events, control procedures, and target biocide residuals. Water treatment chemicals and biocides shall be used in accordance with the product label and manufacturer's instructions.

7.2.4 Water Quality Monitoring

Water quality in the cooling tower shall be monitored as follows:

- (1) Water quality parameters, including but not limited to pH, temperature, conductivity and biocidal indicators, shall be measured and recorded as specified in the water management program and plan as follows:
 - (a) Manual measurements as required by the manufacturer's recommendation and the Authority Having Jurisdiction.
 - (b) When continuous, automated and/or remote measurements and recordings are used, the water management program and plan shall show how effective measurements of system process control are being monitored.
- (2) A bacteriological indicator to estimate microbial content of recirculating water shall be collected and interpreted in accordance with Table 7.2.4(2) at least once each week while the cooling tower system is operating. Indicators shall be taken at times and from water sampling points, as detailed in the water management program, that will be representative of water microbial content. Indicators may be taken at any time from constant chemical treatment systems. Indicators from systems that use intermittent biocide applications shall be taken before biocide application and reflect normal cooling tower operating conditions. If increased levels of bacteriological indicator are found, check biocide program and water program, investigate for possible causes of cooling tower contamination (including extreme weather events), perform a visual inspection and, if necessary, increase biocide dosage and retest as determined by Authority Having Jurisdiction.
- (3) Legionella culture testing shall be conducted no less frequently than every 90 days during cooling tower system operation. A Legionella sample shall be analyzed by an accredited laboratory where Legionella appears on the laboratory's scope of accreditation, or other laboratory approved by the Authority Having Jurisdiction. When required, test results of Legionella at or above the magnitude of 1,000 CFU/mL or MPN/ml, as indicated in Table 7.2.4(1), shall be reported to the Authority Having Jurisdiction within 24 hours of receiving the test results.

Additional emergency Legionella sampling shall be conducted if any of the following occur:

- (a) Power failure, system shutdown, or equipment failure of sufficient duration to allow for growth of bacteria,
- (b) Loss of biocide treatment sufficient to allow for growth of bacteria,

- (c) Failure of conductivity controls to maintain proper cycles of concentration,
 - (d) At the request of the Authority Having Jurisdiction upon a determination that one or more cases of legionellosis is or may be associated with the cooling tower, based on epidemiological data or laboratory testing,
 - (e) Any time two consecutive bacteriological indicator sample results are above (1,000 CFU/mL or MPN/mL) as indicated in Table 7.2.4(1), or
 - (f) Any other conditions specified by the Authority Having Jurisdiction.
- (4) System monitoring and sampling locations shall be representative of the entire cooling tower system. The system shall be operating with water circulating in the system for at least one hour prior to water quality measurements or collection of samples.
- (5) The maintenance program and plan shall identify the procedures, responsible parties, required response time(s) and notification protocol for corrective actions and shall include, at a minimum, corrective actions that shall be implemented according to the result levels in Table 7.2.4(1).

Note: Consider selecting a laboratory that has *Legionella* proficiency as demonstrated by CDC ELITE program certification or another internationally recognized proficiency program (such as the PHE *Legionella* isolation scheme).

7.2.4.1 Water Sampling

An analysis of water samples from a location capable of being contaminated with *Legionella* bacteria shall be performed as required by the Authority Having Jurisdiction to determine the concentration (CFU/mL or MPN/mL) of *Legionella* in the sample. The minimum remediation action shall be in accordance with Table 7.2.4(1).

7.2.4.2 Legionella Test Levels

A means of controlling *Legionella* shall be established in accordance with applicable levels as in accordance with the following:

- (1) **Levels Less than 10 CFU/mL (or MPN/mL).** Water samples containing *Legionella* levels less than 10 CFU/mL shall be permitted to maintain the established water treatment program in accordance with Table 7.2.4(1).
- (2) **Levels Between 10 CFU/mL (or MPN/mL) and 1000 CFU/mL (or MPN/mL).** Water samples containing *Legionella* levels greater than 10 CFU/mL (or MPN/mL), but less than 1,000 CFU/mL (or MPN/mL) shall require the water treatment program to be reviewed, institute immediate online decontamination, and retesting of water 3 to 7 days after decontamination in accordance with Table 7.2.4(1).
- (3) **Levels Greater than 1000 CFU/mL (or MPN/mL).** Water samples containing *Legionella* levels greater than 1,000 CFU/mL (or MPN/mL) shall require the water treatment program to be reviewed, notify Authority Having Jurisdiction, institute immediate online disinfection, and retesting of water 3 to 7 days after decontamination in accordance with Table 7.2.4(1).

