BSR/ASHRAE Standard 188P

Public Review Draft

ASHRAE® Standard

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

Second Public Review (June 2011)
(Complete Draft for Full Review)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed addendum, go to the ASHRAE website at http://www.ashrae.org/technology/page/331 and access the online comment database. The draft is subject to modification until it is approved for publication by the ASHRAE Board of Directors and ANSI. The current edition of any standard may be purchased from the ASHRAE Bookstore @ http://www/ashrae.org or by calling 404-636-8400 or 1-800-527-4723 (for orders in the U.S. or Canada).

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FOREWORD

(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.)

The goal of this document is to specify a Standard Practice for use by facility managers/owners to prevent legionellosis associated with building water systems.

Legionellosis refers to two distinct clinical illnesses. When the bacterium Legionella causes pneumonia, the disease is referred to as Legionnaires' disease, or LD. The Centers for Disease Control and Prevention (CDC) estimates that each year there are between 8,000 and 18,000 cases of Legionnaires' disease in the United States and that more than 10 percent of these cases are fatal. Legionella can also cause a less severe influenza-like illness known as Pontiac Fever. Essentially all cases of legionellosis are the result of exposure to Legionella associated with building water systems.

The presence of Legionella bacteria in building water systems is not in itself sufficient to cause LD. Other necessary factors include environmental conditions that promote the growth of Legionella (e.g., warm water temperatures, biofilms, etc.), a means of transmitting the bacteria to people in the building (e.g., aerosol generation) and exposure of susceptible persons to colonized water that is inhaled or aspirated into the lungs. Legionella bacteria are not transmitted person-to-person or from normal (non-aspirated) ingestion of contaminated water. Susceptible persons at high risk for legionellosis 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 aims to reduce the risk of legionellosis by specifying a practice to identify the conditions in a building water system that can be made less favorable to the growth and transmission of Legionella. By establishing adequate barriers to transmission of Legionella bacteria, implementing sound maintenance procedures and utilizing effective hazard control, the users of this standard can reduce exposure to Legionella. Engineers, architects, and system designers also can use this standard to determine if their building water system design and engineering practices should be reviewed or revised.

The principles of hazard analysis and control have been applied in many industries to prevent harm to individuals from recognized hazards. Since 1996, Hazard Analysis and Critical Control Point (HACCP) plans have been widely used to prevent disease from infectious organisms transmitted from food and water. The World Health Organization specifies use of hazard analysis and control processes for both foodborne and waterborne disease prevention. Because of the widely applied and successful use of HACCP plans in related industries and because a variety of training materials are available at minimal or no cost, the project committee developing this standard chose to specify HACCP as the systematic process to prevent legionellosis associated with building water systems.

This standard consists of numbered normative sections followed by informative appendices. The normative sections specify what is required to comply with the standard. The informative appendices and informative references are provided for guidance about how to do things that may be necessary for a given building water system. Building water systems vary substantially in their design and propensity for transmission of Legionella. Scientific evidence is either lacking or inconclusive in certain aspects of Legionella control. Therefore, the informative appendicies and informative references to this document provide suggestions, recommendations and references to guidance which may be used to establish the HACCP plan for any building water system. The hypothetical examples cited within the appendicies are not to be interpreted as minimum values nor enforced as requirements, but only as illustrations of how to implement a HACCP plan given certain builing construction and operational conditions.

The practice this standard requires is summarized as follows. Initially, facility managers/owners are required to characterize the risk associated with the building and its potential occupants. For those buildings meeting certain criteria, they must next establish a team with assigned responsibilities and

accountabilities. The first job for the team is to describe how water is processed in the building water system and what uses there are for the water by occupants of the facility; this description is schematically represented in process flow diagrams. Each processing step is named and numbered in the diagrams. Next, the team is required to perform systematic hazard analysis in order to identify the potential hazards for each step in the process, decide if the risk of those hazards is significant (yes or no), and if "yes," determine what hazard control is being applied or could be applied at that processing step. Every step in the process at which hazard control is applied is a critical control point. For every critical control point, the team must address four issues about the hazard control method being applied: (1) the critical control limit, (2) the hazard control monitoring method, (3) the frequency of monitoring hazard control and (4) the corrective actions to be taken if the critical control limit is violated. Lastly, the team must decide how it will confirm that the overall HACCP plan is being implemented (verification) and provide evidence that the plan is effective (validation).

