BSR/ASHRAE Standard 188P

Public Review Draft

ASHRAE® Standard

Proposed New Standard 188, Prevention of Legionellosis Associated with Building Water Systems

First Public Review (October 2010)
(Complete Draft for Full Review)

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ASHRAE Standard 188P

Prevention of Legionellosis Associated with Building Water Systems

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

The aim of this standard is to assist those involved in building design and facility management in preventing the disease legionellosis, which is caused by infection with the bacterium *Legionella*. When *Legionella* causes pneumonia, it is typically referred to as Legionnaires' disease, or LD. The Centers for Disease Control and Prevention (CDC) estimates that each year in the US there are between 8,000 and 18,000 cases of Legionnaires' disease illness and that more than 10 percent of these cases are fatal.

The presence of *Legionella* in a building water system is required for the disease to occur but not in itself sufficient. Other factors that must be present include environmental conditions (e.g., temperature) that promote the growth of *Legionella*, a means of transmitting the organism, and a susceptible person. Individuals at high risk for this disease include, but are not limited to, the elderly, dialysis patients, persons who smoke, and persons with underlying medical conditions that weaken the immune system.

This standard facilitates the prevention of legionellosis by identifying the points in a building's water system which, when properly controlled, can make conditions less favorable to the amplification and transmission of *Legionella* through proven system design, operational practices and maintenance practices. By establishing adequate barriers to transmission of *Legionella* bacteria, implementing sound maintenance procedures, and utilizing persistent and effective control mechanisms, users of this standard can reduce the possibility of exposure of at-risk individuals. Engineers, architects, and system designers also can use this standard to determine if their building water system design and engineering practices are in need of review or revision.

Since 1996, Hazard Analysis and Critical Control Point (HACCP) plans have been used in the food industry to reduce transmission of infectious organisms from food and water to humans. Because of the success of HACCP plans in that industry and because a variety of training materials are available at minimal or no cost, Standard Project Committee 188 chose to adopt the HACCP methodology as a systematic disease prevention strategy for legionellosis.

This standard consists of numbered normative sections followed by informative appendices listed by alpha. The normative sections instruct users how to comply with the standard. The informative appendices have been included to provide users with information to aid the user in compliance. However, because building water systems vary substantially in their design and propensity for transmission of *Legionella* and because scientific evidence is either lacking or inconclusive in certain aspects of *Legionella* control, the informative appendicies to this document provide suggestions and recommendations which may be used to assemble a Risk Management plan. The hypothetical examples cited within the appendicies are not to be interpreted as minimum values or enforced as requirements, but only as illustrations of how the Risk Management process works given certain builing construction and operational conditions.

In summary, this document will (a) alert designers and building operators to the types of facilities that require HACCP plans, (b) provide specifications for the processes required to develop a HACCP plan (an illustrated and detailed example of such an exercise is contained in Appendix B of this document), and (c) provide information to facility decision makers on a variety of ways in which the standard can be met.

1. PURPOSE

The purpose of this standard is to present practices for the prevention of legionellosis associated with building water systems.

2. SCOPE

2.1 This standard provides methods of risk management for the prevention of legionellosis associated with centralized industrial and commercial building water systems.

2.2 This standard applies to human-occupied buildings, excluding single-family residential buildings. While not specifically intended for non-centralized or single-family residential building systems, some of the information presented in non-mandatory Appendix B may be useful for these systems.

2.3 This standard is intended for use by those involved in the ownership, design, construction, installation, (including commissioning), management, operation, maintenance and servicing of centralized industrial and commercial building water systems.

3. DEFINITION OF TERMS

***at-risk individual*:** any person who, because of age, health, medication, occupation, or habits such as smoking, is more susceptible than the general population to developing legionellosis.

centralized building water system: any water-receiving system that distributes its water to multiple uses (potable, utility or other) and/or multiple locations within the building or site. Each of these uses can further extend to other sub-processes; for example, potable water is often used for hot water distribution.

confirmed process flow diagram: a process flow diagram created by the HACCP Team that has been verified to be accurate to as-built and operational conditions within the building. After it is confirmed, the process flow diagram can be utilized to identify Critical Control Points.

control: to manage the conditions of an operation in order to maintain compliance with established criteria. (b) a state of operations in which correct procedures are being followed and criteria being met.

control measure: any action or activity that can be used to prevent, eliminate or reduce a significant hazard or reduce it to an acceptable level.

control point (CP): any step in a process at which biological, chemical or physical factors can be controlled.

corrective action: a procedure that defines the actions necessary to correct the conditions at a critical control point when testing or measurement shows that results are falling outside of the critical limits.

criterion: a standard on which a judgment or decision can be based.

critical control point (CCP): a step at which control can be applied and is essential to prevent or eliminate a safety hazard or reduce it to an acceptable level. CCPs are often the last opportunities in the process to eliminate the hazard or prevent it from harming people.

critical limit: a maximum or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP in order to prevent, eliminate or reduce to an acceptable level the occurrence of a hazard.

deviation: the failure to meet a *critical limit*.

EPA: Environmental Protection Agency www.epa.gov

hazard: a biological, chemical or physical agent that can cause illness or injury in the absence of its control (ref: NACMCF definition).

hazard analysis: the process of collecting and evaluating information on hazards associated with the building water system under consideration to decide which hazards are significant and must be addressed in the HACCP plan.

HACCP plan: the written document that is based on the principles of HACCP.

HACCP team: the group of people who are responsible for developing, implementing and maintaining the HACCP plan.

hazard analysis and critical control point (HACCP): a scientifically based risk management method that prevents hazards from harming people.

immunocompromised: a condition describing an individual who has increased susceptibility to infections. This condition may be due to existing human disease, to medication regimens, or to other types of medical treatment.

Legionella: the name of the genus of bacteria that was subsequently discovered as the disease causative pathogen associated with the 1976 outbreak of disease at the American Legion convention in Philadelphia. *Legionella* are common aquatic bacteria found in natural and man-made water systems, as well as occasionally in some soils. More than 50 species of *Legionella* have been identified; however, one species in particular, *Legionella pneumophila*, is associated with the vast majority (approximately 90%) of legionellosis cases.

Legionellae: the plural of *Legionella,* this term is used to refer to more than one type of *Legionella* bacterium and is often used to refer to all species of *Legionella*.

legionellosis: the term used to describe any illness caused by exposure to *Legionella* bacteria. Legionnaires' disease (LD) and Pontiac fever are the two most common types of legionellosis, with Legionnaires' disease being the more serious and of primary of concern for human health.

Legionnaires' disease (LD): an acute bacterial infection of the lower respiratory tract with accompanying pneumonia. (see legionellosis)

monitoring: conducting a planned sequence of observations or measurements to assess whether a CCP is under control and to produce an accurate record for future use in verification.

monitoring procedures: a set of procedures describing a continuous process of monitoring all of the CCPs identified in the HACCP plan.

NACMCF: National Advisory Committee on Microbiological Criteria for Foods, which was established in 1988 in response to recommendations of the National Academy of Sciences for an interagency approach to microbiological criteria for foods.