Table 7.2.4(1)
Legionella Remediation Actions for Cooling Towers

Legionella Concentrations (CFU/mL or MPN/mL)	Remediation Actions
<10	Maintain the established water treatment program
≥10 and <1000	Review water treatment program, institute immediate online disinfection, and retest water 3 to 7 days after disinfection.
≥1,000	Review water treatment program, institute immediate online disinfection, and retest water 3 to 7 days after disinfection. If a retest is still ≥ 1,000 carry out system decontamination until count is <10

Table 7.2.4(2)¹
Corrective Actions Required for
Bacteriological Indicator Results

Level	Heterotrophic Plate Count ² and Dip Slide Result (CFU/mL or MPN/mL)	Process Triggered by Test Results
1	<10,000	Maintain water chemistry and biocide levels.
2	≥10,000 and <100,000	Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, review treatment program, retest water within 3 days to 7 days. Subsequent test results shall be interpreted in accordance with this table until level 1 is reached.
3	≥1000,000 and <1,000,000	Initiate immediate disinfection by increasing biocide concentration or using a different biocide within 24 hours, reviewing treatment program, performing visual inspection to evaluate need to perform cleaning and further disinfection. Retest water within 3 days to 7 days. Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.
4	≥1,000,000	Initiate immediate disinfection by increasing biocides within 24 hours. Within 48 hours perform remediation of the tower by hyperhalogenating ³ , cleaning, and flushing. Review treatment program, retest water within 3 days to 7 days. Subsequent test results shall be interpreted in accordance with this Table until level 1 is reached.

Notes:

¹ Source: <https://www1.nyc.gov/assets/doh/downloads/pdf/about/healthcode/health-code-chapter8.pdf>

² Performed by an accredited laboratory (e.g., TNI, ISO/IEC 17025)

³ At a minimum, dose the cooling water system with 5 ppm to 10 ppm free halogen residual for at least 1 hour; pH 7.0 to 7.6

Note: There is no evidence that HPC values alone directly relate to human health risk, based on epidemiological studies and a lack of correlation with the occurrence of waterborne pathogens. Threshold concentrations of HPC were selected based on interference with the coliform test and not health-related considerations. HPC is an analytic method used to measure the variety of heterotrophic bacteria that are common in water. *Legionella* require specialized culture media for isolation and detection, do not grow on the media used for HPC testing, and their presence is not correlated with HPC values. HPC is a useful tool for monitoring the efficiency of the water treatment process, measuring bacterial regrowth, and evaluating the function of disinfection systems.

7.3 Interruption of Operation (System Shutdown)

7.3.1 Shutdown Date

When an interruption of operation occurs (system shutdown), a shutdown date shall be established prior to shutting down a cooling tower. A shutdown date of a cooling tower shall be a date after which the cooling tower is unlikely to be restarted for the season.

Where shutdown of the cooling tower is required, a shutdown date shall be determined, and the following shall be done as described in Section 7.3.1.1 through Section 7.3.1.4.

7.3.1.1 Reduce Solids and Sterilize the System

The cooling tower shall be drained prior to system shutdown. Biocide shall be applied in accordance with the manufacturer's instructions to kill any bacteria or contaminants.

7.3.1.2 Drain, Inspect and Clean the System

The following shall be done when:

- (1) The cooling tower fill, sump, heat exchangers, chillers, and piping shall be drained.
- (2) The system shall be cleaned as required by the manufacturer's instructions.
- (3) The system shall be inspected, and maintenance shall be performed as required by the manufacturer.
- (4) The controllers shall be taken offline.
- (5) The protective probes shall be removed.
- (6) The tower fill and sump shall be drain down.
- (7) The heat exchangers, chillers and piping shall be drained and protected in accordance with the manufacturer's instructions.

7.3.1.3 Refill, Flush and Drain the Cooling Tower System

Refill the system, add nonoxidizing biocide and recirculate in accordance with the manufacturer's instructions. Then fully drain the cooling tower system. If there is water in the cooling tower system, the system is not considered shut down.