Note to reviewers: Notes and examples are informational (non-mandatory) and integrated in the text of this document to give additional information intended to assist in the understanding or use of this document. Notes and examples do not contain requirements or any information considered indispensable for the use of the document.

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 water 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. DEFINITIONS 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. Also, 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 or eliminate 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 upon which a judgment or decision can be based.

critical control point (CCP): a step in a process 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: a failure to meet a *critical limit*.

EPA: the Environmental Protection Agency. See 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.

Inpatient healthcare facility: any acute care hospital, long-term care facility, or skilled nursing facility.

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. Also 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: the 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 food safety.

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. Typical processing steps include conditioning, storing, heating, cooling, recirculating 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 that provides water 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: the 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 provisions of this standard.

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 housing units with one or more centralized water heaters,

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

(c) it is an inpatient healthcare facility,

(d) its occupants are primarily those over the age of 65 years or those receiving chemotherapy for cancer or 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 water features or devices that, by design, release aerosols. This includes, but is not limited to certain types of ornamental fountains, misters (atomizers), air washers or humidifiers either within it or located on its premises, or

(g) the total residual 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 systems described in 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 ASHRAE Guideline 12 (see Item 1 in Section 9, References). The water system management program in this case shall include 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 according to the new survey, then the building shall be subject to the preventive measures required by this new survey. The results of the survey shall be documented each year and available for review at any time.

7. HACCP PLAN GENERAL REQUIREMENTS

7.1 Hazard Analysis and Critical Control Point (HACCP) risk management shall be used to prevent 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 shall consist of 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 given in Appendix B, Figures B1 and B2.
4. Confirm that the process flow diagrams are accurate by an on-site inspection.
5. Use the process flow diagrams and hazard analysis summaries to identify control points (CPs) in the process. **Note:** 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. **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 and the monitoring frequency.
9. For each critical limit, establish corrective actions to take when deviations from critical limits are found.
10. Validate the selection of CCPs, 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 (non-potable) is processed in the facility. Processing steps shall be named and numbered. **Note:** Figures B1 and B2 in Appendix B 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 give 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. **Note:** Appendix B, Table B3 gives examples.
7. **A verification schedule** shall list all verification activities and the frequency with which they will be performed. **Note:** Appendix B, Table B4, gives examples.
8. **Planned responses to disruptions in water service** shall be documented in the HACCP plan. **Note:** Disruptions in water service have been repeatedly associated with outbreaks of Legionnaires' disease.

8. HACCP PLAN REQUIREMENTS FOR BUILDING WATER SYSTEMS

This section further specifies HACCP plan requirements for:

Section 8.1 - Potable Water Systems
Section 8.2 - Cooling Towers and Evaporative Condensers
Section 8.3 - Whirlpool Spas
Section 8.4 - Decorative Fountains and Other Water Features
Section 8.5 - Aerosol Generating Air Coolers, Humidifiers and Air Washers

8.1 Potable Water Systems. This section describes requirements for potable water systems. Recommendations and guidance on the design, maintenance, and operation of potable water systems are provided in ASHRAE Guideline 12 (see Item 1 in Section 9, References) and the ASHRAE "*Handbook of Fundamentals*" Chapter 49, Service Water Heating.

Potable water treatments referred to in this standard shall comply with all applicable local, state and federal regulations including the Safe Drinking Water Act (40 CFR 141-143).[2] All treatments used for drinking water shall be registered and properly labeled by the EPA (as indicated by the EPA registration number on the product label).