NSF: NSF International (formerly National Sanitation Foundation) is the standards organization that certifies all drinking water chemicals and devices used in the US in compliance with the Safe Drinking Water Act www.nsf.org

other water systems: water delivery systems that cannot be categorized as either potable or utility water systems.

pontiac fever: see *legionellosis*.

process flow diagram: a schematic diagram of the steps used in the processing of water in a building, from the point that it is received to the point that it is dispensed or disposed of. Other typical steps include conditioning, storing, heating, and distributing the water.

process monitoring instrument: a device used to indicate process conditions at a CCP.

potable water system: a building water distribution system intended for human consumption (drinking, preparing food, other activities involving direct human contact). Such systems often include potable hot water distribution.

risk: an estimate of the probability that an identified hazard will be harmful. ***Note:*** The risk of legionellosis cannot be quantitatively measured.

risk characterization: the process by which the HACCP Team evaluates a particular building to determine if HACCP is required for compliance with this standard.

serogroup: a sub-set of bacteria within an identified species. *L. pneumophila* has seventeen numbered serogroups, of which serogroup 1 causes most legionellosis.

utility water system: a building water distribution system that provides water intended for uses other than human consumption.

validation: the element of *verification* focused on collecting and evaluating scientific and technical information to determine if the HACCP plan, when properly implemented, will effectively control the hazards. (ref: NACMCF definition). Obtaining evidence that the elements of the HACCP plan are effective (ref: WHO definition).

verification: those activities, other than monitoring, that determine the validity of the HACCP system and whether the system is operating according to the plan. (ref: NACMCF definition). The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan (ref: WHO definition).

WHO: World Health Organization

4. COMPLIANCE

To comply with this standard, a building shall first be surveyed to determine its risk characterization, which is a qualitative estimation or approximation of the risk associated with a particular building based upon the characteristics of the building and its water systems. Then, based upon its risk characterization, the building facility management/owners of the building are required to comply with certain measures intended to reduce the risk of legionellois by preventing the causative agent of legionellosis (*Legionella* bacteria, LB, Legionnaires' disease bacteria, LDB) from harming building occupants.

5. DETERMINING RISK CHARACTERIZATION

This section describes how to perform the initial survey of a building to determine its risk characterization.

5.1 The building owner shall identity the person, persons, or entity (e.g., building manager, facilities management team) responsible for conducing the following building survey.

5.2 The building shall be surveyed to determine whether it is characterized by one or more of the following risk factors that relate to legionellosis:

(a) it includes multiple rooms or housing units supplied by one or more centralized hot water heaters,

(b) it is more than 10 stories high (including any levels that are below grade),

(c) it is a healthcare facility,

(d) its occupants include immunocompromised individuals or it has special accomodations for persons having immunocompromising conditions (for example, someone undergoing bone marrow transplantation),

(e) it has one or more whirlpools and/or spas either within it or located on its premises (i.e., adjacent to the building),

(f) it has one or more aerosol-generating water features or devices (e.g., ornamental fountains, direct evaporative coolers, misters (atomizers), air washers or humidifiers) either within it or located on its premises, or

(g) the total halogen concentration of the incoming potable water supply to the building is less than 0.5 mg/L (0.5 ppm) as Cl_2.

5.3 The building shall be surveyed to determine whether it has one or more cooling towers and/or evaporative condensers that provide cooling and/or refrigeration for the HVAC&R system.

5.4 After the survey is completed, the preventive measures that are required for the building shall be determined from Table 1:

Table 1: Determining Preventive Measures Required for Building

Section 5 Survey Results	Preventive Measures
NO to Section 5.2 and NO to Section 5.3	Compliance with Section 6 only
YES to Section 5.2	Compliance with Sections 7 and 8 for all building water systems except those addressed under Section 5.3
YES to Section 5.3	A water system treatment and management program shall be in place for the water system that meets or exceeds the HACCP requirements of Section 8.2 and is consistent with the recommendations of Guideline 12 (see Item 1 in Section 9, References). The water system management program in this case shall be inclusive of the evaporative cooling system, whether the system consists of open or closed circuit cooling towers or evaporative condensers.

6. SURVEY REQUIREMENTS

This section describes the requirements for buildings with none of the characteristics of Section 5.2 or 5.3. For these buildings, the survey in Section 5 shall be repeated at least once per year. If the characteristics of the building have changed during this time, then the building shall be subject to the preventive measures determined by the new survey.

7. HACCP PROGRAM REQUIREMENTS

7.1 Hazard Analysis and Critical Control Point (HACCP) risk management shall be used to reduce the potential of legionellosis associated with buildings. This approach to HACCP shall adhere to the seven principles of HACCP:

1. Conduct a hazard analysis
2. Determine the critical control points
3. Establish critical limits for each critical control point
4. Establish a system to monitor control of the critical control points
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
6. Establish procedures for verification to confirm that the HACCP system is working effectively.
7. Establish documentation concerning all procedures and records appropriate to these principles and their application.

7.2 In addition to the principles of Section 7.1, certain specific actions are required in the development of the HACCP plan:

1. An HACCP Team, including at least one person who understands the principles of HACCP and at least one person who understands the building water systems, shall be formed by the building owner and/or owner's building management team. Members of the HACCP team may be employees, suppliers, consultants, or any combination thereof. The HACCP team shall be responsible for the remaining actions in this section.
2. Identify the end point uses of potable and utility (non-potable) water systems within the building.
3. Develop at least two process flow diagrams (one each for the potable water and utility water systems) that illustrate how the water is received, processed and delivered to end-point uses within the building. **Note:** Examples are contained in Appendix B, Figures B1 and B2.
4. Confirm that the process flow diagrams are accurate by an on-site inspection.
5. Use process flow diagrams to identify control points (CPs) in the process. (Appendix B, Tables B1 and B2 contain examples).
6. Decide which control points are critical control points (CCPs) and indicate them on the process flow diagrams.
7. Establish critical control limits for each CCP (refer to Section 6). **Note:** ASHRAE Guideline 12 provides more information on how to establish CCPs (see Bibliography).
8. Establish a monitoring procedure for each critical limit at each CCP.
9. For each critical limit, establish corrective actions to take when deviations from critical limits are found.
10. Validate the selection of CCP's, critical limits and corrective actions.
11. Establish verification procedures.
12. Establish documentation and record keeping procedures as required in Section 7.3. **Note:** Examples of documentation and records are provided in Appendix B, Table B5.

7.3 A single document shall be produced for a complete HACCP plan. The plan shall include, at a minimum, the following eight elements:

1. **Members of the HACCP Team**, including their respective titles, roles, and contact information, shall be listed.
2. **Process flow diagrams** for the potable water system and the utility water system. Schematically show step-wise how potable (domestic) and utility water is processed in the facility. Processing steps shall be named and numbered. **Note:** Appendix B, Fig B1 and B2 contain examples.
3. **Hazard analysis summaries** shall list the name and number of each processing step in the building water system and the potential hazard(s) for each processing step. Indicate whether the team judges the risk at each step to be significant (Yes or No) and briefly state the basis for that decision. List hazard control that is currently applied or could be applied to prevent, eliminate or reduce the hazard at each control point. Critical control points (CCPs) shall be selected and indicated in the hazard analysis summaries and may also be indicated on the process flow diagrams. **Note:** Tables B1 and B2 in Appendix B contain examples.
4. **A monitoring schedule** shall document each CCP, the frequency with which each CCP is monitored, and the timeframe within which corrective actions shall be taken when critical limits are exceeded. **Note:** Refer to Appendix B, Table B4 for examples.
5. **An equipment device maintenance procedure** shall be developed for each potable or utility water device identified in the process flow diagram in accordance with Section 8 of this document.
6. **A validation summary** shall include the justification and, when available, scientific evidence used to validate the selection of each CCP and each critical limit selected by the HACCP Team. The selection of critical limits shall comply with local guidance or regulations (refer to. Section 8.1.1). **Note:** Appendix B, Table B3 contains examples.

7. **A verification schedule** shall list all verification activities and the frequency with which they will be performed. Appendix B, Table B4 contains examples.
8. **Planned responses to disruptions in water service** shall be documented in the HACCP plan. Disruptions in water service have been repeatedly associated with outbreaks of Legionnaires' disease.