7.3.1.4 Records

Records of all procedures and actions performed shall be kept.

Note: *It is possible that the cooling tower equipment is drained, but the cooling tower system remains in operation. A system operating on standby mode are not considered shut down. If there is water in the cooling tower system, the system is not considered shut down and water must circulate with regular biocide additions and active management.*

7.4 Shutdown

7.4.1 General

Cooling towers that are in shutdown mode shall comply with the following:

- (1) Operating configurations and conditions that may occur after periods of extended inactivity lasting more than five days, including idling or low circulation while not being fully drained.
- (2) Specific, detailed seasonal and temporary shutdown and start-up procedures.

7.4.2 System Shutdown

System start-up and shutdown procedures shall include, but not be limited to:

- (1) Management of hazardous conditions associated with untreated water, including the following:
 - (a) Shutdown that includes all chemical pretreatment steps, pump cycling protocols, and procedures for system drainage for shutdown periods longer than five days, or the duration specified by the water management program.
 - (b) Start-up from a drained system shall be in accordance with manufacturer's recommendations.
 - (c) Start-up from an undrained or stagnant system that exceeds five days, or the number of idle days specified by the water management program or the manufacturer's recommendations.

7.4.3 Legionella Prevention

The mechanical hydronic system shall be checked that it is safe to use after a prolonged shutdown to minimize the risk of Legionnaires' disease and other diseases associated with water.

Note: *Stagnant or standing water in a mechanical hydronic system can increase the risk for growth and spread of Legionella and other biofilm-associated bacteria. When water is stagnant, hot water temperatures can decrease to the Legionella growth range 77 °F (25°C) through 110°F (43°C). Stagnant water can also lead to low or undetectable levels of disinfectant, such as chlorine.*

7.4.3.1 Maintenance Personnel

Personal protective equipment shall be provided for maintenance personnel. Maintenance personnel shall wear personal protective equipment in accordance with the facilities' risk assessment. Respiratory protection may be appropriate in enclosed spaces where aerosol generation is likely. Personal protective equipment shall be used in accordance with all local state and Federal requirements. Where respirators are used, a respiratory protection program in accordance with 29 CFR 1910.134 shall be required.

Note: *Maintenance personnel at increased risk of developing Legionnaires' disease, such as those with weakened immune systems, should consult with a medical provider regarding participation in flushing, cooling tower cleaning, or other activities that may generate aerosols.*

7.5 System Reopening (Including Seasonal Startup)

7.5.1 Startup Procedures

If your cooling tower has been shut down or left untreated for five or more days, a full startup procedure shall be completed before startup or continuing to use it. The startup procedures shall be completed as follows:

- (1) Clean the cooling tower through power washing and/or scrubbing, no later than 15 days before the first use, to remove biofilm, scale or other debris. Once cleaned, disinfect with an approved biocide(s) to kill pathogens, such as Legionella.
- (2) Enlist your qualified person or building owner designee to conduct and document the pre-startup inspection. The required inspection shall be as follows:
 - (a) Visually assessing the cooling tower system,
 - (b) Inspecting all components for the presence of contaminants and other adverse conditions,

- (c) Checking that the water treatment equipment is working properly, and
 - (d) Ensuring that records are complete.
- (3) Once disinfected, the cooling tower system shall be filled with water and begin circulating biocides and chemicals, as specified in the water management program. At this point, the system is operational and must meet the requirements of the Authority Having Jurisdiction.
- (4) Collect and analyze a water sample for the presence of Legionella. The sample shall be analyzed by a laboratory as approved by the Authority Having Jurisdiction. The results must then be interpreted, and action taken, as described in Table 7.2.4(1).
- (5) Startup records of all procedures and actions performed shall be kept on file. Startup records should include, but not be limited to, the following:
- (a) Cooling tower system ID,
 - (b) System startup date,
 - (c) Individual cooling tower startup date (if different than the system startup date) and
 - (d) Dates and procedures for startup cleaning and disinfection, including:
 - i. The service provider,
 - ii. Pre-startup inspection,
 - iii. Legionella sampling and test results,
 - iv. Disinfection dose and circulation time,
 - v. Data monitoring, and
 - vi. Treatment logs.



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