8.1.1 New Construction/Renovation. For new construction or for significant modifications to a potable water system, drawings shall be reviewed to identify and address issues prior to beginning construction. The HACCP plan shall address potential hazards from:

a) possible cross connections between potable and non-potable water
b) inadequate access to equipment with water storage capacity such as water expansion tanks, water hammer arrestors and water heaters
c) dead legs or low flow portions of the piping system
d) stratification in hot or cold water storage tanks and heaters
e) heat transfer from hot or cold water piping or heat rejection equipment resulting in heat gain in cold water piping or heat loss in hot water piping

8.1.2 New Systems, Startup and Shutdown. The HACCP plan shall include procedures for:

a) cleaning and disinfection before commissioning any new system
b) shutdown, including any draining, purging, cleaning treatment and control settings
c) any unplanned loss of operating energy, loss of water treatment chemicals or system component repair or replacement
d) restarting safely from a drained shutdown condition or from an undrained (stagnant) shutdown condition
e) monitoring and treatments following water supply interruptions or breaks in water supply piping
f) the method and frequency of temperature measurements in the water heater and in the distribution system

Identification of the responsible persons for these activities shall be documented.

8.1.3 System Maintenance. The HACCP plan shall include:

a) inspection frequencies for water containing vessels and system components
b) maintenance procedures based on equipment manufacturers' recommendations for
    1) cleaning, disinfection and/or replacement of system components
    2) flushing or mixing of stagnant or low flow areas
    3) other treatments and any required monitoring that the HACCP team decides are necessary for
        i. hot and cold storage tanks
        ii. ice machines
        iii. water hammer arrestors
        iv. expansion tanks
        v. water filters
        vi. shower heads and hoses

vii. electronic faucets
viii. aerator and/or faucet flow restrictors
ix. non-steam, aerosol generating humidifiers
x. water heaters with any stored volume of water

c) inspection notes and a corrective actions log
d) regular updates of system component operating manuals
e) identification of the responsible persons.

8.1.4 Water Treatment. The HACCP plan shall include the:

a) monitoring method and frequency of temperature measurement in the hot and cold water systems.

Note: Water temperature recommendations for *Legionella* control are as follows: hot water heater outlet temperature at or above 60°C (140°F); hot water temperature at coldest point in hot water heater, storage tank or distribution system at or above 51°C (124°F); cold water temperature in any part of system at or below 25°C (77°F). If the HACCP team determines that these temperatures cannot be achieved, then it may find that additional hazard control measures are required.

b) monitoring method and frequency of chlorine residual measurement in the hot and cold water system.

Note: The chlorine concentration recommendation for *Legionella* control is >0.5 ppm (mg/l) free residual oxidant, as chlorine. If the HACCP team finds that this recommended concentration is not achieved, then it may determine that supplemental treatments are required.

c) inspection and maintenance schedule for all water treatment equipment and chemicals, which shall be EPA-registered and labeled for potable water disinfection; all treatments shall be applied in compliance with local, state and federal regulations
d) schedule for any monitoring required as part of the water treatment plan
e) procedures following water supply interruptions or breaks in water supply piping
f) identification of responsible persons for maintaining equipment and chemicals

8.1.5 Emergency Disinfection. The HACCP plan shall include procedures to be followed if there are suspected legionellosis health problems associated with the use of potable water in a building system. The plan shall include any directions given by state and local health department authorities. When an outbreak of legionellosis has been associated with a potable water system or suspected cases of the disease occur, disinfection shall be performed. These procedures shall include criteria for when and where to test for *Legionella* in the potable water. The method of emergency disinfection shall be thermal or chemical or any combination. Point-of-use filtration (0.2 micrometer) may be used for *Legionella* control at specific taps and faucets.

Note: Emergency disinfection of hot and cold water systems is potentially hazardous and can cause increased corrosion rates in the potable water system. Routinely performing these procedures can significantly impact equipment/piping lifecycles and is therefore not recommended.
Note: Combining thermal shock (see Section 8.1.5.1.1) and chemical disinfection (see Section 8.1.5.1.2 or 8.1.5.2) 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 or other design/maintenance conditions that caused the problem are corrected.
Note: Point-of-Use filtration does not disinfect a system. It provides hazard control at the point of use only.

