Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings

George W. Young, CHC, CIEC
Vice President of Operations
Environmental Safety Technologies
Hospital-acquired LD (HA-LD)
-or-
Healthcare-associated LD

Many different *Legionella* species and serogroups
Legionella are a Family of Environmental Bacteria that Live in Water

- Family of different species
  - > 50 different species in genus Legionella
  - L. pneumophila – 90% of disease
  - Some species no disease
Legionella Live in Building Water

- Building water – requirements to be met for Legionnaires disease
  - warm (not too cold, not too hot)
  - high levels of *Legionella*
  - mechanism for airborne (aerosol) dissemination or drinking
  - susceptible host (hospitalized, older, normal people)
- Cooling towers
- Potable water (hot water)
- Whirlpool spas
- Decorative fountains / Water walls
- Hydrotherapy pools
Cooling Tower Outbreaks

Legionella increase to high numbers in the water

Travel distances with the wind

Aerosol

Legionella
Traditional pump install at "A" waste significant resources reheating pipes "B" Installing RedyTemp or it's Temp Probe just after last load on loop and utilize temperature based cyclic-pumping, minimizes demand and extends the life of both water heater and pump.
Potable Water Outbreaks

Legionella

Estimates that 70% of all cases of Legionnaires’ disease are from potable water
Potable Water Outbreaks

Legionella colonize building
potable water systems (especially hot loop)

Faucets/showerheads

Water containing Legionella gets into the air (aerosolization)

Inhale sufficient Legionella into lungs

Growth in lungs

Legionnaires’ Disease pneumonia

Not all of the patients used the showers!
Legionnaires’ Disease

How can this be prevented?
• Complying with ASHRAE Standard 188
• Preventing Legionnaires’ Disease
Part III

• Complying with ASHRAE Standard 188
• Preventing Legionnaires' disease

ASHRAE Standard 188 Committee
Department of Veterans Affairs
Veterans Health Administration
Washington, DC 20420

PREVENTION OF HEALTHCARE-ASSOCIATED LEGIONELLA DISEASE AND SCALD INJURY FROM POTABLE WATER DISTRIBUTION SYSTEMS

1. REASON FOR ISSUE: This Veterans Health Administration (VHA) Directive addresses the prevention of healthcare-associated Legionella Disease and Scald Injury from Potable Water Distribution Systems in VHA buildings.

2. SUMMARY OF CONTENTS: This Directive establishes policy for the prevention and control of healthcare-associated Legionella disease in VHA-owned buildings in which patients, residents, or visitors stay overnight.
Why is there still a problem? (i.e., why haven’t they worked?)

Lack of consensus on some issues,
No mandate to do anything in most locales
Legionnaires’ disease is a severe pneumonia typically acquired through inhalation of aerosolized water containing *Legionella* bacteria. *Legionella* can grow in the complex water systems that supply many buildings, including health care facilities, when those systems are not well managed. Thus, effective water management programs could prevent the growth of *Legionella* in these building water systems.
Legionnaires' disease in hospitals is widespread, deadly and preventable," said CDC Acting Director Anne Schuchat, M.D., in a June 6 news release.(www.cdc.gov) "These data are especially important for health care facility leaders, doctors and facility managers because it reminds them to think about the risks of Legionella in their facility and to take action.

"Controlling these bacteria in water systems can be challenging, but it is essential to protect patients."
CDC Vital Signs Report

- *Legionella* Poses Risk for Patients in Health Care Facilities

- June 15, 2017 05:00 pm *News Staff* – The CDC released a *Morbidity and Mortality Weekly Report (MMWR)* [www.cdc.gov](http://www.cdc.gov) and an accompanying *Vital Signs* report on June 6 that analyzed the prevalence of Legionnaires' disease in the U.S. health care system and found that 76 percent of facilities studied reported health care-associated cases of the disease.
Seventy-two health care facilities in 16 of the 21 U.S. jurisdictions the CDC studied reported definite health care-related cases of *Legionnaires’* disease, which is known to kill one-quarter of patients who are infected.
On June 2, 2017, CMS published a Survey & Certification memorandum entitled:

*Requirement to Reduce Legionella Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires’ Disease (LD).*
DATE:  June 02, 2017

TO:  State Survey Agency Directors

FROM:  Director
Survey and Certification Group

SUBJECT:  Requirement to Reduce Legionella Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires’ Disease (LD)

Memorandum Summary

- **Legionella Infections**: The bacterium *Legionella* can cause a serious type of pneumonia called LD in persons at risk. Those at risk include persons who are at least 50 years old, smokers, or those with underlying medical conditions such as chronic lung disease or immunosuppression. Outbreaks have been linked to poorly maintained water systems in buildings with large or complex water systems including hospitals and long-term care facilities. Transmission can occur via aerosols from devices such as showerheads, cooling towers, hot tubs, and decorative fountains.

- **Facility Requirements to Prevent Legionella Infections**: Facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of *Legionella* and other opportunistic pathogens in water.

Background

LD, a severe sometimes fatal pneumonia, can occur in persons who inhale aerosolized droplets of water contaminated with the bacterium *Legionella*. In a recent review of LD outbreaks in the United States occurring in 2000–2014, 19% of outbreaks were associated with long-term care facilities and 15% with hospitals. The rate of reported cases of legionellosis, which comprises both LD and Pontiac fever (a milder, self-limited, influenza-like illness) has increased 286% in the US during 2000–2014, with approximately 5,000 cases reported to the Centers for Disease Control and Prevention (CDC) in 2014. Approximately 9% of reported legionellosis cases are fatal. The Centers for Medicare & Medicaid Service (CMS) is aware of multiple recent LD outbreaks in hospitals and long-term care facilities as reported by the CDC, state and local health departments, or investigated by State Survey Agencies (SA).

Outbreaks generally are linked to environmental reservoirs in large or complex water systems, including those found in healthcare facilities such as hospitals and long-term care facilities. Transmission from these water systems to humans requires aerosol generation, as can occur from
Legionella Infections:

The bacterium *Legionella* can cause a serious type of pneumonia called LD in persons at risk. Those at risk include persons who are at least 50 years old, smokers, or those with underlying medical conditions such as chronic lung disease or immunosuppression. Outbreaks have been linked to poorly maintained water systems in buildings with large or complex water systems including hospitals and long-term care facilities. Transmission can occur via aerosols from devices such as showerheads, cooling towers, hot tubs, and decorative fountains.
Facility Requirements to Prevent Legionella Infections:

Facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of *legionella* and other opportunistic pathogens in water.
In manmade water systems, *Legionella* can grow and spread to susceptible hosts, such as persons who are at least 50 years old, smokers, and those with underlying medical conditions such as chronic lung disease or immunosuppression. *Legionella* can grow in parts of building water systems that are continually wet, and certain devices can spread contaminated water droplets via aerosolization. Examples of these system components and devices include:
**CMS Memorandum Summary**

Examples of these system components and devices include:

<table>
<thead>
<tr>
<th>Hot and cold water storage tanks</th>
<th>Centrally-installed misters, atomizers, air washers, and humidifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water heaters</td>
<td>Nonsteam aerosol-generating humidifiers</td>
</tr>
<tr>
<td>Water-hammer arrestors Pipes, valves, and fittings Expansion tanks</td>
<td>Hot tubs/saunas</td>
</tr>
<tr>
<td>Water filters</td>
<td>Decorative fountains</td>
</tr>
<tr>
<td>Electronic and manual faucets</td>
<td>Cooling towers</td>
</tr>
<tr>
<td>Aerators</td>
<td>Medical devices (such as CPAP machines, hydrotherapy equipment, bronchoscopes, heater-cooler units)</td>
</tr>
<tr>
<td>Faucet flow restrictors</td>
<td></td>
</tr>
<tr>
<td>Showerheads &amp; hoses</td>
<td></td>
</tr>
<tr>
<td>Eyewash stations</td>
<td></td>
</tr>
<tr>
<td>Ice machines</td>
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</table>
Surveyors will review policies, procedures, and reports documenting water management implementation results to verify that facilities:

Conduct a facility risk assessment to identify where *Legionella* and other opportunistic waterborne pathogens (e.g. *Pseudomonas*, *Acinetobacter*, *Burkholderia*, *Stenotrophomonas*, nontuberculous mycobacteria, and fungi) could grow and spread in the facility water system.
Surveyors will review policies, procedures, and reports documenting water management implementation results to verify that facilities:

Implement a water management program that considers the ASHRAE industry standard and the CDC toolkit, and includes control measures such as physical controls, temperature management, disinfectant level control, visual inspections, and environmental testing for pathogens.
Surveyors will review policies, procedures, and reports documenting water management implementation results to verify that facilities:

Specify testing protocols and acceptable ranges for control measures, and document the results of testing and corrective actions taken when control limits are not maintained.
In 2015, a total of 6,079 cases of legionellosis were reported to NNDSS, although the CDC noted that this estimate may be low due to underdiagnosis.
Does the Standard apply to all buildings?

Who needs to **comply** with the Standard?
Scope
Size of the committee depends on the complexity of the building risks

Hospital – multiple risks (potable water, cooling towers, etc)

- Risk Management / Safety
- Infection Prevention
- Infectious Diseases Physician
- Legionella Microbiologist
- Administration / Management
- Operations / Engineering
- Water Treatment Company (under contract)

Appoint Program/Designated Team

Assembled by the owner/CEO/top management
Assembled by the owner/CEO/top management

**Step 1**

**PROGRAM TEAM** – Identify persons responsible for Program development and implementation.

**Most Buildings**

- Comply with the main body of Standard 188

**Healthcare Facilities** (Accredited with Infection Preventionists)

- Comply with Normative Appendix A

**Appoint the Program Team**

**Appoint the Designated Team**
Compliance

Appoint a person or committee

Perform a risk characterization survey for Legionnaires’ disease based on building characteristics, its water systems, and its occupants

Potable water system?

Standard only applies for buildings if:
- Inpatient healthcare facility
- Persons taking immunosuppressive drugs, chemotherapy
Compliance

Appoint a person or committee

Perform a **risk characterization survey** for Legionnaires’ disease based on building characteristics, its water systems, and its occupants

Potable water system?

Standard only applies for buildings if:
- Inpatient healthcare facility
- Persons taking immunosuppressive drugs, chemotherapy
- **Persons over 65 years old** (i.e. nursing homes)
Perform a risk characterization survey for Legionnaires’ disease based on building characteristics, its water systems, and its occupants.

Appoint a person or committee.

Potable water system?

Standard only applies for buildings if:

- Inpatient healthcare facility
- Persons taking immunosuppressive drugs, chemotherapy
- Persons over 65 years old (i.e. nursing homes)
- Multiple housing units with centralized hot water heaters (hotels, condos, prisons, etc)
- Building more than 10 stories
Compliance

Appoint a person or committee

Perform a risk characterization for Legionnaires’ disease based on building characteristics, its water systems, and its occupants

Cooling tower?

Building owners, CEO, Facility Management
Building owners, CEO, Facility Management

Compliance

Appoint a person or committee

Perform a risk characterization for Legionnaires’ disease based on building characteristics, its water systems, and its occupants

- Cooling tower?
- Whirlpool spa?
- Decorative fountain?
- Other aerosol-generating device?
Building owners, CEO, Facility Management

Compliance

1. Appoint a person or committee
2. Perform a risk characterization for Legionnaires’ disease based on building characteristics, its water systems, and its occupants
3. If "no," stop
4. File a document with this finding and repeat yearly
Building owners, CEO, Facility Management

Required to comply with certain measures in the Standard intended to reduce or eliminate the risk of Legionnaires’ disease in those building water systems.
Compliance

Most Buildings
Comply with the main body of Standard 188

Healthcare Facilities
(Accredited with Infection Preventionists)
Comply with Normative Appendix A

or
Compliance

7 Easy Steps to Compliance

1. PROGRAM TEAM – Identify persons responsible for Program development and implementation.

2. DESCRIBE WATER SYSTEMS/FLOW DIAGRAMS – Describe the potable and non-potable water systems within the building and on the building site and develop water system schematics.