8. DESIGN, MAINTENANCE AND OPERATIONAL CONTROLS

8.1 Potable Water Systems. This section describes the standard's requirements for potable water systems.

8.1.1 General. All potable water treatments referred to in this standard shall comply with the following:

a) All potable water treatments shall comply with all applicable federal, state and local regulations.
b) All drinking water system treatments in the US shall be in compliance with the Safe Drinking Water Act (40 CFR 141-143).[2]
c) All disinfectants used for drinking water treatment shall be registered by the EPA (as indicated by the EPA registration number on the product label).
d) All chemicals and devices used for drinking water treatment shall be certified by NSF.[3]

8.1.2 Design. Potable water systems shall either meet the following design requirements or satisfy the requirements of Section 8.1.5 relating to secondary disinfection systems:

a) Hot water heaters and storage vessels shall have a drain at the lowest point and the heating element shall be located as close as possible to the bottom of the vessel to facilitate mixing and prevent temperature stratification.
b) In high-risk facilities, insulated recirculation loops shall be incorporated as a design feature.
c) For all facilities, the pipe runs shall be as short as practical.
d) New shower systems in large buildings, hospitals, and nursing homes shall be designed to ensure mixing of hot and cold water near the showerhead. The warm water section of pipe between the control valve and shower-head shall be self-draining.

8.1.3 Operation. Storage and distribution temperatures for potable water systems shall be as follows:

a) In health care facilities, nursing homes, and other high-risk building facilities, cold water shall be stored and distributed at temperatures below 25°C (77°F). Hot water shall be stored above 60°C (140°F) and circulated with a minimum return temperature of 51°C (124°F).
b) In non-healthcare building facilities or when local regulations prohibit use of the temperatures of 51°C (124°F) and higher, hot water shall be stored at 49°C (120°F) or above.

8.1.4 Maintenance/Inspection. The following maintenance and inspection procedures shall be required for potable water systems. Any deviations found shall be corrected. **Note:** Care shall be taken to avoid scalding hazards.

a) Systems shall be inspected at least annually to ensure that thermostats are functioning properly.
b) Hot-water tanks shall be drained at least twice per year to remove scale and sediment.

c) Hot or cold water systems that incorporate an elevated holding tank shall be inspected and cleaned annually.
d) A visual inspection of the cold-water storage tank shall verify that the:
   - access hatch fits closely and is in good condition.
   - insect screen on the overflow pipe is intact and in good condition.
   - thermal insulation on the tank (if installed) is in good condition.
   - water surface is clean, shiny, and free from foam, scum, and oil sheen.
   - interior tank above the water line is clean and shows no signs of corrosion, scale, encrustation, or biological growth.
   - water does not contain any debris or contamination (if debris or traces of vermin are found, the inspection shall be carried out more frequently).

8.1.5 Secondary Disinfection System. For building water systems where the requirements of Sections 8.1.2, 8.1.3 and 8.1.4 cannot be implemented or where potential risks require more frequent disinfection of the potable water system, an installed secondary disinfection system shall be required. Potable water systems which require secondary disinfection for hazard control shall use one or more of the following products and/or devices for drinking water disinfectants in accordance with local, state and federal EPA regulations in compliance with the Safe Drinking Water Act: chlorine, chloramines, chlorine dioxide, ozone, copper-silver ionization, or UV irradiation. **Note:** Secondary disinfection is the addition of supplemental disinfectant to drinking water over and above what has already been applied for primary disinfection. Its purpose is to maintain water quality by killing potentially harmful organisms that may get in water as it moves through pipes. For more information on disinfection methods, refer to ASHRAE Guideline 12 (see Appendix A, Bibliography).

8.1.6 Preventive Measures for Systems That Are Opened. Opening systems for repair or water pressure changes associated with construction, both inside the building and in the potable water supply system to the building, can cause the concentration of *Legionella* to dramatically increase. Potable water systems that have been opened for repair or construction shall be thoroughly flushed. Systems that were subjected to water pressure changes associated with construction shall be thoroughly flushed. High-temperature flushing and/or halogenation shall be used if deemed necessary by the HACCP Team. If only a portion of the system is involved, high-temperature flushing or halogenation shall be used on only that portion of the system if this approach is deemed sufficient by the HACCP Team.

8.1.7 Emergency Disinfection. When an outbreak of legionellosis has been associated with a potable water system or suspected cases of the disease occur, disinfection shall be performed. The method of emergency disinfection shall be thermal, chemical or point-of-use filtration (0.2 micrometer) or any combination of them.
Note: Combining thermal shock (see Section 8.1.7.1.1) and chemical disinfection (see Section 8.1.7.1.2) is the most effective method of emergency disinfection.
Note: After emergency disinfection, re-colonization is likely to occur unless proper temperatures are maintained or a continuous disinfectant residual is maintained.
Note: Emergency disinfection of hot and cold water systems is potentially hazardous and can cause increased corrosion rates in the potable water system. Therefore, these procedures should not be performed routinely.

8.1.7.1 Hot Water Systems. Disinfection shall be accomplished by the methods of Section 8.1.7.1.1 and/or 8.1.7.1.2.

8.1.7.1.1 Where possible, the following thermal shock treatment shall be used:

1) Local building and sanitary codes shall be checked for any temperature limits of water discharged to the sewer.
2) Appropriate safety procedures to prevent scalding shall be implemented.
3) Flushing shall be performed when the building is expected to have low occupancy. (e.g., nights and weekends).
4) The hot water temperature shall be raised to 71-77°C (160-170°F) and maintained at that level while progressively flushing each outlet around the system, starting with the closest to the most distal.
5) Efforts shall be made to achieve a flush time of thirty minutes. Because the intent is to provide thermal eradication, the outlet flow is kept low to prevent exhausting the ability of the heater to maintain temperature.

8.1.7.1.2 An effective method for emergency disinfection of contaminated hot water systems is shock hyperchlorination which shall be implemented using the following procedure.

1) An EPA-approved type of chlorine shall be added.
2) The water heater or tank shall be chlorinated to levels of up to 50 mg/L (ppm) to achieve a free chlorine residual of at least 2 mg/L (ppm) throughout the system, as verified at distal locations.
3) The pH of the water shall be maintained between 6.5 and 8.0.
4) Each outlet shall be flushed until chlorine is detected at the outlet.
5) The chlorine shall remain in the system for a minimum of 2 hours (not to exceed 24 hours), after which the system shall be thoroughly flushed.

8.1.7.2 Cold Water Systems. Emergency disinfection of cold water potable lines shall be accomplished by the following hyperchlorination procedure:

1) Building occupants and facility personnel shall be informed that halogen disinfection with concentrations exceeding normal limits for drinking water disinfection will be used in the procedure.
2) The level of free residual chlorine shall be raised to 20-50 mg/L (ppm) of chlorine and maintained at this concentration for one hour at approximately 50 mg/L (ppm) or for two hours at approximately 20 mg/L (ppm).
3) Run faucets until chlorine is detected and then close faucets for the disinfection period (one or two hours depending on concentration).
4) Measure chlorine concentration at the distal point to confirm dose.
5) After the disinfection period and at least twelve hours before re-use, flush all cold-water outlets and fountains for four minutes to remove disinfectant.
6) Before reuse of the system for drinking water service, measure chlorine to confirm free residual chlorine concentration is less than 1 mg/L (ppm) or not more than the measured chlorine residual in the drinking water source.

8.1.8 When *Legionella* Is Suspected. The HACCP plan shall have a description of the procedures to be followed if there are suspected *Legionella* health problems associated with the use of potable water, as directed by state and local health department authorities.These procedures shall include criteria for when to test for *Legionella* in the potable water.

