LEGIONELLA
WATER SAFETY PLANS
What Engineers and Water Suppliers Need to Know

Frank Sidari III, PE, BCEE
Technical Director, SPL Consulting Services
Today’s *Legionella* Journey

1. Legionella in Drinking Water
2. Legionella in Buildings
3. Risk Management
   a. Assessment
   b. Water Safety Plan
4. Site Characterization
5. Environmental Testing
6. Construction and Renovation
7. Remediation
Multi-factorial Risk of Acquiring Legionnaires’ Disease

Reservoir + Transmission + Susceptible Host

Pathogenic Legionella in water system

Exposure to water & Water reaches airway

Disease can occur if host is susceptible

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Legionella in Drinking Water

• *Legionella* can be found in surface and ground water.

“Public water supplies may contaminate the plumbing systems of hospitals and other large buildings.” [States et al 1987]
Legionnaires’ Disease is a Potable Water Concern

“Legionella…is the single most common etiologic agent associated with outbreaks involving drinking water.”

National Academy of Sciences Report by EPA and Committee on Public Water Supply Distribution Systems

Centers for Disease Control and Prevention reported:

• *Legionella* accounted for 66% of reported drinking water–associated outbreaks

• *Legionella* in building plumbing systems lead to drinking water–associated outbreaks.
Not Just *Legionella* in Our Faucets

- **S. maltophilia**
- **Amoeba Resistant Microorganisms** (*Mycobacteria*)
- **Acinetobacter**
- **Pseudomonas aeruginosa**
Legionella and Amoeba

• *Legionella* can survive chlorination 50 times higher than drinking water inside amoeba [King et al 1988]

• *Legionella* in biofilms and cysts can survive treatment with 50 ppm free chlorine [Cooper 2010, Kilvington 1990]
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**Legionella is NOT Ubiquitous**

- *Legionella* bacteria are found in:
  - 12-70% of hospital water systems
  - Up to 60% of large high rise buildings
  - 10-40% of residential homes
  - 30-50% of cooling towers colonized with *Legionella*

- Not ubiquitous, but found in ~50% of building water systems
Where You May Find *Legionella*

- **Building (warm) water systems**
  - Faucets, showers
  - Hot water tanks
  - Decorative fountains
  - Pools, spas
  - Cooling tower

- **Not** airborne, surfaces, condensation
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Centers for Medicare & Medicaid Services

DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Medicare & Medicaid Services
7500 Security Boulevard, Mail Stop C2-21-16
Baltimore, Maryland  21244-1850

Center for Clinical Standards and Quality/Survey & Certification Group

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)

Ref: S&C 17-30-ALL
ASHRAE Standard 188-2015

• First *Legionella* standard in the United States

• Approved June 26, 2015

• Establish minimum Legionellosis risk management requirements for building water systems.
# Elements of a Water Management Program

<table>
<thead>
<tr>
<th><strong>Program Team</strong></th>
<th>Persons responsible for Program development and implementation.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Systems/Flow Diagrams</strong></td>
<td>Describe potable and non-potable water systems and develop water system-schematics.</td>
</tr>
<tr>
<td><strong>Water System Analysis/Control Measures</strong></td>
<td>Evaluate where hazardous conditions may occur and decide where control measures should be applied.</td>
</tr>
<tr>
<td><strong>Monitoring/Corrective Actions</strong></td>
<td>Establish procedure for monitoring whether control measures are within operating limits and, if not, take corrective actions.</td>
</tr>
<tr>
<td><strong>Confirmation</strong></td>
<td>Establish procedure to confirm Program is being implemented as designed (verification) and the Program effectively controls the hazardous conditions (validation).</td>
</tr>
<tr>
<td><strong>Documentation</strong></td>
<td>Establish documentation and communication procedures for all activities of the Program.</td>
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</table>
Elements of Designing Building Water Systems

- New construction, renovation, refurbishment, replacement or repurposing a facility

Documentation of Design Compliance – Specific items that need to be considered in the design to address potential hazardous conditions.

Final Installation Documents – Deliverables that should be provided to the building owner to document the design and installation.

Balancing – Requirement that all water systems be balanced and a report provided to the owner.

Commissioning – Required post-construction flushing and disinfection prior to beneficial occupancy.
Knowledge

The program team shall have knowledge of the building water system design and water management as it relates to Legionellosis.
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ASHRAE 188 Site Characterization

• Section 5: Building Survey
  ▪ Building owners must survey all existing buildings for the following:
    • Non-potable systems
      – Cooling towers, spas, fountains, misters, etc.
    • Building characteristics
      – Multiple housing units, >10 stories
      – Healthcare, long-term care facilities, etc.
Building Survey

- Cooling Tower
  - Spa/Pool
- Decorative Water Feature
- Other Aerosol Devices
- Multiple Housing Units
- >10 Stories
- Healthcare
  - Long term Care
Q: How does water flow through the building?

A: Create Process Flow Diagrams
Occupyant Risk

- Elderly
- Smokers
- Immunocompromised
  - Transplant patients
  - High-dose steroids for lung disease
  - Diabetes
  - Cancer
  - Neo-nate’s
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5. **Environmental Testing**
6. Construction and Renovation
7. Remediation
Why Test?

• *Legionella* is not ubiquitous
  - Are you in the 50% of buildings with or without *Legionella*?
  - Is *Legionella* present at >30% of distal outlets?
  - Is *Legionella* present in non-potable systems?

• Not all *Legionella* have the same risk
  - *L. pneumophila* serogroup 1 has highest risk for disease
  - Is appropriate clinical screening being performed

• Is there evidence to support:
  - Need for engineering controls/changes
  - Need for supplemental disinfection

• Validates Water Safety Plan
First Draw Hot Water from Outlets

- Minimum of 10 samples per system
- Minimum of 2 samples per floor
- Select locations from:
  - Different risers and loops
  - Different fixture types (showers/faucets)
  - Patient rooms and care areas
Cooling Towers and Fountains

• Grab sample from the basin
• Sample each cell of a cooling tower
• Select location from:
  ▪ The basin (not circulating pipe)
  ▪ Away from inlet or drain
  ▪ Away from chemical treatment
  ▪ Just prior to any slug dose of treatment
Zero *Legionella* is NOT needed to Prevent Disease

- The *Legionella* dose rate (concentration) for disease to occur has not been established
- Alternate approach supported by peer reviewed publications
  - Percentage of distal hot water outlets positive for *Legionella* as indicator
  - Greater than 30% of outlets positive corresponds with increased risk of disease
Not Zero, But No Disease

Legionnaires' Disease

<table>
<thead>
<tr>
<th></th>
<th>Before Monochloramine</th>
<th>After Monochloramine</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Cases</td>
<td>0 Case</td>
<td></td>
</tr>
</tbody>
</table>

30% Distal Site Positivity

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Construction and Renovation Concern for *Legionella*

- *Legionella* risk can be increased with construction or renovation
  - Sediment entry, cross-connections, loss of pressure, loss of disinfectant residual, stagnation, improper commissioning, etc.

- Many cases of Legionnaires’ disease associated with new construction and renovation
Construction Dislodges This

Cross section of 4 inch pipe from hospital hot water system

Got Brown Water?

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Potable Water as a Source of Legionnaires’ Disease

Kathryn N. Shands, MD; John L. Ho, MD; Richard D. Meyer, MD; George W. Gorman; Paul H. Edelstein, MD; George F. Mallison, MPH; Sydney M. Finegold, MD; David W. Fraser, MD

A three-year epidemic of legionnaires’ disease in a hospital was dramatically curtailed following hyperchlorination of the potable water supply. The hypothesis that potable water was the source for the outbreak was further supported by isolation of Legionella pneumophila (the agent of legionnaires’ disease) from the hospital water supply, observation that a sudden upsurge had occurred in the number of cases following a peculiar manipulation of the hospital water system, and documentation of a 30-fold increase in concentration of organisms in the water when this manipulation was artificially recreated. Thus, potable water may be an important source of epidemic legionnaires’ disease and continuous hyperchlorination a method of control.