8.1.5.1 Hot Water Systems. Disinfection shall be accomplished by the methods of Section 8.1.5.1.1 and/or 8.1.5.1.2.

8.1.5.1.1 An effective method for emergency disinfection of contaminated hot water systems is thermal shock treatment to be implemented using the following procedure:

a) local building and sanitary codes shall be used to set temperature limits
b) building occupants and facility personnel shall be informed that disinfection with water temperatures that could cause scalding will be used
c) water temperatures shall be maintained at 71-77°C (160-170°F) while progressively flushing each outlet in the system

d) a flush time of thirty minutes shall be attempted. The intent is to provide thermal eradication for as long as possible up to thirty minutes; the outlet flow rate shall not surpass the capacity of water heaters to maintain temperature.

Note: In healthcare facilities, flushing should be performed in a manner that reduces the risk of scalding and aerosolization of potable water in patient-care areas. This can be accomplished by flushing to waste upstream of outlets, by flushing risers and recirculation loops from outlets not used by or near patients, or by flushing outlets in patient rooms at low flow or with aerators removed.

8.1.5.1.2 An effective method for emergency disinfection of contaminated hot water systems is shock halogenation to be implemented using the following procedure:

a) building occupants and facility personnel shall be informed that halogen disinfection with concentrations exceeding EPA allowable limits for drinking water will be used
b) an EPA-registered and labeled drinking water product shall be added in accordance with use directions for the EPA-labeled product
c) all outlets shall be flushed until halogen concentration at representative distal taps and faucets is confirmed by measurement and documented
d) close all outlets and disinfect with halogen for a minimum of 2 hours (not to exceed 24 hours).
e) thoroughly flush all outlets. Measure halogen concentration at representative outlets to confirm it is within EPA limits before reuse of the system.

Example: One EPA approved halogen is chlorine. If using chlorine for disinfection, the level of free residual chlorine should be raised to 20-50 mg/L (ppm) of free residual oxidant, as chlorine and maintained at approximately 50 mg/L (ppm) for one hour or at approximately 20 mg/L (ppm) for two hours. The pH of the water should be maintained below pH 8.0 to prevent significant reduction of disinfection efficacy. (Note: If chlorine dioxide is used, pH control is not required)

8.1.5.2 Cold Water Systems. Emergency disinfection of the cold water potable water system shall be achieved by the following halogenation procedure:

a) building occupants and facility personnel shall be informed that halogen disinfection with concentrations exceeding EPA allowable limits for drinking water will be used in the procedure
b) an EPA-registered and labeled drinking water product shall be added to the hot water system in accordance with use directions for the EPA-labeled product
c) all outlets shall be flushed until halogen concentration at representative distal taps and faucets is confirmed by measurement and documented
d) close all outlets and disinfect with halogen for a minimum of 2 hours (not to exceed 24 hours)
e) thoroughly flush all outlets. Measure halogen concentration at representative outlets to confirm it is within EPA limits before reuse of the system.

Example: One EPA approved halogen is chlorine. If using chlorine for disinfection, the level of free residual chlorine should be raised to 20-50 mg/L (ppm) of free residual oxidant, as chlorine and maintained at approximately 50 mg/L (ppm) for one hour or at approximately 20 mg/L (ppm) for two hours. The pH of the water should be maintained below pH 8.0 to prevent significant reduction of disinfection efficacy. (Note: If chlorine dioxide is used, pH control is not required)

8.2 Cooling Towers and Evaporative Condensers. This section describes requirements for cooling towers and evaporative condensers.

Note: In addition, recommendations and guidance on the design, maintenance, and operation of cooling towers and evaporative condensers are provided in ASHRAE Guideline 12 and in the chapter on water treatment in the *ASHRAE Handbook—Applications* (see Bibliography in Appendix A).

Note: Other resources include Association of Water Technologies (AWT) and the Cooling Technology Institute (CTI). See Appendix A, Bibliography.

8.2.1 Equipment Siting. At the time of cooling tower installation (either in a new system or as a replacement in an existing system), drawings shall be reviewed and siting issues addressed prior to beginning construction. The HACCP plan shall identify and address potential hazards related to any:

a) equipment siting issues that allow contamination from building systems or facility processes to be drawn into the equipment

b) equipment siting issues that allow cooling tower or evaporative condenser exhaust to infiltrate buildings
c) equipment access issues that inhibit maintenance and inspection activities.

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

a) any cleaning steps that are part of commissioning of the cooling system, with responsible persons identified
b) 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 the frequency of 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 persons 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 microbiological activity, scale and corrosion. The water treatment plan shall:

a) specify all equipment and chemicals used for the purpose of treating the open recirculating loop
b) require that control of solids in cooling tower water and in basins be achieved through filtration, physical cleaning, or other means such as chemical water treatment

Note: Contaminants in a cooling tower system, both suspended and precipitated solids, facilitate the growth of bacteria and biofilms that can increase the potential for *Legionella*.

c) include a schedule for required inspection, maintenance, monitoring and a corrective actions log
d) identify the persons responsible for providing and maintaining the system water treatment

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

a) shutdown that includes all 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) startup from a drained system
c) startup 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 persons responsible for initiating and executing the procedure.

8.2.6 Disinfection of Cooling Towers and Evaporative Condensers. The HACCP plan shall include written disinfection procedures for:

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

8.2.7 Location of Cooling Tower Make-up Valve. The height of the discharge outlet of the cooling tower make-up valve over the maximum water level in the cooling tower or evaporative condenser basin must comply with state and local codes, but in no case shall be less than 4 inches (10.2 cm).

8.3. Whirlpool Spas. This section describes 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.[3] 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.*[4]

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 also applicable to public portable spas.

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
b) a written policy to ensure that the allowable bather load for each whirlpool spa is clearly posted and enforced.
c) a written policy to ensure 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 include a written policy for the inspection and replacement schedule for all cartridge-type filters and related equipment, including pressure gauges and valves.

8.3.3.2 Granular Filters. The HACCP plan shall include 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, including pressure gauges and valves.

8.3.4 Water Quality and Disinfection. The HACCP plan shall include a written description of the procedures for maintaining adequate water quality and disinfection. **Note:** The maintenance of continuous disinfection in whirlpool spas is critical for control of infectious agents (including *Legionella*) in 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 4, References).

The HACCP plan shall include the following:

a) schedule for changing the whirlpool spa water on a regular basis
b) policy for maintaining the pH of the water between 7.2 and 7.8
c) policy for maintaining free residual halogen levels, including either a free residue of chlorine of 3—8 mg/L (ppm), or a free residual bromine of 4—8 mg/L (ppm)
d) policy for shock disinfection of the whirlpool spa at the end of each day with at least a free residual of 10 mg/L (ppm) halogen, followed by circulation for at least 1 hr
e) policy for maintenance of the halogenation system in accordance with the manufacturer's recommendations
f) measurement schedule and logbook of all residual halogen measurements
g) a corrective actions log
h) policy for requiring operational logbooks to retain 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:

a) description of the scheduled (at least monthly) testing of the spa water for indicator organisms and pathogens of concern.
b) policy for maintaining the levels of indicator organisms at or below the standard threshold, including:
   - the Total Heterotrophic Aerobic Bacteria colony count shall be ≤200 CFU/ml
   - the *E. coli* count shall be < 1 CFU/100 ml.

Note: CFU = colony forming unit in standardized tests

c) description of the procedures to be followed if the results are unsatisfactory, including a review of the halogenation records and the repetition of the microbiological tests.

Note: The HACCP team makes the decision whether or not to test specifically for *Legionella* or other pathogens (e.g., *Pseudomonas aeruginosa*), the frequency of testing, the nature of the samples (water and/or biofilm), and the interpretation of the results. A description of this process can be found in informative Appendix B. Refer to Validation Summary and Monitoring Schedule in this appendix.

8.3.5.2 When Contamination Is Discovered. The HACCP plan shall include 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 Legionellosis Cases Are Suspected. The HACCP plan shall include a description of the procedures to be followed if there are suspected legionellosis health problems associated with the use of a whirlpool spa. The plan shall include any directions given by state and local health department authorities. When an outbreak of legionellosis has been associated with a potable water system or suspected cases of the disease occur, disinfection shall be performed (see 8.3.4d). 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 halogenation equipment and maintaining them at a secure location that is accessible to maintenance personnel.

8.4 Decorative Fountains and Other Water Features This section describes HACCP plan requirements for decorative fountains and other water features that are associated with buildings.