8.2 Cooling Towers and Evaporative Condensers. This section describes the standard's requirements for cooling towers and evaporative condensers. In addition, recommendations and guidance on the design, maintenance, and operation of cooling towers and evaporative condensers are provided in ASHRAE Guideline 12 (see Item 1 in Section 9, References). **Note:** Other resources include Associated Water Technologies (AWT) and the Cooling Technology Institute (CTI). See Appendix A, Bibliography.

8.2.1 Equipment Siting. For new construction or for significant modifications to a cooling system that includes a cooling tower or an evaporative condenser, drawings shall be reviewed to minimize site issues prior to beginning construction. In addition, the HACCP plan shall

a) identify and address any equipment siting issues that might allow contamination to be drawn into the equipment.
b) identify and address any equipment siting issues which may allow cooling tower or evaporative condenser exhaust to infiltrate buildings or public areas.
c) identify and address equipment access issues which might inhibit desired maintenance and inspection activities.

8.2.2 New System Startup. The HACCP plan shall include a written startup plan that

a) includes any cleaning steps that are part of commissioning of the cooling system and identifies responsible parties.
b) includes a means of ensuring that an ongoing water treatment program is initiated immediately once the system is charged with water.

8.2.3 System Maintenance. The HACCP plan shall include a written maintenance program that

a) specifies inspections for general system cleanliness, drift eliminator condition, condition of fill material, and water distribution system operation.
b) includes basin or remote sump cleaning and purging of stagnant or low flow zones.
c) identifies responsible parties and includes a mechanism for recording maintenance activities and inspection notes.

8.2.4 Water Treatment. The HACCP plan shall include a written water treatment plan for control of biofouling (including *Legionella*), scale and corrosion. The water treatment plan shall:

a) specify all equipment and chemicals used for the purpose of treating the system's open recirculating loop.
b) include evaluation for control of solids. **Note:** Contaminants in a cooling tower system, both suspended and precipitated solids, facilitate the growth of bacteria and biofilms that can impact the potential for *Legionella*.
c) require that control of solids in cooling tower water and in basins be accomplished through filtration, physical cleaning, or other means such as chemical water treatment.
d) identify the parties responsible for providing and maintaining the system water treatment.
e) include an inspection and maintenance schedule for the water treatment equipment and a schedule for any testing required as part of the water treatment plan.

8.2.5 Shutdown and Startup. The HACCP plan shall meet the following requirements regarding startup and shutdown procedures. It shall:

a) include a written shutdown procedure that includes any chemical pretreatment steps or pump cycling protocols, as well as provision for system drainage for shutdown periods of longer duration, as specified in the plan.
b) include a written procedure for startup from a drained system.
c) include a written procedure for start-up from an undrained (stagnant) system that exceeds the number of idle days specified in the plan.

Each of these shutdown and startup procedures shall identify the parties responsible for initiating and executing the procedure.

8.2.6 Disinfection of Cooling Towers and Evaporative Condensers. The HACCP plan shall include the following two disinfection procedures:

1) a written procedure for remedial on-line disinfection which includes the conditions that would prompt its application and identifies the parties responsible for initiating and executing the procedure.
2) a written procedure for emergency disinfection which includes the conditions that would prompt its application and identifies the parties responsible for initiating and executing the procedure.

8.3. Whirlpool Spas. This section describes the standard's requirements for public whirlpool spas.

8.3.1 General. Public whirlpool spas shall be operated according to the state and local codes that relate to public swimming and spas.[4] If none apply, then the public whirlpool spas shall be operated according to the voluntary consensus standard APSP 11, *Standard for Water Quality in Public Pools and Spas*.[5] **Note:** These codes and standards typically cover mechanical specifications, operational parameters, water chemistry, and microbiology. While specifically targeted to fixed spas, the operational principles are applicable to public portable spas as well.

8.3.2 Bather-Related Requirements. The HACCP plan shall include the following requirements relating to bathers:

a) a written determination of the allowable bather load for each whirlpool spa and shall assure that it is clearly posted and enforced.
b) a written policy to assure that there is a clear posting of the increased health risk related to use of whirlpool spas by individuals who are immunocompromised or who have chronic lung disease.

8.3.3 Filter Operation and Maintenance. The HACCP plan shall include a written policy for adequate filtration of the whirlpool spa water. **Note:** Filtration of the whirlpool spa water is essential for adequate water quality.

8.3.3.1 Cartridge (canister) filters. The HACCP plan shall have a written policy for the inspection and replacement schedule for all cartridge-type filters and related equipment such as pressure gauges and valves.

8.3.3.2 Granular filters. The HACCP plan shall have a written policy for the backwashing criteria and schedule and for the routine inspection, replacement procedures, and schedule for all granular-type filters and related equipment such as pressure gauges and valves.

8.3.4 Water Quality and Disinfection. The HACCP plan shall have a written description of the procedures for maintaining adequate water quality and disinfection. **Note:** The maintenance of continuous disinfection conditions in a whirlpool spa is critical for control of infectious agents (including *Legionella*) in the spa water. These disinfection and water changing procedures are generally well-described in most state and local regulations relating to public swimming and bathing facilities and in APSP Standard 11 (see Item 5, References).

The HACCP plan shall include the following:

a) a description of the schedule for changing the whirlpool spa water on a regular basis.
b) a policy for maintaining the pH of the water between 7.2 and 7.8.
c) a policy for maintaining free residual halogen levels, including either a free residue of chlorine of ≥ 3.0 mg/L (ppm) and ≤10 mg/L (ppm), or a free residual bromine of ≥4.0 mg/L (ppm) and ≤ 10 mg/L (ppm).

d) a policy for shock disinfection of the whirlpool spa at the end of each day with at least 10.0 mg/L (ppm) halogen, followed by circulation for at least 1 hr.
e) a policy for maintenance of the halogenation system in accordance with the manufacturer's recommendations.
f) a description of the measurement schedule and logbook recording of residual halogen levels during operation.
g) a policy for maintaining operational logbooks that retains at least the most recent 12 months.

8.3.5 Microbiology. The microbiological standards to be achieved by public whirlpool spas are regulated by state and local health departments in order to control disease transmission, particularly fecal-oral transmission of disease. The HACCP plan shall have a written description of these operational procedures.

8.3.5.1 Monitoring. The HACCP plan shall include the following:
a) a description of the scheduled monthly monitoring of the spa water for indicator organisms.
b) a policy for maintaining the levels of indicator organisms below the standard threshold, including:
   - The aerobic heterotrophic colony count shall be ≤200 CFU/ml
   - The total coliform count shall be ≤ 2 CFU/100ml
   - The total *E. coli* count shall be < 1 CFU/100 ml.
c) a description of the procedures to be followed if the results are unsatisfactory, including a review of the halogenations records and the repetition of the microbiological tests.

8.3.5.2 When Contamination Is Discovered. The HACCP plan shall have a description of the procedures to be followed if there is evidence of gross contamination (e.g., feces, vomiting). The policy for addressing such incidents shall include taking the spa out of use immediately for cleaning and disinfection of the entire system.

8.3.5.3 When *Legionella* Is Suspected. The HACCP plan shall have a description of the procedures to be followed if there are suspected *Legionella* health problems associated with the use of a whirlpool spa. These procedures shall include criteria for when to test for *Legionella* in the spa water.

8.3.6 Operating Manuals. The HACCP plan shall include a policy for regularly updating all operating manuals for filters, pumps and halogenations equipment and maintaining them at a secure location that is accessible to maintenance personnel.