(JAMA 1985;253:1412-1416)

BACKGROUND

Our studies were conducted at the Wadsworth Medical Center in western Los Angeles. The 710-bed hospital building was first occupied in March 1977. Almost immediately thereafter, cases of legionnaires’ disease in hospitalized patients began occurring at a rate that averaged 4.5 cases per month from May 1977 through February 1980. Patients with an immune status compromised by malignant conditions or drugs were at highest risk. Early investigations into the problem did
Pressure Change Increased Legionella

Fig 2.—Samples of water taken before (1) and after (2 and 3) the shock reproduction test at Wadsworth Veterans Administration Hospital, with distilled water sample (C) shown for comparison.
Other Studies Identified Construction Related Risk of Disease

<table>
<thead>
<tr>
<th>Reference</th>
<th>Cases / Deaths</th>
<th>Construction Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haley et al, 1979</td>
<td>49 / 15</td>
<td>Entry of soil into piping</td>
</tr>
<tr>
<td>Thacker et al, 1978</td>
<td>81 / 14</td>
<td>Entry of soil into piping</td>
</tr>
<tr>
<td>Helms, et al 1983</td>
<td>24 / 11</td>
<td>Hospital Addition - New Hem/Onc Unit</td>
</tr>
<tr>
<td>Parry et al, 1985</td>
<td>5 / 0</td>
<td>Entry of soil into piping</td>
</tr>
<tr>
<td>Mermel et al, 1995</td>
<td>2 / 2</td>
<td>Re-pressurization of piping</td>
</tr>
<tr>
<td>Sharp, 2005</td>
<td>2 / 1</td>
<td>Water system not operated (stagnation)</td>
</tr>
<tr>
<td>Stout et al, 2000</td>
<td>6 / 0</td>
<td>Water system not operated (stagnation)</td>
</tr>
<tr>
<td>Sutherly, 2011</td>
<td>11 / 1</td>
<td>Water system not operated (stagnation)</td>
</tr>
<tr>
<td>Reuters, 2000</td>
<td>4 / 0</td>
<td>Water system not operated (stagnation)</td>
</tr>
<tr>
<td>Greig et al, 2004</td>
<td>125 / 4</td>
<td>Improperly treated cooling tower</td>
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Commissioning
What ASHRAE 188 says….

• Specifications by Designer…
  ▪ Meet AWWA C651/652 or Local Regulation
  ▪ Complete within 3 weeks prior to occupancy
    • If delayed occupancy flushing or re-disinfection
  ▪ Confirm water system meets performance parameters for operation
Commissioning
What ASHRAE 188 DOESN’T say….

- Actual chlorination requirements
  - AWWA C651 25 mg/L for 24 hours?
  - ICC Plumbing Code 50 mg/L for 24 hours?
- Hot and cold water systems and equipment
- Pre/Post chlorine checks and logging
- Extent of flushing and disinfection
- Qualification requirements of company performing disinfection
- Is *Legionella* testing needed
  - Species, concentration, extent, action limits
  - How many samples, location, collection method
  - Laboratory qualifications
- Who is responsible to perform testing?
- What if testing fails?
- How to maintain water systems after testing
  - Who is responsible for on-going flushing
  - Who is responsible if occupancy extends beyond three weeks
Your *Legionella* Journey…

1. Form a Knowledgeable Team
2. Conduct a Risk Assessment
3. Test for *Legionella*
4. Develop a Water Safety Plan
5. Address Construction Risks
6. Be *Legionella* Proactive
THANK YOU

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