DCA, 2018 IPC and ISPSC Task Force Meeting

Legionella Prevention

Melissa Tobin-D’Angelo, MD, MPH
November 27, 2018
Legionella

Gram-negative bacteria

Multiple species

- All species and serogroups are potentially pathogenic
- Most Legionellosis caused by *L. pneumophila*
- Multiple serotypes, but *L. pneumophila* 1 is most common
Legionella – ecology

Found naturally in warm water

Grows and survives well in biofilms, particularly in areas where there is low water flow (i.e. dead legs)

Cooling towers, hot tubs, hot water tanks and heaters, showers and faucets, decorative fountains, large plumbing systems

Lives in the built environment

Grows optimally in temperatures from 77°-108°F, survives in 68-125 °F

Chlorine-sensitive (not if in biofilm)
Legionellosis

Illness caused by *Legionella* bacteria
Three main categories:
- With pneumonia: Legionnaire’s Disease
- Respiratory/Fever w/o pneumonia: Pontiac Fever
- Non-respiratory: Extrapulmonary (wound infection)

Symptoms start 1-14 days after exposure
Treated with antibiotics

**Very Serious Health Outcomes!**
- 44% ICU (intensive care unit) Admission
- 27% Required Ventilation
- 9% Death
Legionellosis in Georgia


<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
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<tbody>
<tr>
<td>2007</td>
<td>43</td>
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<td>2008</td>
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<td>2015</td>
<td>131</td>
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<tr>
<td>2016</td>
<td>132</td>
</tr>
<tr>
<td>2017</td>
<td>172</td>
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</tbody>
</table>
Legionellosis in Georgia

172 Reported Cases in 2017
• 97% hospitalized
• 51% admitted to ICU
• 9% death rate
• 13 outbreak investigations (5 in 2016)
• Outbreaks in variety of settings
  • Hospitals
  • Hotels
  • Hot tubs/recreational water
  • Occupational/industrial
  • Correctional institutions
  • Fitness centers
  • Assisted living
  • Residential complexes (e.g. condo buildings)
  • Outpatient medical office buildings
  • And more...
• Most GA outbreaks are associated with potable premise plumbing!
Cases are Preventable!

Key = Water Management Program (WMP)

- Regular checks of water temperature, pH balance, chlorine levels

WMP Key Components

- WMP Team
- Description of Water Systems
- Identify risk areas and control points
- Measure and document water parameters
- Respond to critical measures (changes in temperature/pH/disinfectant, service disruptions, etc.) according to plan!
New Resources

ASHRAE Standard 188
CDC Partner Toolkit intended to help with interpretation and implementation of ASHRAE Standard 188
Environmental Risk Factors

- Construction
- Water main breaks
- Changes in municipal water quality
- Biofilm, scale, and sediment
- Water temperature, pH fluctuation
- Inadequate levels of disinfectant
- Changes in water pressure
- Water stagnation
Environmental Interventions

Environmental assessment
- Plumbing structure, chlorine residuals, water temperature

Environmental testing
- Water sample testing at CDC certified laboratory

Remediation
- Plumbing engineering changes
- Hyperchlorinate or heat water
- Serial repeat testing
- Requires skilled contractor
- Hard to eradicate!
Outbreak Examples

Hospital A
- Patient admitted for transplant
- Patient develops pneumonia and tests positive more than 14 days after admission
- Public health investigation
- Positive environmental results, emergency remediation, implement/update WMP, follow up testing

Hospitals are required to have WMP by Centers for Medicare and Medicaid Services to prevent this situation.

Apartment Building B
- 25 story apartment building with centralized hot water distribution
- Resident ill with legionellosis in March
- Three more residents ill with legionellosis over next seven months
- Public health investigation
- Positive environmental results, emergency remediation, implement/update WMP, follow up testing

ASHRAE 188 efforts could have prevented this, but no code in place.
Costs of Outbreaks

- Outbreak investigations may require repeated rounds of testing and expert consultation.
- One example from a private laboratory/consultant estimates consulting activities (conference calls, site assessments, sample plans, disinfection recommendations, final report) to be approximately $15,000.
- Testing is not included in this amount and depending on results, follow up testing may be necessary for months after the initial round of testing.

https://www.gsaadvantage.gov/ref_text/GS21F114BA/0N6P3P2VD2T6_GS-21F-114BA_SPLCATALOG.PDF
Why should building owners/operators care?

• Don’t want residents/visitors to develop illness
• Liability issues--shouldn’t be main reason but lawyers and insurance companies are already on it!
  • https://www.douglasandlondon.com/environmental-toxic-exposure/legionnaires-disease
  • https://thelegionnaireslawyer.com/legionnaires-disease-claims-compensation/
Conclusions

• Legionella causes severe illness and is increasing in frequency
• Outbreaks require a lot of time and effort and cost
• ASHRAE 188 provides guidance on preventive measures
• The Georgia Department of Public Health supports incorporating ASHRAE 188 language into the upcoming Georgia adoption of the International Plumbing Code.
Thank you

**Key Georgia Department of Public Health Contacts**

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

Published June 26, 2015

Claressa Lucas, PhD
Member SSPC-188
November 27, 2018
Slides adapted from…

ANSI/ASHRAE Standard 188-2015

► Standard 188 can be purchased from ASHRAE at: http://www.techstreet.com/ashrae/products/1897561

► Standard 188 can be read for free from ASHRAE website under the Preview ASHRAE Standards, bottom left of page, at: www.ashrae.org/standards
While Legionnaire's disease has been known for many years, recent outbreaks have increased awareness of the disease, its causes and prevention strategies.

The Centers for Disease Control & Prevention estimates:
- each year between 8,000 & 18,000 cases LD in U.S.
- more than 10% of these cases are fatal

ASHRAE has been actively involved in providing information on *Legionella* since 1979 in response to the first Legionnaire’s disease outbreak in 1976 and the subsequent discovery by the CDC of the causative bacteria – *Legionella*
Guidelines Since Early 1990s …
This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of ASHRAE.

Consensus is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this standard as an ANS, as:

“...substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution.”
ASHRAE Standard Development

- ASHRAE obtains *consensus* through participation of its national and international members, associated societies, and public review.

- Every effort is made to *balance* the concerned interests on all project committees.

- This project committee was comprised of *Legionella & water treatment* specialists, consulting engineers, health professionals, building owners & operators, manufacturers, government officials, and others from around the world.
ASHRAE develops subject matter, voluntary consensus standards that are accredited by the American National Standards Institute (ANSI)

Standard 188 is a Standard Practice with design considerations; written in ‘mandatory’ and ‘code intended language’; and readily adoptable into related codes, regulations or legislation!
*Feb 2005: 1st meeting of GPC-12 (guideline) - later as SPC-188

PR = Public Reviews (required by the ANSI/ASHRAE process)
Compliance with Standard 188 requires facility owners (their managers) to:

1. Establish a Team with assigned responsibilities & accountabilities

2. Have, Practice, Audit and Maintain a Water Management Plan for legionellosis risk management of their building water systems
ASHRAE 188 provides a framework, but the TEAM must develop specific Legionella control measures for:

- New Construction
- Siting
- Startup and Shutdown
- Inspections
- Maintenance
- Cleaning and Disinfection
- Water Treatment
- Monitoring (temperatures, disinfectant levels, etc.)
- Responding to Legionnaires' disease
A ‘closer’ look at Standard 188 ...
The SPC-188 Team: 32 Voting Members

(7 Professional Organizations / Many Other Active Professionals)

<table>
<thead>
<tr>
<th>Thomas E. Watson, <em>Chair</em></th>
<th>Robert J. Cunningham, III</th>
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<tr>
<td>Paul A. Lindahl, Jr., <em>Vice-Chair</em></td>
<td>David F. Geary</td>
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<td>Michael P. Patton, <em>Secretary</em></td>
<td>Ronald George</td>
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<td>Stu Asay*</td>
<td>Joseph M. Hannigan, Jr.</td>
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<td>Clive R. Broadbent*</td>
<td>Lauri Hicks</td>
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<td>Linda L. Dickey*</td>
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<td>Charles E. Dorgan*</td>
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<td>Wayne R. Thomann</td>
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<tr>
<td>Tim Keane*</td>
<td>Alain Trahan</td>
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</tbody>
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* Denotes members of voting status when the document was approved for publication
Included …

1) CDC: Centers for Disease Control & Prevention
2) AWT: Association of Water Technologies
3) ASHE: American Society for Healthcare Engineering
4) APIC: Association for Professionals in Infection Control & Epidemiology
5) ASPE: American Society of Plumbing Engineers
6) IAPMO: International Association of Plumbing and Mechanical Officials
7) NSF International
# ANSI/ASHRAE 188-2015

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PURPOSE: Establish minimum Legionellosis risk management requirements for building water systems.

SCOPE:
1) for design, construction, commissioning, operation, maintenance, repair, replacement, and expansion of new and existing buildings and their associated water systems
2) applies to human-occupied commercial, institutional, multi-unit residential, and industrial buildings ... excludes single-family residential buildings
3) use by owners and managers of such defined buildings and those involved in the design, construction, installation, commissioning, operation, maintenance and service of their centralized building water systems and components
188: Section 4. Compliance

4.1 Building Designer Requirements … comply w/survey per Sec.5 and then Sec.8

4.2 Building Owner Requirements … comply w/survey per Sec.5 and then Sec.6 & 7

4.3 Health Care Facility Requirements … comply with Sec. 4.2 ←OR→ with Annex A

188 compliance requires Section 5 surveys be repeated (at least) annually, fully documented & available for review at any time.
4.3.1 Health care facilities that do not meet all of the qualifications of Section 4.3.2 (below) shall comply with the requirements in Section 4.2.

4.3.2 Health care facilities that meet all of the following qualifications shall comply with either the requirements in Section 4.2 – OR – the requirements in the Normative Annex A, “Health Care Facilities” …
(a)… health care facility is accredited by an accrediting agency or by the authority having jurisdiction (AHJ) over the health care IC activities

(b)… the health care facility IC program has a certified infection preventionist … or the health care facility has an epidemiologist with a minimum Master’s Degree or equivalent

Compliance for Health Care Facilities via Annex A of the standard requires (a) and (b) above
5.1 Determine whether it has one or more:

(a) cooling towers or evaporative condensers providing cooling/refrigeration for HVAC&R or other systems;

(b) whirlpools or spas either in the building or on site;

(c) ornamental fountains, misters, humidifiers, air washers, atomizers or other nonpotable water systems or devices that release water aerosols

All buildings must be surveyed to identify nonpotable water aerosolizing/misting devices or systems
Implement a Water Management Program (WMP) for...

- Cooling Towers
- Whirlpool Spas
- Ornamental Fountains
- Misters, Atomizers, Humidifiers, Air Washers
- Other Devices that release water droplets
5.2 → Determine whether it is characterized by one or more of the following risk factors that relate to legionellosis:

(a) multiple housing units with one or more centralized hot water systems;

(b) more than 10 Stories (including levels below grade);

(c) health care facility w/patient stays exceeding 24 hours;

(d-e) an area housing or treating occupants with certain medical conditions or risk factors: burns, immunocompromised, solid organ or bone marrow transplantations, chemotherapy, at-risk with renal disease, diabetes, or chronic lung disease;

(f) identified as housing for occupants over the age of 65.
Implement a WMP for premise plumbing systems if a building is characterized with any one of the following:

• Multiple housing units with a centralized hot water system,
• More than ten stories,
• Housing designated for people over 65 years of age,
• Patients staying >24 hours,
• An area housing or treating people with certain medical risk factors...
Implement a **WMP** for **potable** systems if a building has an area for **housing or treating people** …

- for burns, cancer chemotherapy, or solid organ or bone marrow transplantation;
- that are immunocompromised or otherwise more susceptible than the general population because of age, medication, health, smoking, occupation or drug treatment;
- that have renal disease, diabetes, or chronic lung disease
6.1 → Principles of a Water Management Program
   6.1.1-6.1.7: outline of risk management principles

6.2 → Program Development (WMP)
   6.2.1-6.2.9: detail of management program development
### Figure 1. Elements of a Water Management Program (WMP)

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

**2. DESCRIBE WATER SYSTEMS/FLOW DIAGRAMS**—Describe the potable and nonpotable 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/CORRECTIVE ACTIONS**—Establish procedures for monitoring whether control measures are operating within established limits and, if not, take corrective actions.

**6. CONFIRMATION**—Establish procedures to confirm that
   - the Program is being implemented as designed (verification), and
   - 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.
CDC 188
‘ToolKit’
(June 2016)
Flow Diagrams
Establish for every LB Control ➔

1. Control Limits for each point where LB control is applied
2. Monitoring Method for each point where LB control is applied
3. Monitoring Frequency for each point where LB control is applied
4. Corrective Actions to make when LB control measures are Outside Limits
WMP: VERIFICATION ➔

The process and evidence used to support that compliance with the Plan is being done – i.e. record-keeping, control monitoring, process procedures and other evaluations. It ensures that the Water Management Plan is being correctly followed in practice;

“Are you Doing what you Planned to Do?”

WMP: VALIDATION ➔

The process or evidence used to support that the hazard control strategies of the plan are effective. Testing for the control of the hazard or assessment of technical, scientific, medical and other data that can be used to show that control measures for the hazard are effective – i.e. no legionellosis;

…“Are you Doing the Right Thing – Does it Work?”
188: Section 7. Requirements for Building Water Systems

7.1 Potable Water Systems
7.2 Cooling Towers & Evaporative Condensers
7.3 Whirlpool Spas
7.4 Ornamental Fountains & Other Water Features
7.5 Aerosol-Producing Humidifiers, Misters, Atomizers and Air Washers

Section 7 is the more extensive & detailed section in Standard 188 – it deals with the various potable & nonpotable water system requirements
Section 8 deals with legionellosis risk/hazard considerations and the documentation required when designing for new construction, renovations, refurbishment, replacement, or repurposing of a facility.
Designers must provide Documentation, Drawings, and/or Instructions for …

• Monitoring & Control
• Code Compliance
• Operation & Maintenance
• Control System Operation
• Calibration
• Installation & Start-up
• Commissioning (including Flushing & Disinfection)

• Filling & Draining
• Equipment Sizes
• Piping Layout
• System Materials
• Pipe Sizes
• Design Flow Rates
• Design Temperatures
• Impact of Heat Loss or Gain
Designers must note locations of …

- Equipment
- Access (note inadequate access)
- Filling and Draining
- Flushing
- Sampling
- Temperature monitoring
- Treatment
- No flow & Low Flow areas
- Outside Air Intakes
- Possible Cross Connections
Prior to Occupancy . . .

- **Balance Water Systems**
- **Disinfect & flush** no more than 3 weeks before any part of the building is occupied for its intended purpose
A1. Supplemental Definitions for Terms used in Annex A

A2. Designated Team


A4. Risk Management Plan – Legionellosis RM plan

A5. Existing Buildings, New Construction & Renovations

A6. Building Water System Procedures (Sec. 7 elements)

A6. is the more extensive/detailed section of Annex A – it deals with all the various potable & nonpotable water system requirements
What Is Different?

Program Team → Designated Team

Water Management Program → Legionellosis Risk Management Plan

Section 7 → A6.1 Building Water System Procedures
If You Test for *Legionella* . . .

➔ Be Prepared & make sure all stakeholders know, including Public Relations, about *Legionella* Testing!

1. That testing is FOR a Reason & WITH a Plan;

2. That testing is a Pro-Active Position;

3. That testing provides the Only Direct Validation of *Legionella* control;

4. And, How to communicate a Positive Test Result!
SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus Standard developed under the auspices of ASHRAE. Consensus is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this Standard as an ANS, as “substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution.” Compliance with this Standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Senior Manager of Standards of ASHRAE should be contacted for:
- interpretation of the contents of this Standard,
- participation in the next review of the Standard,
- offering constructive criticism for improving the Standard, or
- permission to reprint portions of the Standard.

‘Compliance with this Standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.’
Adoption of ASHRAE Standards

CODE vs. LEGISLATION

Typical Adoption Cycle for an ASHRAE Standard:

1) Into Related Codes → Typically 1-5 Years or more;
2) Into Related Legislation → Immediately, as decided by local Municipal, County or State agencies

 Portions of Standard 188 were quickly adopted and passed into Legislation in New York City, while New York State issued emergency regulations that ultimately became the Law
Legionella is a common bacteria in man-built water systems;

Disease Causation is Not Simple – involves many factors:
- Favorable conditions for LB growth & amplification
- Means of transmitting water aerosols containing LB
- Exposure route to Susceptible persons

Cooling Water & Potable Water Systems are all important;

ANSI/ASHRAE Standard 188-2015
- Owners-Managers – as well as Design Engineers, plus
- Minimum Legionellosis Risk Requirements
- Must Establish a Water Management Program
Water Management Programs – Simply Put …

“Don’t Make a Mountain Out of a Molehill!”

A Water Management Program should be thorough – keeping it simple (KISS) should be more than adequate!
Encouraging Building Water Systems Management

Claressa Lucas, PhD
ELITE Program Coordinator
National Center for Immunization and Respiratory Diseases
2018 IPC/ISPC Task Force Meeting
November 27, 2018

The findings and conclusions in this report are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
Legionnaires’ disease is on the rise in the United States

Rate of reported cases increased 5.5 times (2000–2017)

Source: National Notifiable Diseases Surveillance System
Reported rates of legionellosis in the United States demonstrate geographic variability.

Rates of reported legionellosis cases by state, 2007
Cases/100,000 population

Source: National Notifiable Diseases Surveillance System
Reported rates of legionellosis in the United States demonstrate geographic variability

Rates of reported legionellosis cases by state, 2012
Cases/100,000 population

Source: National Notifiable Diseases Surveillance System
Reported rates of legionellosis in the United States demonstrate geographic variability.

**Rates of reported legionellosis cases by state, 2017**

Cases/100,000 population

- **≥ 2.43**: 5 states
- **1.72 – 2.42**: 8 states
- **1.20 – 1.71**: 12 states
- **0.93 – 1.19**: 17 states
- **≤ 0.92**: 24 states

**Source:** National Notifiable Diseases Surveillance System
**Legionella** to Legionnaires’ disease

1. **Legionella** lives in fresh water
   
   Internal and external factors can lead to **Legionella** growth in building water systems.

2. Certain conditions can lead to **Legionella** amplification
   
   **Legionella** grows best in large, complex water systems that are not adequately maintained.

https://www.cdc.gov/legionella/infographics/legionella-affects-water-systems.html
**Legionella to Legionnaires’ disease**

3. Certain devices can lead to aerosolization

   Water containing *Legionella* is aerosolized through devices.

4. *Legionella* can be transmitted to susceptible hosts

   People can get Legionnaires’ disease when they breathe in mist or accidentally swallow water into the lungs containing *Legionella*. Those at increased risk are adults 50 years or older, current or former smokers, and people with a weakened immune system or chronic disease.

[https://www.cdc.gov/legionella/infographics/legionella-affects-water-systems.html](https://www.cdc.gov/legionella/infographics/legionella-affects-water-systems.html)
*Legionella* grow within a host

Credit: Public Health Image Library, CDC
Credit: Holland/Özel, Robert Koch-Institut
What do we know about source attribution?

• 2016: CDC analyzed data from 27 building-associated outbreaks (2000–2014)

• Common settings
  • Hotels (44%)
  • Long-term care facilities (19%)
  • Hospitals (15%)

• Common sources
  • Potable water (56%)
  • Cooling towers (22%)
  • Hot tubs (7%)
  • Decorative fountains (4%)
  • Industrial equipment (4%)

What can be done to prevent Legionnaires’ disease?

• Effective WMPs can reduce the risk of Legionnaires' disease

9 in 10 CDC investigations show almost all outbreaks were caused by problems preventable with more effective water management
Primary prevention of Legionnaires’ disease

- Ensuring proper maintenance of building water systems and aerosol-generating devices is key
- Current guidelines, standards, and protocols
  - VHA Directive 1061 (2014)
  - **ASHRAE Standard 188 (2015)**
  - AIHA Guideline (2015)
  - NYC/NYS regulations (2015, 2016)
  - NSF protocol 453 (2017)
  - CMS Memo (2017)
  - Others in development
Increasing uptake of ASHRAE 188

- Step-by-step guide to creating a WMP
- Does not provide specific instructions
- CDC supportive of adopting ASHRAE 188 language into International Plumbing Code

www.cdc.gov/legionella/WMPtoolkit
Elements of a Water Management Program

1. Establish a water management program team
2. Describe the building water systems using text and flow diagrams
3. Identify areas where Legionella could grow and spread
4. Decide where control measures should be applied and how to monitor them
5. Establish ways to intervene when control limits are not met
6. Make sure the program is running as designed and is effective
7. Document and communicate all the activities

Continuous program review (see below)

Source: CDC Water Management Program Toolkit
Daily Activities

Source: CDC Water Management Program Toolkit
Defining Important Terms

**Verification:** initial and ongoing confirmation that the Program is being implemented as designed.

**Validation:** initial and ongoing confirmation that the Program, when implemented as designed, effectively controls the hazardous conditions throughout the building water systems.

Source: ASHRAE Standard 188
Validating a Program

“The Program Team shall establish procedures to confirm...that the Program...effectively controls the hazardous conditions throughout the building.”

Excerpt paraphrased from ASHRAE Standard 188 Section 6.2.8

**Testing:** conducting a planned sequence of observations or measurements of physical, chemical, or microbial characteristics of water to assess whether conditions throughout building water systems meet the goals set by the Program Team

Source: ASHRAE Standard 188
Traditional *Legionella* Culture – Processing Samples
Enumerating *Legionella* by Traditional Culture

<table>
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<tr>
<th>Medium</th>
<th>BCYE Direct</th>
<th>PCV Concentrated 20X Acid Treatment</th>
<th>GPCV Direct Acid treatment</th>
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<td>Result</td>
<td>Not detected</td>
<td>0.1 cfu/ml</td>
<td>120 cfu/ml</td>
</tr>
</tbody>
</table>
# Accuracy and Precision of Enumeration

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Number Tested</th>
<th>Percent Positive</th>
<th>Mean QC (cfu/ml)</th>
<th>Mean Result</th>
<th>Log difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Negative</td>
<td>789</td>
<td>3%</td>
<td>0</td>
<td>18</td>
<td>0.53</td>
</tr>
<tr>
<td>Pure Positive</td>
<td>854</td>
<td>91%</td>
<td>10,191</td>
<td>9,840</td>
<td>-1.54</td>
</tr>
<tr>
<td>Pure Variable</td>
<td>903</td>
<td>54%</td>
<td>1,149</td>
<td>3,493</td>
<td>-0.65</td>
</tr>
<tr>
<td>Mixed Negative</td>
<td>968</td>
<td>5%</td>
<td>0</td>
<td>32</td>
<td>0.93</td>
</tr>
<tr>
<td>Mixed Positive</td>
<td>781</td>
<td>73%</td>
<td>3,516</td>
<td>3,446</td>
<td>-1.80</td>
</tr>
<tr>
<td>Mixed Variable</td>
<td>971</td>
<td>51%</td>
<td>257</td>
<td>142</td>
<td>-0.076</td>
</tr>
</tbody>
</table>
Other Detection Methods

- Liquid culture with bacterial enzyme detection
- Nucleic acid based
- Antibody capture and visualization
- Increased sensitivity
- Faster turnaround time
- Limited specificity
- Variable sensitivity
- Live/dead discrimination
Pathogenicity of Legionellae

>70 species/serogroups of *Legionella*
Lp1 causes > 85% cases of disease
20-50% of environmental isolates are Lp1

MAb2(+) strains cause >80% cases of disease
≤ 20% environmental isolates are MAb2(+)

~3000 STs
~300 are known to cause disease in the US

~30 STs cause > 80% of disease in the US
Summary

• Water management is a dynamic process.
• Water management programs should be site specific.
• Program Team decides validation criteria.
• *Legionella* test results may inform validation.
• *Legionella* test results are NOT predictive of disease.
• Periodic Program review is crucial for effective management.
http://www.cdc.gov/legionella/index.html

Thank you!

For more information, contact CDC
1-800-CDC-INFO (232-4636)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.