3. ANALYSIS OF BUILDING WATER SYSTEMS – Evaluate where hazardous conditions may occur in the water systems and determine where control measures can be applied.

4. CONTROL MEASURES – Determine locations where control measures must be applied and maintained in order to stay within established control limits.

5. MONITORING – Establish procedures for monitoring whether control measures are operating within established limits and if not, take corrective actions.

6. CORRECTIVE ACTIONS/CONFIRMATION – Establish procedures to confirm that:
   - The Program is being implemented as designed. (verification)
   - The Program effectively controls the hazardous conditions throughout the building water systems (validation)

7. DOCUMENTATION – Establish documentation and communication procedures for all activities of the Program.

Written into a document
Water Management Program

Risk Management Plan

Most Buildings

Main Path for compliance

Hospitals

Healthcare Path for compliance

Written into a document

ASHRAE Standard 188-2015
Legionellosis: Risk Management for Building Water Systems
Water Management Program

Cooling towers

Whirlpool spas

Decorative fountains

Potable water (hot water)

Step 2

Program/Designated Team

DESCRIBE WATER SYSTEMS/FLOW DIAGRAMS – Describe the potable and non-potable water systems within the building and on the building site and develop water system schematics.

Develop flow diagrams/end points of use
Water Management Program

Cooling towers

Whirlpool spas

Biocides

Steps 3-5

Control Measures

ANALYSIS OF BUILDING WATER SYSTEMS – Evaluate where hazardous conditions may occur in the water systems and determine where control measures can be applied.

CONTROL MEASURES – Determine locations where control measures must be applied and maintained in order to stay within established control limits.

MONITORING – Establish procedures for monitoring whether control measures are operating within established limits and if not, take corrective actions.

Potable water (hot water)

Program/Designated Team

Decorative fountains

Potable water (hot water)
Water Management Program

Cooling towers

Potable water (hot water)

Step 6

Verification

Validation

CORRECTIVE ACTIONS/CONFIRMATION – Establish procedures to confirm that:

- The Program is being implemented as designed. (verification)
- The Program effectively controls the hazardous conditions throughout the building water systems (validation)

Legionella

Program/Designated Team

Whirlpool spas

Decorative fountains
Water Management Program

Cooling towers

Potable water (hot water)

Cooling Tower Registration

NYC

Validation?

Quarterly testing for Legionella

Step 6

CORRECTIVE ACTIONS/CONFIRMATION – Establish procedures to confirm that:

- The Program is being implemented as designed. (verification)
- The Program effectively controls the hazardous conditions throughout the building water systems (validation)

Program/Designated Team

Whirlpool spas

Decorative fountains
Water Management Program

Let’s look at an example

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Multiple building campus needs only one Legionella Risk Management Plan as long as management is handled by the same group.
Hospital A

Control Measures
Potable Water
Flow diagrams

Designated Team
Control Measures

- **Cl₂ from city >0.5 ppm**
  - Not reliable

**Water temperature**
- 140°F storage
- >130°F discharge
- >124°F return (VA Directive 2014)
  - Helpful- not 100%

**Patient rooms**
- Hot water must exceed 124°F in order to prevent growth of *Legionella*
- Cold water must <67°F to the greatest extent practical in order to prevent growth of *Legionella*

**Mixing valve**
- To reduce the water temperature to 110°F at each distribution point immediately before the faucet or showerhead. Plus anti-scald devices.
**Control Points**

- **Cl<sub>2</sub> from city > 0.5 ppm**
  - Not reliable

**Water temperature**
- 140° F storage
- 130° F discharge
- >124° F return
  - (VA Directive 2014)
  - Helpful - not 100%