8.4 Decorative Fountains and Other Water Features

8.4.1 Design. Water features shall be designed such that the following requirements are satisfied:

a) Organic contamination drawn into the system shall be minimized. Equipment shall not be located in the immediate area of kitchen exhaust fans, plants, truck bays, or other sources of organic matter.
b) Provision for maintenance shall be considered in the design stage.
   - Drains shall be situated at the lowest level of the feature, with no other local low points that are not served by drains.
   - Stagnant areas or areas that cannot be cleaned are not allowed.
   - Easy access shall be provided to pump(s), filter(s), tanks and treatment equipment.

c) External heat sources shall be minimized.
   - If submerged lighting is used, the water circulation and evaporation rate shall be such that the water temperature in the area of the light and the overall water temperature in the feature are not significantly elevated by submerged lighting.
   - LED lighting shall be used in place of incandescent whenever possible.
   - If UV systems are used, they shall be sized for the flow volume. **Note:** Oversized UV units will add excess heat to the system.

d) Air flow shall be provided for water features located indoors. Where possible, air flow shall be towards water feature and away from people. Note: Small water features typically reject little to no heat. Larger water features, especially units with significant heat sources, may need additional air flow to remove generated heat and moisture.

8.4.2 Operation. The HACCP plan shall include a written description of the procedures for operating water features such that they meet the following requirements:

a) If the water feature is not in operation for three or more consecutive days, it shall be drained, all components cleaned with a disinfectant, and refilled.
b) Submerged lights shall not be operated without a circulating pump running.
c) A circulating pump shall be kept running as much as possible to minimize stagnant conditions.

8.4.3 Maintenance. The HACCP plan shall include a written description of the procedures for maintenance of water features to include the following:

a) Fountains and other water features shall be cleaned regularly in order to reduce the nutrients available for *Legionella* growth. The basin of the unit shall be cleaned when buildup of dirt, organic matter, or other debris is visible.
b) Use of filters shall be considered. If filters are used, a microbial fouling treatment program shall be implemented because filters provide an excellent medium for bacterial growth.
c) Pumps and filters shall be maintained as recommended by manufacturer. **Note:** Issues with bearings or pressure drop from dirty filters can cause pumps to run hotter.

8.4.4 Water Treatment. Microbial fouling control is required for water features. The HACCP plan shall include a written description of water treatment procedures. For small systems (less than 5 gallons total water volume), this can be accomplished by weekly cleaning, disinfecting of the equipment and components, and replacement of water or by using an effective biocide program. For medium-to-large systems, fouling control will require an effective biocide program. If biocides are used, they shall be used in accordance with local and governmental regulations. **Note:** Further information and details on the use of biocides are given in ASHRAE Guideline 12 and the ASHRAE Handbook, HVAC Applications (see Appendix A, Bibliography).

8.5. Direct and Indirect Evaporative Air Coolers, Misters, Humidifiers and Air Washers. This section describes the standard's requirements for direct and indirect evaporative air coolers, misters, humidifiers, and air washers. **Note:** In addition, ASHRAE Guideline 12 provides informative guidance on design, maintenance, and operation of these types of equipment and systems (see Appendix A, Bibliography).

8.5.1 Design. For the types of aerosol-generating equipment identified in this section, the HACCP plan shall:

a) identify and address any deficiencies in equipment siting that might allow contamination to be drawn into the system.

b) identify and address any deficiencies in equipment access that might inhibit desired maintenance and inspection activities.

8.5.2 New System Startup. The HACCP plan shall include a written startup plan that includes any cleaning steps that are part of commissioning of evaporative air coolers, misters, humidifiers and air washers and identifies responsible parties.

8.5.3 System Maintenance. For the types of aerosol-generating equipment identified in this section, the HACCP plan shall (where applicable):

a) include a written maintenance schedule that specifies inspections for general system cleanliness, air washer mist eliminator condition, condition of evaporative cooler media, condition of any spray nozzles and water distribution system operation.
b) include basin or remote sump cleaning and purging of stagnant or low flow zones.
c) identify responsible parties and include a mechanism for recording maintenance activities and inspection notes.

8.5.4 Water Treatment. When water treatment is used in evaporative air coolers, misters, humidifiers or air washers, the HACCP plan shall:

a) include a written water treatment plan that specifies all equipment and chemicals used for the purpose of treating the system's open recirculating loop.
b) include an inspection and maintenance schedule for the water treatment equipment and a schedule for any testing required as part of the water treatment plan.
c) identify the parties responsible for providing and maintaining the system water treatment.

8.5.5 System Shutdown and Start-Up. For the types of aerosol-generating equipment identified in this section, the HACCP plan shall (where applicable):

a) include a written shutdown procedure that includes any chemical pretreatment steps or pump cycling protocols, as well as provision for system drainage for shutdown periods of longer duration, as specified in the plan.
b) include a written procedure for startup from a drained system.
c) include a written procedure for startup from an undrained (stagnant) system that exceeds the number of idle days specified in the plan.
d) identify the parties responsible for initiating and executing each startup and shutdown procedure.

8.5.6 Disinfection. For the types of aerosol-generating equipment identified in this section, the HACCP plan shall:

a) include a written procedure for remedial on-line disinfection that specifies the conditions which would prompt its application and identifies the parties responsible for initiating and executing the procedure.
b) include a written procedure for emergency disinfection that specifies the conditions which would prompt its application and identifies the parties responsible for initiating and executing the procedure.

9. REFERENCES

1. ASHRAE Guideline 12-2000, *Minimizing the Risk of Legionellosis Associated with Building Water Systems.*

2. Code of Federal Regulations, 40 CFR 141-143.

3. Refer to the NSF International web site to determine whether a particular water-treatment chemical or device is certified. See http://www.nsf.org/Certified/PwsComponents/ or http://www.nsf.org/Certified/PwsChemicals/

4. Refer to the National Swimming Pool Foundation web site for applicable state and local codes. (http://www.nspf.org/Codes_Links.html).

5. ANSI/APSP 11-2009, *Standard for Water Quality in Public Pools and Spas.*

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX A, BIBLIOGRAPHY

ASHRAE Guideline 12-2000, Minimizing the Risk of Legionellosis Associated with Building Water Systems, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

2009 ASHRAE Handbook—Fundamentals, Chapter 10, "Indoor Environmental Health," American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

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2007 ASHRAE Handbook—Applications, Chapter 48, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Association of Water Technologies, Inc. (AWT); Rockville, MD; *Legionella* 2003: An Update and Statement by the Association of Water Technologies. June 2003 (www.awt.org)

Cooling Technology Institute (CTI); Houston, TX; Legionellosis Guideline: Best Practices for Control of *Legionella*; July 2008. (www.cti.org)

Van Schothorst, M.. *A Simple Guide to Understanding and Applying the Hazard Analysis Critical Control Point Concept.* Brussels; 2004.

World Health Organization. *Legionella and the Prevention of Legionellosis*. Geneva, Switzerland: WHO; 2007.

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INFORMATIVE APPENDIX B

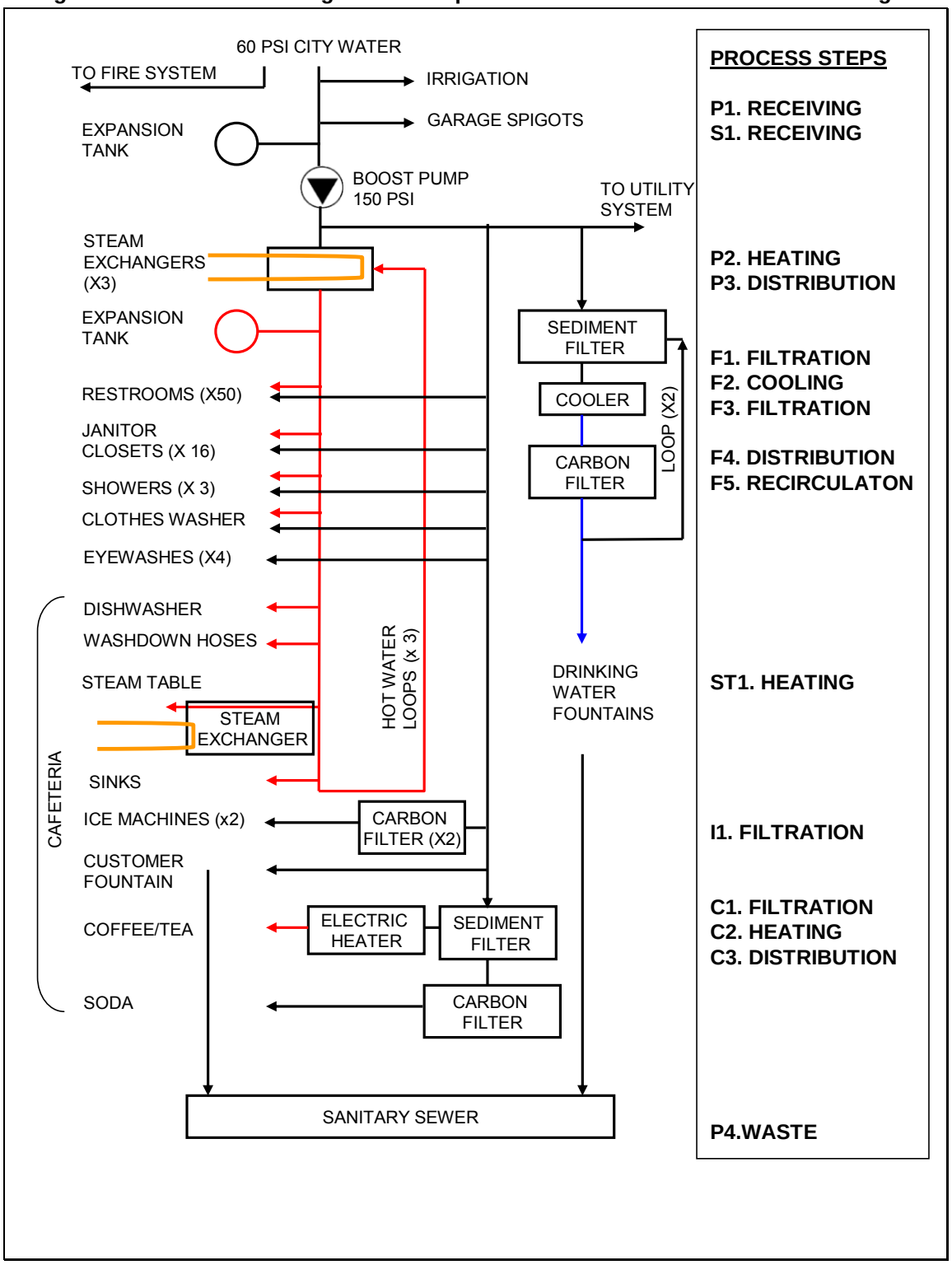
Guidance for Hazard Analysis and Control, HACCP

The following tables and figures provide guidance for Sections 7-8 of this standard. This HACCP plan and the supporting documents are examples and can be used as a template. They do not constitute specific nor general recommendations and should not be construed as such.

Appendix B contains a hypothetical HACCP plan for a hypothetical building water system:

1. Process flow diagrams (Figures B1 and B2)
2. Hazard analysis summaries (Tables B1 and B2)
3. Validation summary and monitoring schedule

Figure B1. Process flow diagram for the potable water service in an office building.

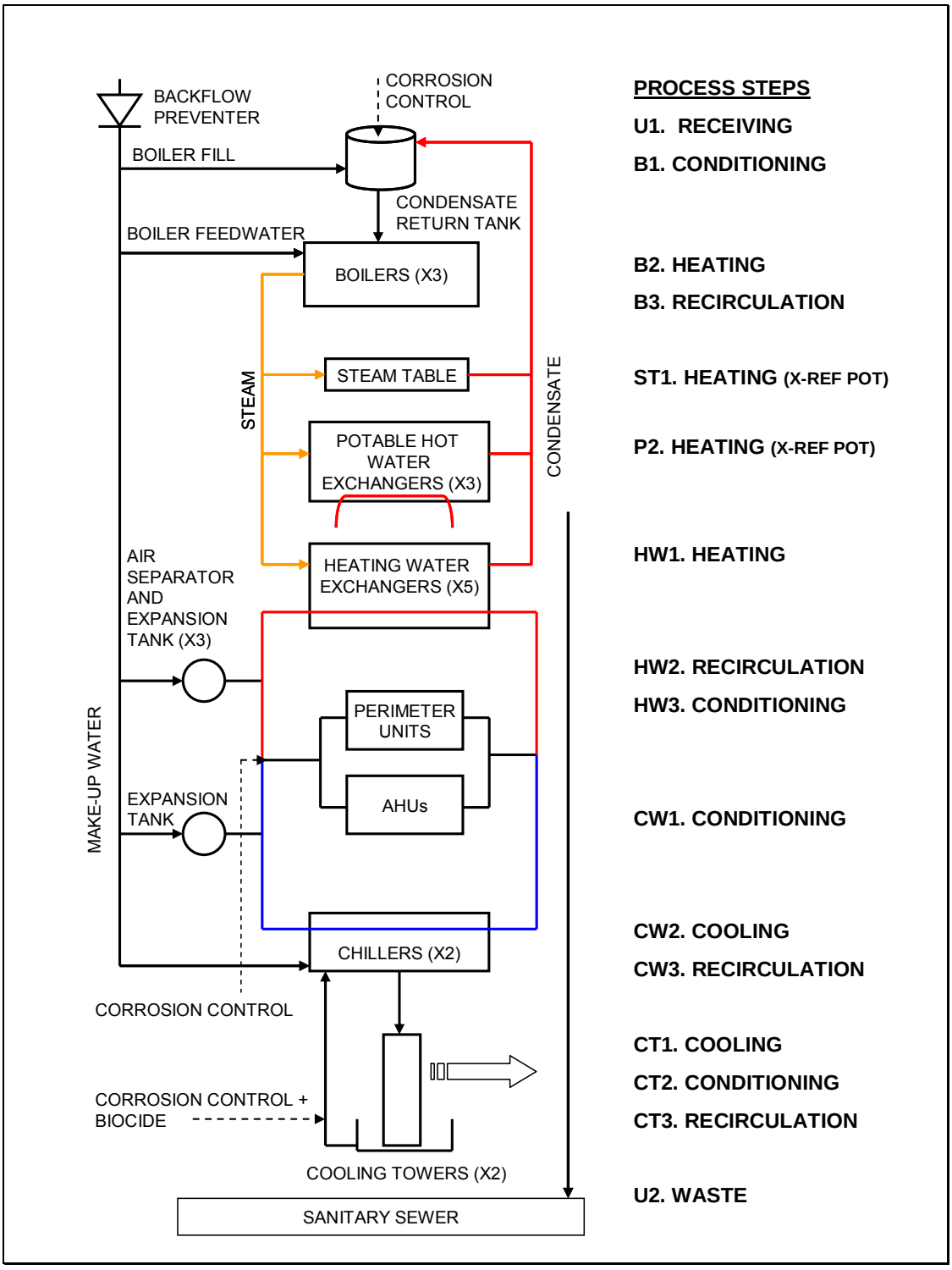


P = primary potable S = fire suppression F = drinking fountains

ST = steam table I = ice machine C = cafeteria service line

Note that each processing step is named and numbered; these names and numbers are used in the Hazard Analysis Summaries (Table B1 and B2).

Figure B2. Process flow diagram for the utility water service in an office building.



U = utility B = boiler ST = steam table P = primary potable HW = hot water CW = chilled water (evaporator) CT = cooling tower (condensate) X-REF POT = cross-reference potable water system

Note that each processing step is named and numbered; these names and numbers are used in the Hazard Analysis Summaries (Table B1 and B2).

