Legionella Continues to Make the News

You May be the Eyes on the System

Mark Inmann...
Installation effects components of the backflow preventer: Water Quality, Installation Environment, System Hydraulics
- These can impact Legionella growth or nutrients in the system

Ken Waite...
Caution considering thermal expansion and backflow prevention placement.
- Also consider hot/cold cross-connection or supplemental disinfection installed on hot water for Legionella control.

Adam Risher...
The public utility faces challenges in implementing backflow prevention program.
- Same challenges for Legionella.
- Old complicated buildings and plumbing systems.
- Decorative water fountains and other non-potable system connections
- Public utility not always permitted to look inside buildings past the meter

Tampa Bay Times
https://www.tampabay.com/opinion/2020/01/25/protecting-against-legionnaires-disease/

ASHRAE Standard 188-2018
5.7.9 Location of Coupling Test Making Value. The Program documents shall include requirements for the location of couplings: making values and the necessary compliance with all applicable laws, regulations, and industry standards. Wherever such codes and regulations do not exist or be the location, then the Program shall include requirements for maintaining compliance with ASHRAE A12.2.1 for air gaps and for maintaining compliance with codes and regulations applicable to other locations, selected by the owner or alliance, for backflow preventers.

Topic of Interest to Building Owners

You May be the Eyes on the System

What I saw this morning…your work can impact building water quality
- Galvanized piping and corrosion
- Wrong sizing of components
- Wrong placement of components
- Water off while repairs are made
- Rotating equipment or valves
- Non-potable systems connected within the building

Today’s Topics

- Current regulatory perspective
- Legionella and other waterborne pathogens
- Water system risk assessment and testing approach
- Water safety and management programs
- Legionella and construction
Regulatory Perspective

Public Water Systems
Safe Drinking Water Act

<table>
<thead>
<tr>
<th>Organism</th>
<th>MCLG</th>
<th>MCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryptosporidium</td>
<td>0</td>
<td>TT</td>
</tr>
<tr>
<td>Giardia lamblia</td>
<td>0</td>
<td>TT</td>
</tr>
<tr>
<td>Heterotrophic Plate Count</td>
<td>n/a</td>
<td>TT</td>
</tr>
<tr>
<td>Legionella</td>
<td>0</td>
<td>TT</td>
</tr>
<tr>
<td>Total Coliforms</td>
<td>0</td>
<td>5.0%</td>
</tr>
<tr>
<td>Turbidity</td>
<td>n/a</td>
<td>TT</td>
</tr>
<tr>
<td>Viruses (enteric)</td>
<td>0</td>
<td>TT</td>
</tr>
</tbody>
</table>

- **MCLG**
  - Maximum Contaminant Level Goal
  - No known or expected health risk
  - Non-enforceable

- **MCL**
  - Maximum Contaminant Level
  - Highest level allowed using best available treatment technology

**Regulation:**
- Treatment technology
- Process intended to reduce the level of contaminant

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Public Water Systems
EPA Contaminant Candidate List

- **CCL 4** – Final November 2016
- **CCL 5** – Closed December 2018

- Currently not subject to any proposed or promulgated NPDW regulations
- Known or anticipated to occur in public water systems
- May require future regulation under SDWA

**CCL 4**: 12 Microbial Contaminants, Including *Legionella*

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Building Water Systems
Codes and Commissioning

**IPC 2015, Section 610**

- **Disinfection Method**
  - AHJ
  - AWWA C651/652
  - IPC Method

- **Confirmation Approach**
  - Bacteriological examination that no contamination remains

**IPC Definition of contamination**
- An impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or the spread of disease by sewage, industrial fluids or waste.

**Building Codes Do Not Address Legionella**

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Disinfection Standards – AWWA C651

- “bacteriological quality…shall show the absence of coliform bacteria”
- “standard HPC may be required”
- “no coliforms and HPC <500 CFU/mL”

**AWWA C651 Does Not Address Buildings or Legionella**
Healthcare Water Systems

Moist environments and aqueous solutions in healthcare setting have the potential to serve as reservoirs for waterborne microorganisms

Local Regulations

Established
- New York City – Cooling Towers
- New York State – Cooling Towers
- New York State – Healthcare
- Garland, TX – Cooling Towers
- Veterans Admin – Potable Water

Proposed
- Florida – Cooling Towers
- New Jersey – All water systems

Some Local Regulations Address Potable and Non-potable

Centers for Medicare & Medicaid Services

- Conduct a facility risk assessment
- Implement a water management program
- Specify testing protocols, control measures, etc.