**Bottled water for patient drinking**
- 100% effective

---

**Hospitals**

- 100% effective
- Point-of-use filters

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

- **PROCESS STEPS**
  - P1. RECEIVING
  - S1. RECEIVING
  - P2. HEATING
  - P3. DISTRIBUTION
  - F1. FILTRATION
  - F2. COOLING
  - F3. FILTRATION
  - F4. DISTRIBUTION
  - F5. RECIRCULATION

- **Temperature and Storage**
  - 140° F storage
  - 130° F discharge
  - >124° F return
  - (VA Directive 2014)

- **Sanitary Sewer**
  - **Cafeteria**
    - Ice machines (x2)
    - Customer fountain
  - **Customers**
    - Coffee/tea
    - Soda
  - **Patient rooms**
    - Steam exchangers (x3)
    - Expansion tank
    - Restrooms
    - Janitor closet
    - Showers and washes (x3)
    - Eyewashes (x4)
    - Dishwasher
    - Washdown hoses
    - Steam table
    - Sinks
  - **Process Steps**
    - Sediment filter
    - Carbon filter
    - Electric heater
    - Sediment filter
    - Carbon filter
  - **Utility System**

**Bacteria are captured by the filter.**

**Water passes through the filter.**
Hospital A

Control Measures
Potable Water

Temperature (140/130/124 F)
• Monitoring the Control? Continuous temp records

Designated Team
Hospital A

Samples throughout the distribution system (typically at least 10)

Many healthcare facilities do both, as the best possible risk management of Legionnaires’ disease

Critical Control Points (CCP) Potable Water

Temperature (140/130/124 F)
- Validation - *Legionella* testing of water
- cases of Legionnaires’ disease
Controlling *Legionella* in Hospital Drinking Water: An Evidence-Based Review of Disinfection Methods

Yusen E. Lin, PhD, MBA; Janet E. Stout, PhD; Victor L. Yu, MD

Hospital-acquired Legionnaires’ disease is directly linked to the presence of *Legionella* in hospital drinking water. Disinfecting the drinking water system is an effective preventive measure. The efficacy of any disinfection measures should be validated in a stepwise fashion from laboratory assessment to a controlled multiple-hospital evaluation over a prolonged period of time. In this review, we evaluate systemic disinfection methods (copper-silver ionization, chlorine dioxide, monochloramine, ultraviolet light, and hyperchlorination), a focal disinfection method (point-of-use filtration), and short-term disinfection methods in outbreak situations (superheat-and-flash with or without hyperchlorination). The infection control practitioner should take the lead in selection of the disinfection system and the vendor. Formal appraisals by other hospitals with experience of the system under consideration is indicated. Routine performance of surveillance cultures of drinking water to detect *Legionella* and monitoring of disinfectant concentrations are necessary to ensure long-term efficacy.

Infect Control Hosp Epidemiol 2011;32(2):166-173

Corrective Action

Designated Team
Hospital A

Corrective Action

Emergency Potable Water Disinfection
- **heat/flush** (flush all distal sites for 30 min with 160-170 F water)
- **hyperchlorination** (flush all distal sites for at least 2 hr with 5 ppm Cl₂)

*Not reliable for permanent eradication*

Designated Team
Hospitals

Corrective Action

- Long-term Potable Water Disinfection
  - Secondary disinfection system

Designated Team
Hospitals

Corrective Action

Long-term Potable Water Disinfection

• Cu/Ag Ionization - good biofilm penetration
  - extensively validated in >300 hospitals worldwide
  - monitor Cu/Ag

New Control Measure
Hospitals

Corrective Action

Long-term Potable Water Disinfection
- **Cu/Ag Ionization** - good biofilm penetration
- extensively validated in >300 hospitals worldwide
- rigorous maintenance plans to monitor Cu/Ag

New Control Measure

Cu 0.2-0.8 mg/L
Ag 0.01-0.08 mg/L

Program/Designated Team
Corrective Action

Long-term Potable Water Disinfection
- Chlorine dioxide - good biofilm penetration
- hospital validation but slower than Cu/Ag
- lower concentrations obtained in hot water vs cold water