Table B1 Hazard analysis summary for the office building potable water system described in the process flow diagram (Figure B1).

Product: Potable Water **Processing Steps**	**System /subsystem**	**Identify potential hazard introduced, enhanced or controlled at this step**	**Risk and Severity Significant?**	**Basis for the Risk Characterization**	**What controls *could* be applied to eliminate, reduce or prevent the hazard from causing harm?**	**CP**	**CCP**
P1 RECEIVING	General system	**B = Biological Hazards** Coliforms, *Legionella*, viruses, and protozoa **C = Chemical Hazards** Lead, other metals, and disinfection by-products **P = Physical Hazards** Radon	No	Low risk because water is treated to US Standards for drinking water given in the Code of Federal Regulations	Obtain product from sources that are certified to the National Primary Drinking Water Regulations (NPDWR) Obtain water quality test results from the water provider every six months	B C P	No
S1 RECEIVING	Fire suppression	B = microbial growth due to stagnant water in FS system	No	Low risk because limited exposure	Wear PPE during routine maintenance and periodic flushing	B	No
P2 HEATING Steam Tables	General system	B = Growth of microbes in the heating system	No	Medium risk because no storage tanks	Maintain temperature in hot water loop above 140 °F Thermal flush hot water loop >120 °F periodically	B	NO
P3 DISTRIBUTION	General system	B = Microbial growth in the potable water distribution system which could be transmitted by faucets and showerheads C = Toxins could be transmitted by ingestion P = Scaling	Yes	Low or medium risk because municipal water source has a measurable halogen residual in the building water system	Flush system x times per year Chlorinate x times per year	B C	YES B,C
F1 FILTRATION	Drinking fountains	B = Microbial growth in filter media	Yes	Medium risk because improperly maintained filters can cause poor microbiological quality	Maintain filters according to manufacturers instructions Replace filters x times per year	B	NO
F2 COOLING	Drinking fountains	B = Microbial growth in the potable water distribution system	No	Low risk because temperature is maintained below 65 °F		B	NO
F3 2^{ND}	Drinking	B = Microbial growth in filter	Yes	High risk because filtration media	Maintain filters according to	B	YES

FILTRATION	fountains	media		are known to harbor pathogenic bacteria if not properly maintained	manufacturers instructions Backwash filters? Eliminate the filter UV disinfection	P	B
ST1 HEATING	Steam table	No Biological Hazard	No	Low risk; no exposure	None	B	NO
I1 FILTRATION	Ice machines	B = Microbial growth in filter media	Yes	High risk because filtration media are known to harbor pathogenic bacteria if not properly maintained	Maintain filters according to manufacturers instructions Backwash filters Replace filters x times per year	B P	YES B
C1 FILTRATION	Cafe service line	B = Microbial growth in filter media	Yes	Low risk because filtration media, in particular carbon filters, can be a source of contamination but the kitchen SOP is adequate	Maintain filters according to manufacturers instructions Backwash filters? Replace filters x times per year	B	NO
C2 HEATING	Cafe service line	B = Growth of microbes in the heating system P = Scalding	No	Low risk because hot water temperature is maintained above 148 °F	Maintain temperature above 148 °F	B	NO
C3 DISTRIBUTION	Cafe service line	B = Microbial growth in the potable water distribution system	Yes	Low risk because kitchen hot water is above 125 °F and the kitchen SOP is based on HACCP plan	Periodic validation and verification of HACCP plan which is basis for kitchen SOP	B	NO
P4 WASTE	General system	B, C and P = Exposure hazards	No	Sewage can transmit waterborne pathogens but exposure is limited	Maintain physical barriers	B	NO

Note: Firewater and Waste system process flow diagrams were produced; the team decided that HA risk characterization was low risk for both systems. If the control limit is exceeded at a CCP occurs, then corrective actions must be immediately implemented.

Table B2 Hazard analysis summary for an office building utility water system described in the process flow diagram (Figure B2).

Product: Utility Water **Processing Steps**	**System/ subsystem**	**Identify potential hazard introduced, enhanced or controlled at this step**	**Risk and Severity Significant?**	**Basis for the Risk Characterization**	**What controls *could* be applied to eliminate, reduce or prevent the hazard from causing harm?**	**CP**	**CCP**
U1 RECEIVING	General utility system	**B = Biological Hazards** Coliforms, *Legionella*, viruses, and protozoa **C = Chemical Hazards** Lead, other metals, and disinfection by-products **P = Physical Hazards** Radon	No	Low risk because water is treated to US Standards for drinking water given in the Code of Federal Regulations	Obtain product from sources that are certified to the National Primary Drinking Water Regulations (NDWR) Obtain water quality test results from the water provider every six months	B C P	NO
B1 CONDITIONING	Boilers	C = treatment chemicals	No		Maintain boilers to manufactures' specifications	P	NO
B2 HEATING	Boilers	No Biological Hazards	No		Maintenance	P	NO
B3 RECIRCULATION	Boilers	No Biological Hazards	No		Maintenance	P	NO
ST1 HEATING	Steam table (x-ref potable sys)	No Biological Hazards	Yes	Low risk because no exposure	Maintenance		NO
P2 HEATING	Potable hot water (x-ref potable sys)	No Biological Hazards	Yes	Low risk because no exposure	Routine Maintenance	P	
HW1 HEATING	Heating water	No Biological Hazards	No		Routine Maintenance	P	
HW2 RECIRCULATION	Heating water	No Biological Hazards	No		Routine Maintenance	P	
HW3 CONDITIONING	Heating water	No Biological Hazards	No		Routine Maintenance	P	
CW1–CW3 CHILLED WATER	Chilled water	No Biological Hazards	No		Routine Maintenance		
CT1-3 CONDENSER WATER	Cooling towers	B = pathogenic bacteria such as *Legionella* can thrive in improperly maintained cooling water systems	Yes	Medium risk because transmission from cooling water to susceptible people can cause disease	Control makeup water hardness Control pH, scale, corrosion and microbial fouling Perform regular maintenance Maintain drift eliminators	B C	YES B C
U2 WASTE	General utility system	Possible bio hazards from fecal coliforms and viruses. Possible chemical hazard from overfeeding inhibitors	No	Low risk; limited exposure. Sewage can transmit waterborne pathogens	Routine Maintenance	B C	

Validation Summary and Monitoring Schedule

The Validation Summary and Monitoring Schedule documents should be prepared by the HACCP Team as described in Section 5.1.1. The Validation Summary should include the supporting scientific evidence and/or scientific consensus used in the selection of each control point, critical control point, critical limit, and corrective action. A wide variety of sources can be used to validate various elements of the HACCP plan, including published original *Legionella* research, published *Legionella* review articles, or published *Legionella* guidelines and standards from government and professional organizations. For example, the published literature, including the VHA Directive 2009-009 *Domestic Hot Water Temperature Limits for Legionella Prevention and Scald Control*, have documented the relationship between temperature and the growth of *Legionella* and can be used to validate the selection of temperatures for storage and distribution of hot and cold potable water and for corrective actions when critical limits are exceeded. Similarly, the choice of potable water secondary disinfection systems (e.g., chlorine, chlorine dioxide, cooper-silver ionization) can be validated by referencing published information on the effectiveness of those procedures, especially when studied under conditions similar to those in the facility where the HACCP plan is being developed. All biocide users are legally required to insure the biocides they use are EPA approved for the application and are required to have an EPA product label that lists that specific approval. The EPA product label can be used as one point of validation. Point-of-use filtration devices that prevent passage of *Legionella* may be selected as another hazard control method at critical control point(s) in potable water systems.