National Regulation to Address Legionella in Potable Water

A Case of Legionnaires’ Disease

Source: Public water supplies
Growth: Building (warm) water systems
- Faucets, showers
- Hot water tanks
- Decorative fountains
- Pools, spas
- Cooling tower
- Not airborne, surfaces, condensation
- Reservoir

Legionella and Legionnaires’ disease

- Pathogenic Legionella
- Reservoir

Legionella is not ubiquitous, ~50% of building water systems
Lots of Legionella species and serogroups (>60)
Legionella pneumophila serogroup 1 causes majority of infections
A Case of Legionnaires’ Disease

3 Routes: Aspiration, Aerosolization, Direct Installation

- Transmission
- Pathogenic Legionella
- Reservoir

Primary: Elderly, Smokers, Immunocompromised

- Susceptible Host
- Transmission
- Pathogenic Legionella
- Reservoir

Legionnaires’ disease is on the rise in the United States

Management of Legionella in Water Systems

Committee on Management of Legionella in Water Systems

- Water Science and Technology Board
- Board on Life Sciences
- Board on Population Health and Public Health
- Division on Earth and Life Studies
- Health and Medicine Division

- Joint Committee Study of the National Academy of Sciences-Engineering-Medicine

Other Opportunistic Waterborne Pathogens

Stronger Policies Needed to Protect the Public From Legionnaires’ Disease.”

"...mortality for Legionnaires’ disease continues to be high -- as high as 25 percent for cases acquired in the healthcare facility.”

https://www.workingpressuremag.com/Legionella-building-water-distribution-systems/

https://www.nap.edu/catalog/25474/management-of-legionella-in-water-systems
Opportunistic Waterborne Pathogens

- Legionella
- Pseudomonas aeruginosa
- Nontuberculous mycobacteria (NTM)
- Acinetobacter
- Burkholderia
- Stenotrophomonas
- Fungi
- Serratia marcescens

Source/Reservoir

Legionella
- Building Water Systems

Other Pathogens
- Building Water Systems
- Surfaces
- Soil, Dust, Debris
- Air
- Cleaning Solutions, Soap
- Medical Devices, Solutions
- Sink Drains, Sanitary
- Flowers, Fruits and Vegetables
- Infected Patients or Staff

Transmission

Legionella
- Aspiration
- Inhalation / Aerosols

Other Pathogens
- Aspiration
- Inhalation / Aerosols
- Direct Contact
- Indirect Contact
- Environmental Contact

Also: Growth Factors, Survival Outside of Water, Susceptibility to Disinfectants

Infection Site

Legionella
- Lungs / Pneumonia

Other Pathogens
- Lungs / Pneumonia
- Urinary Tract
- Soft Tissue / Eyes
- Burns
- Wounds
- Blood

Environmental Testing

- Different sampling plans
- Different culture media
- Not the same as clinical medias
- Different laboratory qualifications and methods

Risk Assessment and Water Safety Programs
Risk Assessment

Sampling Plan for Risk Assessment

“What is the greatest chance someone may be exposed to Legionella from the water system?”

Sampling Approach for Risk Assessment

Other Sampling Plans

Potable Water
- First Draw Hot Water

Ice Machine
- Grab sample from ice dispenser

Cooling Tower
- Grab sample from each tower basin

Spa/Pool/Water Feature
- Grab sample from basin

Incoming water?
- Flushed sample at backflow preventer

Hot water tank?
- Sample from drain.
- First draw (sediments) and flushed (bulk water)

Hot water return?
- Flushed sample at common hot water return

Case investigation?
- Water and swab samples

Evidenced Based Recommendations

Data Analysis
- Physicochemical measurements
- Environmental testing results
- Clinical data (testing or cases)

Outcomes
- Water system adjustments
- Disinfection
- Water Safety Plan

Water Safety and Management Program

ASHRAE Standard 188
First and only Legionella standard in the United States
Scope:
- Minimum Legionella risk management requirements
- Applies to human-occupied buildings (except single-family)
- Intended for use by owners and managers of buildings
- Includes design, construction, commissioning, operation, and repair of buildings
### ASHRAE 188 – Water Safety Approach

<table>
<thead>
<tr>
<th>Program Team</th>
<th>• Persons responsible for Program development and implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Diagrams</td>
<td>• Water system descriptions • Water system schematics</td>
</tr>
<tr>
<td>Analysis</td>
<td>• Assess potential for Legionella growth and determine control locations</td>
</tr>
<tr>
<td>Control Measures</td>
<td>• Determine control limits to manage potential for Legionella</td>
</tr>
<tr>
<td>Monitoring/Corrective Actions</td>
<td>• Establish monitoring procedures for controls • Determine actions to take when outside limits</td>
</tr>
<tr>
<td>Confirmation</td>
<td>• Verification: Is program being implemented • Validation: Is Legionella being controlled</td>
</tr>
<tr>
<td>Documentation</td>
<td>• Program documentation and communication</td>
</tr>
</tbody>
</table>

### Legionella and Other Pathogens

**Risk Assessment**
- Assessment for other pathogens should be driven by infection prevention concerns
- Water may not be the only source of other pathogens

**Water Safety Plans**
- ASHRAE 188 written for Legionella
- Other pathogens may have different control measures, mitigation approaches, and validation methods