Hospitals

ClO₂ 0.5-0.7 mg/L

Program/Designated Team
Hospitals

Corrective Action

Long-term Potable Water Disinfection
- **Monochloramine** - good biofilm penetration
  - hospital validation

Program/Designated Team
Hospital Campus

Critical Control Points (CCP)

Cooling Towers

Flow diagrams

Program/Designated Team
Cooling Tower #1

Typical Cooling Tower Operation
Water flowing out of a cooling tower circulates to equipment that needs cooling. The equipment is cooled; the water is warmed. The warm water is returned to the cooling tower where it is re-cooled and the process begins again.

Flow Diagram
Cooling Towers – Control Measures

Microbiological Control

Which biocides to choose?

Control Legionella (hazard) in the cooling tower water

Legionnaires’ Disease

Cooling Towers – Control Measures
Critical Control Point

Microbiological Control

Verification

Control *Legionella* (hazard) in the cooling tower water

Legionnaires’ Disease

Is the control being implemented as planned?

Document biocide addition or achieved concentration

- Aerosols
- *Legionella* (hazard)
- Micobiological Control
- Critical Control Point
Control Measure

Microbiological Control

Legionnaires’ Disease

Is the hazard (Legionella) under control?

Validate via Legionella testing

Cooling Towers – Control Measures

Validation

Control Legionella (hazard) in the cooling tower water

Is the hazard (Legionella) under control?

Validate via Legionella testing

Legionnaires’ Disease

Cooling Towers – Control Measures
Hospital A

Critical Control Points (CCP)

Cooling Towers

Biocides
• Validating effectiveness? *Legionella* testing
  Frequency? Monthly, Quarterly or Annually?

Program/Designated Team
Critical Control Points (CCP) Cooling Towers

• Validating effectiveness? *Legionella* testing Frequency? Monthly, Quarterly or Annually?

Interpretation of *Legionella* results?

Program/Designated Team
Hospital A

Critical Control Points (CCP)
Cooling Towers

Biocides
• Validating effectiveness? **Legionella** testing
  Frequency? Monthly vs quarterly?

What to do with a positive test result?

Program/Designated Team
Corrective Action

Online disinfection - 20-50 ppm chlorine
- 2 hr with bleed off
Re-test following disinfection (24 hr)
Verify that biocides were being added
Change to different biocides?
More frequent validation in future

Hospital A

Program/Designated Team
Hospital A

Control Measures
Whirlpool spa

Same process
Halogen control in spas

Program/Designated Team
Control Measures
Water wall

Same process

Program/Designated Team
The New Face of Legionnaires Disease Prevention

- ASHRAE Standard 188 is a voluntary consensus standard and ASHRAE has no enforcement or regulatory authority
The New Face of Legionnaires Disease Prevention

- The Standard language is normative (mandatory) and “code ready”. ASHRAE/ANSI standards are often incorporated into regulatory codes such as building codes, and into local, state or federal regulations.
The New Face of Legionnaires Disease Prevention

- The Standard language is **normative (mandatory)** and **“code ready”**. ASHRAE/ANSI standards are often incorporated into **regulatory codes** such as **building codes**, and into **local, state** or federal regulations.
The New Face of Legionnaires Disease Prevention

- The Standard language is normative (mandatory) and “code ready”. ASHRAE/ANSI standards are often incorporated into regulatory codes such as building codes, and into local, state or federal regulations.

No reimbursement for hospital-acquired infections
The New Face of Legionnaires Disease Prevention

- Standard 188 is a voluntary consensus standard and ASHRAE has no enforcement or regulatory authority.

- The Standard language is normative (mandatory) and “code ready”. Many ASHRAE/ANSI standards are often incorporated into regulatory codes such as building codes, and into local, state or federal regulations.

- ASHRAE/ANSI standards invariably become an important consideration in litigation proceedings.
Litigation

Start your facilities movement toward *Legionella* control

Decrease

Litigation

Decrease

Illness and Death from Legionnaires’ Disease