A Monitoring Schedule for each critical control point must also be established and should include the frequency with which each control (e.g. chlorine residual, temperature, dissolved copper/silver concentrations, etc.) is monitored, and the time frame within which corrective actions should be taken when critical limits are violated. Information on the choice of these time intervals can be found in the same published *Legionella* information mentioned above (examples are found in Table B3 below).

It should be understood by the HACCP Team that neither a HACCP plan, in general, nor critical control points, in particular, represent guarantees of prevention of *Legionella* colonization in building water systems. Nevertheless, some critical control points are more reliable than others. For example, biocide use in cooling tower utility water systems is important for *Legionella* control. However, there are no biocides or combination of biocides that eliminate *Legionella* under all conditions, and high levels of *Legionella* colonization have been documented with all biocide combinations. Failures at the critical control points (often in spite of corrective actions) are obviously a concern in all buildings, but are a particular concern for hospitals where the patient populations are more susceptible to *Legionella* infection once exposed. Thus, the HACCP Team should consider the value of determining if Legionella are present at detectable quantities in the water system. Procedures for Legionella testing should be carefully considered, and published standards, directives, and guidelines should be consulted by the HACCP Team for advice in the following:

1. Testing methodology: Culture remains the recommended method for *Legionella* monitoring. Alternative methods to detect *Legionella* such as direct fluorescence microscopy (DFA) or polymerase chain reaction (PCR) methods that do not differentiate living from non-living *Legionella* nor enumerate them should not be used until additional data on their sensitivity and predictive value has been scientifically validated. Standardized culture procedures include ISO 11731: *Detection and Enumeration of Legionella,* and CDC: *Procedures for the Recovery of Legionella from the Environment.* Laboratory results should include specific reporting of *L. pneumophila* serogroup 1. Laboratories chosen for processing of water samples for *Legionella* should be accredited in environmental microbiology (e.g., EPA NELAP or AIHA EMLAP) and also specifically certified for *Legionella* in the CDC ELITE program.

2. Selection of sample locations: Sample locations and the numbers of samples should be determined by the HACCP team based on knowledge of the systems. Sample locations for potable water systems, for example, should roughly represent the building water distribution system (floors, wings, risers, storage and outlets). For healthcare facilities, samples should be taken from patient care units (ICU's, hematology-oncology, medical-surgical, transplant).

3. End-points for *Legionella*: Some published guidelines or directives (e.g. VHA Directive 2008-010, *Prevention of Legionella Disease*) for potable water systems support using the proportion of cultured sites positive for *Legionella* (regardless of the concentration at any one site). Other published guidelines rely on colony counts within individual sites to characterize risk. Certainly utility water, heated spas and other water systems will rely on the detected number of *Legionella* at any one site. There are no definitive data which can be used to ascribe acceptable levels of *Legionella* in building water systems. Any detectable *Legionella* can represent risk under certain circumstances. The HACCP Team must assess the risks of individuals exposed to their building water system and review national and international published guidelines, standards, and directives when making these decisions.

4. Monitoring Frequency: For water systems where *Legionella* monitoring has been selected by the HACCP Team as part of the Critical Control Point validation, a monitoring schedule for *Legionella* must be included in the required Monitoring Schedule. Advice on monitoring frequency can be obtained from the referenced national and international published guidelines, standards, and directives.

Table B3. Example form of validation and verification schedule for the office building water system described in Figs. B1 and B2 and in Table B1-2.

Activity	**Frequency*** ((i.e., Initially, quarterly , annually or other specified trigger point))	**Responsibility**** (i.e., Engineering Technician, Independent surveillance, Executive Engineer)	**Reviewer Accountability**** (i.e., Facility Manager Chief Building Operating Engineer, Independent Reviewer)
Initial validation of the HACCP plan	_____	_____	
Verification that CCP monitoring is according to plan	_____	_____	
Subsequent validation of hazard control	_____	_____	_____
Review of corrective action monitoring to verify that it is according to plan	_____	_____	_____
Scheduling verification activities	_____	_____	_____
Comprehensive plan verification and reassessment	_____	_____	_____

*These are typical frequencies, responsibilities and accountabilities. The Risk Management Team should decide the specification.
**Names and contact information are required for all personnel indicated.

Table B4. HACCP plan for the building water system described in Fig B1, B2 and Tables B1-3.

Product: Potable Water **Processing Step**	**CCP #**	**Critical Control Limit**	**Monitoring Method**	**Frequency**	**Corrective Actions for Deviation from Limits**	**Location of Records**	**Verification Procedure** (Responsible persons)
STEP No. P3 DISTRIBUTION	1B 1C						
STEP No. F3 2nd FILTRATION (Drinking water fountains)	2B						
STEP No. I3 ICE MACHINE FILTRATION	3B						
Product: Utility Water **Processing Step**	**CCP #**	**Critical Control Limit**	**Monitoring Method**	**Frequency**	**Corrective Actions for Deviation from Limits**	**Location of Records**	**Verification Procedure** (Responsible persons)
STEP No. CT1-3 CONDENSER WATER (Cooling Towers)	1B 1C						

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INFORMATIVE APPENDIX C

Guidance on the Protection of Personnel

C1. Personal Protection Equipment for Cooling Tower Cleaning, Repair and Maintenance

Individuals working near cooling towers do not normally need to wear protective equipment. However, maintenance personnel and others working on or in the equipment may.

Chemicals are often used to treat cooling tower recirculating water. Safe handling of these chemicals requires the use of personal protective equipment (PPE). There are many guidelines for safely handling these products. One such guideline is CTI Bulletin WTP-129 “Recommendations for Handling Water Treatment Chemicals Safely”.

In addition to the PPE required for safely working with chemicals, additional equipment may be appropriate when the potential for *Legionella* exposure is significant.

Legionella infection occurs by the inhalation or aspiration of *Legionella* bacteria. Maintenance workers for cooling water systems can be at increased risk of exposure to airborne bacteria, particularly during cleaning. Most *Legionella* bacteria in a cooling system are located in biofilms attached to wetted surfaces. During cleaning, especially with power washing, *Legionella* bacteria in the biofilm may become airborne. Cleaning, repair and maintenance should always be performed in a way that minimizes the generation of airborne debris.

There are no OSHA (US Occupational Safety and Health Organization) exposure limits for *Legionella*, however it is good practice to encourage the voluntary use of dust masks when performing cleaning, repair, or maintenance on open cooling systems. When dust masks are used, a NIOSH certified N95 dust mask or better is recommended. N95 refers to particulate masks that are not resistant to oil and have 95% efficiency in removing 0.3-micron particles. If chemical vapors will be present in significant concentrations, a different style of filter may be required.

OSHA requires that a written program be in place whenever respirators are required to be worn, however, medical evaluations, fit tests, and in-depth care training are not required for workers who voluntarily wear dust masks. OSHA does require that workers who voluntarily wear dust masks be provided with the information in Appendix D of the Respiratory Protection Standard[1].

If there has been an identified outbreak of legionellosis, OSHA requires that investigators

> “wear appropriate respiratory protection in the form of a half-face piece respirator equipped with a HEPA filter or a similar type of filter media capable of effectively collecting particles in the one micron size range during the examination of water systems if a significant potential exists for exposure to high concentrations of contaminated aerosols.”

A NIOSH certified N95 dust mask will meet this requirement, but this now is a required use of a dust mask rather than voluntary, and the employer must satisfy all of the requirements of the OSHA Technical Manual Section 8 Chapter 2 “Respiratory Protection.”

C2. Appendix C References

1) OSHA Technical Manual Section 8 Chapter 2 “Respiratory Protection”
2) http://www.osha.gov/dts/osta/otm/otm_viii/otm_viii_2.html Technical Manual Respirators
3) http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_7.html Technical Manual *Legionella*
5) http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/