8.4.1 Equipment Sitting. The HACCP plan shall identify and address potential hazards due to:

a) organic contamination drawn into the system (for example from of kitchen exhaust fans, plants, truck bays, or other sources)
b) inadequate drains and stagnant areas

Note: Drains should 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 should be eliminated.

c) Inadequate access to pump(s), filter(s), tanks and treatment equipment.
d) external heat sources and inadequate air flow

Note: If submerged lighting is used, the water circulation and evaporation rate should be such that the water temperatures in the area of the light and in the overall water feature are not significantly elevated from this external heat source. Whenever possible, LED lighting should be used in place of incandescent lights. If UV systems are used for disinfection, they should be sized for the flow volume because oversized UV units will add excess heat to the system.

Note: Where possible, air flow should be towards the water feature and away from people. 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 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) pumps and filters shall be maintained as recommended by filter manufacturer.

Note: Issues with bearings or pressure drop from dirty filters can cause pumps to run hotter.

c) when filters are used, a microbial fouling treatment program shall be implemented to prevent bacterial growth on the filters.

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 (20 liters) total water volume:

a) weekly cleaning, disinfection of equipment and components, and replacement of water shall be required or
b) periodic use of an effective EPA-registered biocide applied according to instructions on the EPA-label.

For larger systems, an effective biocide program shall be required for fouling control. If biocides are used, they shall be registered by the EPA for this application and 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, Applications (see Appendix A, Bibliography).

8.5. Aerosol Generating Air Coolers, Humidifiers and Air Washers. This section describes requirements for air coolers, humidifiers, and air washers that cool or humidify by generating small water droplets discharged into the air. It includes, but is not limited to:

- **Air Washers.** Air washers utilize high-pressure nozzles to reduce water to small droplets for efficient evaporation.
- **Misters.** Misters produce an aerosol by use of ultrasonic devices, spinning disks, or spray nozzles.

Note: Heated element and vapor-type humidifiers convert water to vapor (not aerosols) that is discharged into the space being conditioned. Due to the elevated temperature and the fact that water droplets are not generated, the risk of *Legionella* transmission from these types of humidifiers may not be significant.
Note: 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 Equipment Siting. For the types of aerosol-generating equipment identified in this section, the HACCP plan shall identify and address any deficiencies in:

a) equipment siting that allows contamination to be drawn into the system
b) equipment access that inhibits required maintenance and inspections.

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 persons.

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

a) a written maintenance schedule that specifies inspections for general system cleanliness, air washer mist eliminator condition, condition of evaporative cooler/humidifier media, condition of any spray nozzles and water distribution system operation
b) basin or remote sump cleaning and purging of stagnant or low flow zones
c) documented maintenance procedures, inspection notes and corrective actions
d) identification of responsible persons

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

a) a written water treatment plan that specifies all equipment and chemicals used for the purpose of treating the open recirculating loop
b) an inspection and maintenance schedule for the water treatment equipment
c) a schedule for any monitoring required as part of the water treatment plan
d) identification of the persons responsible for providing and maintaining the system water treatment program

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

a) shutdown 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) startup from a drained system
c) startup from an undrained (stagnant) system that exceeds the number of idle days specified in the plan
d) identification of the persons 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 include written procedures for:

a) remedial on-line disinfection that specifies the conditions which would prompt its application and identifies the persons responsible for initiating and executing the procedure
b) emergency disinfection that specifies the conditions which would prompt its application and identifies the persons 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 National Swimming Pool Foundation web site for applicable state and local codes. (http://www.nspf.org/Codes_Links.html).

4. 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.

2008 ASHRAE Handbook—HVAC Systems & Equipment, Chapter 21, "Humidifiers" American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

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

2007 ASHRAE Handbook--Applications, Chapter 49, "Service Water Heating" 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.

Veterans Affairs Healthcare System *Legionella* Directive. 2008. (*www.va.gov*)

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

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INFORMATIVE APPENDIX B

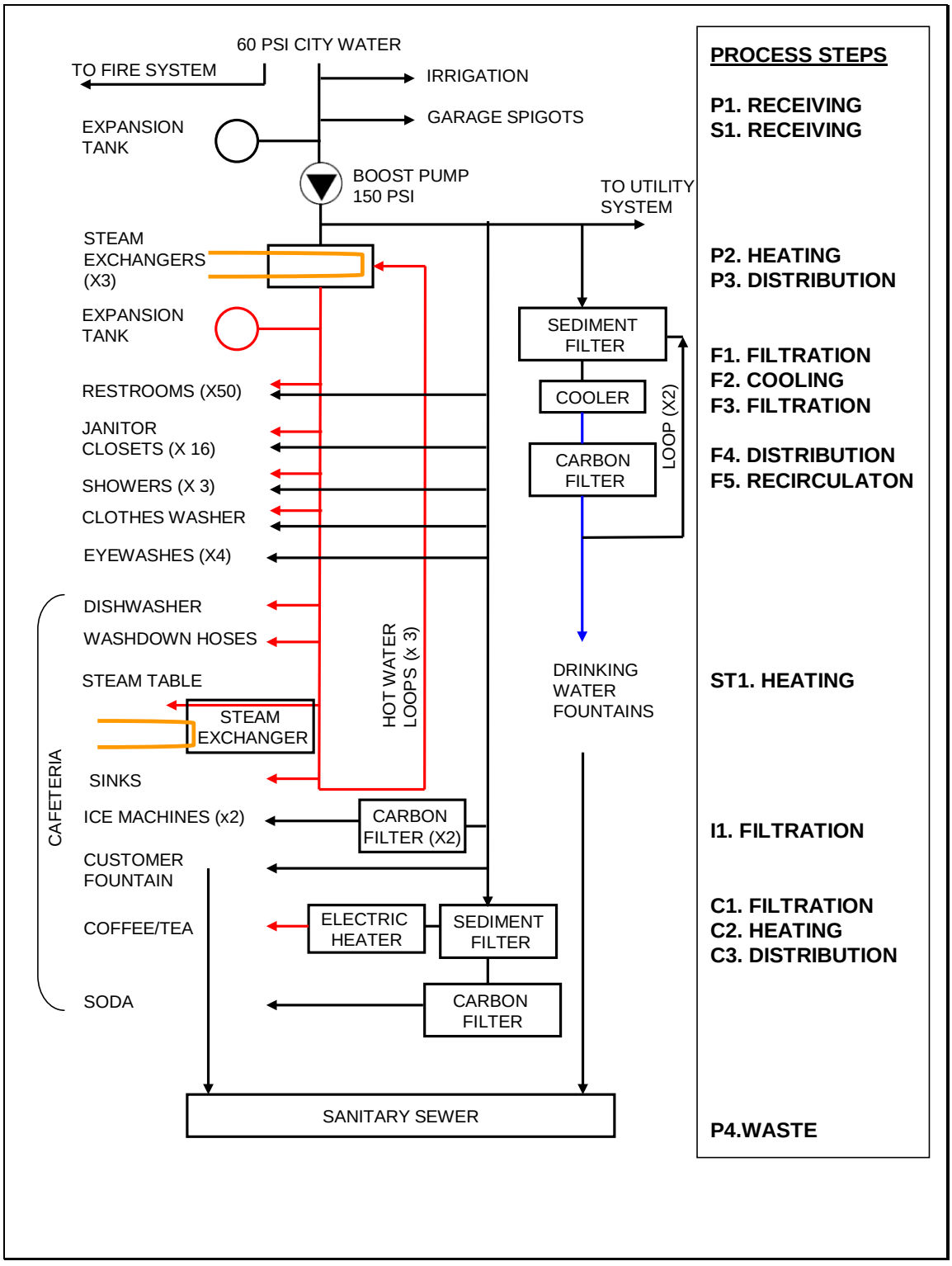
Guidance for Hazard Analysis and Control, HACCP

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, monitoring schedule HACCP plan document (Tables B3 and B4)

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

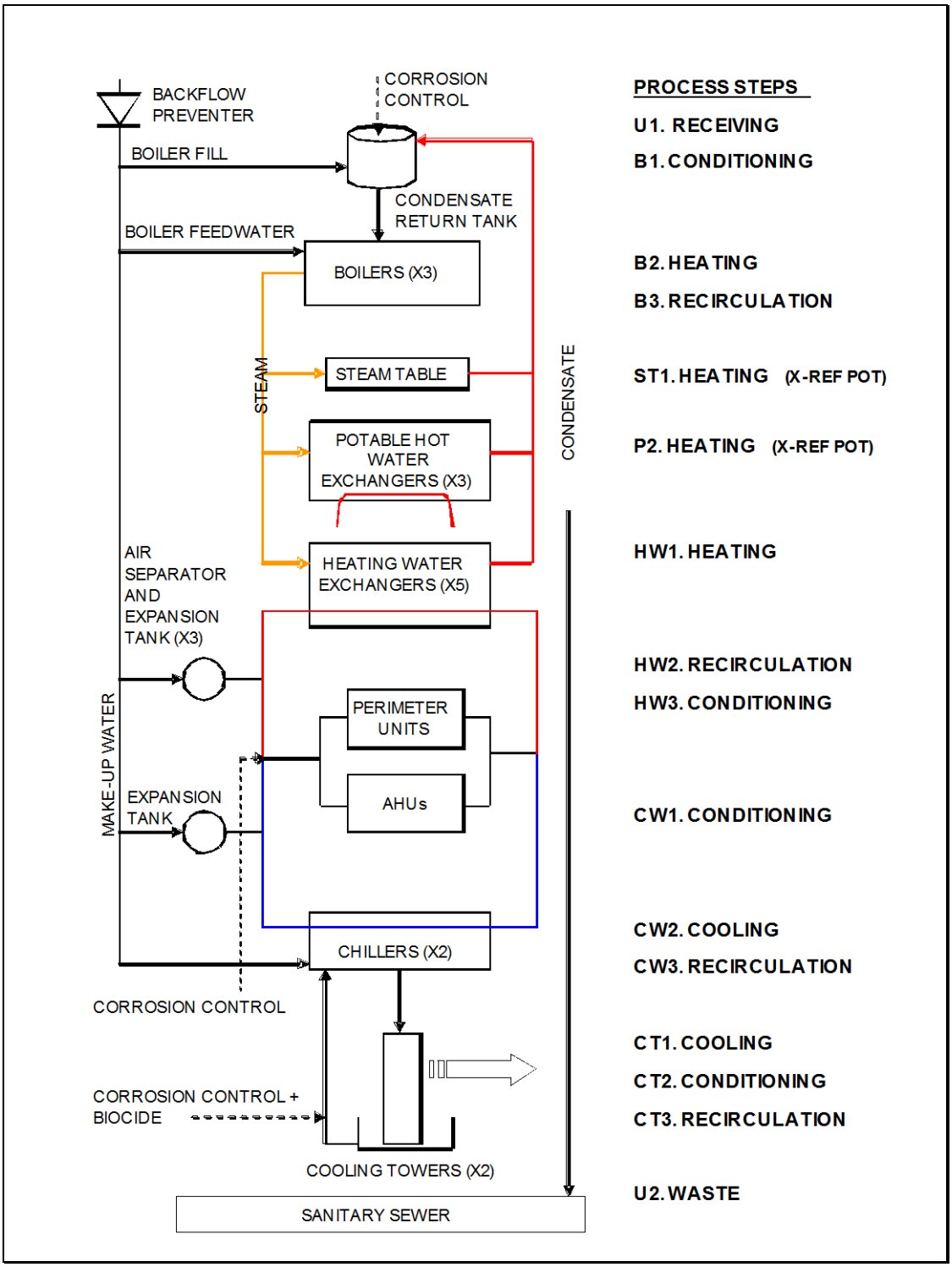


P = primary potable S = fire suppression F = drinking fountains

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 = Scalding	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 and basin cleaning 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 7.3. The Validation Summary should include the supporting scientific evidence and/or scientific consensus used in the selection of each critical control point, critical limit, monitoring method 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 (registered) 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* testing. 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. Testing Frequency: For water systems where *Legionella* testing has been selected by the HACCP Team as part of the Critical Control Point validation, a testing schedule for *Legionella* must be included. Advice on testing 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

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 local and federal guidelines for safely handling certain products and they must be followed.

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."

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/