### ASHRAE 188 – Design & Commissioning

| Design Compliance | • Design address potentially hazardous conditions which could promote Legionella growth |
| Documentation     | • Final installation deliverables |
| Balancing         | • All water systems are balanced and reported |
| Commissioning     | • Post-construction flushing and disinfection prior to beneficial occupancy |

### Legionella and Construction

**Plan**
- Project scope?
- ASHRAE 188?
- CMS?
- Legionella testing performed?
- Facility history?

**Design**
- Operating limits
- Materials of construction
- Fixture selection
- Monitoring locations
- Non-potable systems

**Program**
- ASHRAE 188?
- CMS?
- Legionella testing performed?
- Facility history?

**Commission**
- Project scope?
- ASHRAE 188?
- CMS?
- Legionella testing performed?
- Facility history?

**Hand Over**
- Operating limits
- Materials of construction
- Fixture selection
- Monitoring locations
- Non-potable systems
### Design Stage

**Materials**
- Choices
  - SS, copper, PVC, CPVC, PP-R, PE-X, PE-RT, DI, CI, rubber, epoxy...
  - Uses
  - Pipe, valves, equipment, gaskets, filters, coating...
  - Interactions
  - Disinfectants, water chemistry, dissimilar metals

**Fixtures**
- Opportunity to promote bacteria growth
- Point of use filter compatibility
- Disinfection compatibility
- Splashing and surfaces

### Design Stage

**Monitoring Points**
- Temperature
- Flow
- Water quality
- Sample collection
- Flushing
- Chemical injection

### Design Stage

**Non-Potable Systems**
- Backflow prevention
- Proximity to occupants
- Extent of aerosolization
- Chemical treatment program
- Isolation of piping or basins

### Legionella and Construction

**Plan**
- Project scope?
- ASHRAE 188?
- CMS?
- Legionella testing performed?
- Facility history?

**Design**
- Operating limits
- Materials of construction
- Fixture selection
- Monitoring locations
- Non potable systems

**Program**
- Water Safety and Management Plan
- Coordinated with Design
- Mitigation approaches

**Commission**
- Specified Method
- Timing
- Legionella Testing

**Hand Over**
- Ensure water system meets performance parameters for operation

###_progam Stage

**Coordination with WSP**
- Examples:
  - Check/change filters, but not accessible
  - Control limit monitoring, but no sample point
  - Flush tank or basin, but insufficient drain point
  - Maintain complete circulation, but off-line basin or pipe segment

**Mitigation Approaches**
- Examples:
  - Thermal disinfection, but mixing valves installed
  - Chemical disinfection, but incompatible materials
  - Install POU filter, but no adapters

### Legionella and Construction

**Plan**
- Project scope?
- ASHRAE 188?
- CMS?
- Legionella testing performed?
- Facility history?

**Design**
- Operating limits
- Materials of construction
- Fixture selection
- Monitoring locations
- Non potable systems

**Program**
- Water Safety and Management Plan
- Coordinated with Design
- Third Party?

**Commission**
- Specified Method
- Timing
- Legionella Testing

**Hand Over**
- Ensure water system meets performance parameters for operation

### Commissioning – ASHRAE 188

**Does say...**
- 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

**Does not 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
- 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
**Concerns with Commissioning**

1. Standards not designed for building distribution systems or *Legionella* validation

   **Disinfection Standards – AWWA C651**

2. *Legionella* is more resistant to chlorine than coliforms

3. Assumption that if coliforms or HPC is controlled then no risk for *Legionella*

   **IDEXX Colilert**
   **HPC Plate Count Media**
   **Legionella BCYE Media**

**Validation of Legionella Control**

- *Legionella*
- HPC
- *E. coli* / Coliform
- Temperature
- Disinfectant (chlorine)
- pH
- Flushing
- New equipment or pipes

**Goal: Prevent Disease**

**Regulatory**

- Some regulations, standards and guidelines exist
- Need to do more to protect the public from *Legionella*

**Other Opportunistic Pathogens**

- Other pathogens are associated with water
- Primarily a healthcare concern
- Consider risk approaches differently than *Legionella*

**The only way to know *Legionella* is being controlled is to test for *Legionella*.**

At 21°C and 0.1 mg/L free chlorine

- 99% kill *Legionella pneumophila* in 40 minutes
- 99% kill *E. coli* < 1.0 minute

*Legionella* is more resistant to chlorine than other bacteria such as coliform bacteria.
Goal: Prevent Disease
Risk Assessment and Water Safety
• Approaches existing to understand and manage risk
• Environmental testing for Legionella only way to determine risk
• No correlation between Legionella and other pathogens
Construction
• Address conditions favorable to Legionella growth
• Legionella specific commissioning required
• Actively test building water systems prior to and after beneficial occupancy

Questions/Discussion

Thank you!

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Acknowledgement: