PLUMBING MANUFACTURERS INTERNATIONAL ®

Just the Facts:

Legionella and Water Supply Systems

New Kinds of Plumbing Systems, Old Infrastructure Create Additional Challenges

Everyone wants – and expects – safe, clean water when they turn on the tap. However, keeping potable and non-potable water supply systems safe can be challenging, as underground water infrastructure ages or becomes outdated and as newer types of water supply systems and lower flow rates keep water in pipes longer.

The Centers for Disease Control and Prevention (CDC) has acknowledged that opportunistic premise plumbing pathogens (OPPPs) are the primary cause of waterborne disease in the United States.[1] Legionella pneumophila, one type of OPPP, can develop in water supply systems and result in Legionnaires' disease, a severe form of pneumonia. About 5,000 cases of Legionnaires' disease are reported each year in the U.S., according to the CDC.[2]

As an advocate for safe plumbing, Plumbing Manufacturers International (PMI) is working diligently to help keep water delivery safe. PMI supports and promotes research relating to safe plumbing and backs efforts to educate legislative leaders and policymakers on potential threats to safe drinking water, as well as on the need for a restored national underground water infrastructure.

This PMI FAQ document provides answers to several key questions about Legionella and its potential effects on water supply systems.

What is Legionella?

Legionella are naturally occurring bacteria found in freshwater sources, such as rivers and lakes, where the bacteria generally are present in low amounts and do not lead to disease.[3]

However, Legionella can multiply to dangerous levels under certain conditions and potentially cause Legionnaires' disease, or Legionellosis. People contract this disease by inhaling small droplets of the contaminated water through mist or vapor.[4]

Legionella was first discovered in 1976 in the building water supply system at a hotel in Philadelphia during a meeting of the U.S. Bicentennial Convention of the American Legion. By the end of the convention, more than 200 people had contracted the bacteria, which resulted in what would be called Legionnaires' disease.[5]

Who can be affected by Legionella and Legionnaires' disease?

Legionnaires' disease is caused by infection with Legionella bacteria. Individuals who have an underlying illness or weakened immune system are most susceptible to Legionella infections. The elderly, those with chronic lung disease, smokers and those with suppressed or compromised immune systems are most at risk for contracting the disease.[2] However, relatively healthy individuals can be at risk of contracting the disease as well.[6]

How can water supply systems become contaminated with Legionella?

Today, a lot more is known than 40 years ago about the factors contributing to the growth and spread of Legionella. New outbreaks of Legionnaires' disease have been discovered throughout the country, proving there is still much more to learn. Legionella contamination can occur when water supply systems are improperly maintained, leading to an environment that feeds Legionella growth.[9]

Recent research by Dr. Marc Edwards, a professor of civil engineering at Virginia Tech, has shown that OPPPs, like Legionella, are more likely to grow when water aging problems occur in water pipes leading to the tap.[7] This finding provides an alert at a time when lower flow rates and alternative kinds of water supply systems that keep water in pipes longer are being considered as solutions to water shortages. Edwards, a nationally prominent voice in leading the response to the water crisis in Flint, Mich., continues conducting research on water quality in water supply systems with water age issues.

There are several key elements that can promote the growth of Legionella bacteria in a water supply system, including:

- **Excessive water age.** The longer water sits in a system or piping in a system, the greater likelihood the water disinfectant will dissipate over time, leading to pathogen growth.[8]
- **Biofilm.** When biofilm, a sticky substance created by bacteria, forms on the inside wall of water supply piping, it protects Legionella from heat and disinfectant.[9]
- **Lukewarm water.** Legionella growth is enabled by lukewarm water temperatures, usually in the range of 77 degrees Fahrenheit to 108 degrees Fahrenheit.[9]
- **Dead legs.** A "dead leg" is caused by no flow or rare flow of water in pipes.[9]
- **Insufficient disinfectant.** Effective water disinfectant strategies are necessary to control Legionella in a water system. For example, chlorination is one method used by water districts to disinfect drinking water that provides a lasting residual disinfectant.[10]

- **Inadequate corrosion control.** Corrosion can occur in system pipes, depending on several water quality variables, including disinfectants used, water temperature and pH levels. Improper corrosion control can create the ideal environment for Legionella growth.[11]
- **Cross connections.** Cross connections between potable and non-potable water can introduce Legionella into the potable water supply system.[12]

What types of environments are susceptible to Legionella contamination?

First, Legionella needs to grow to cause a health risk. Parts of a water system with insufficient circulation or lukewarm temperature can provide the ideal environment for Legionella growth.

Once Legionella grows, it needs a way to spread. Any source that generates aerosol or a fine mist of water has the potential to transmit Legionella. Large complex plumbing systems like those used in hospitals, retirement communities, and cruise ships are most often associated with Legionnaires' disease outbreaks.[13]

In essence, three key elements contribute to Legionella risk:

- Intrusion introduces Legionella into the system.
- Growth occurs when Legionella increases within the system.
- Transmission happens when aerosols, or small water droplets, containing Legionella are inhaled.

Can you see Legionella?

No. Legionella are bacteria that grow in water; they are not visible to the naked eye. The water droplets that carry Legionella into the lungs are also not visible to the naked eye.[15]

How can Legionella contamination be prevented in water supply systems?

The key to preventing Legionnaires' disease is to prevent Legionella growth in water supply systems. Legionella can colonize in water delivery lines and building plumbing systems, contaminating water supplies after the water has been centrally treated at a public water facility.[16]

One of the best ways to reduce the risk of Legionella growth and spread is to design, implement and regularly update an overall water safety plan for an entire system, taking into account any potential hazardous conditions for a particular system and including industry best practices for prevention. The foundation of this plan is an engineering audit of the water system.

When, and how often, should building water systems be tested for potential Legionella contamination?

No evidence-based consensus recommendation exists regarding routine testing for Legionella for preventing Legionellosis.

The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) 188 (Legionellosis: Risk Management for Building Water Systems), a commonly recognized standard in the U.S., says that a building water management team can consider whether testing should be performed. If a team agrees testing should take place, it should determine the frequency of testing,

as well as locations and plans for the response to testing results. If a program team chooses to test for Legionella in their water supply systems, ASHRAE 188 does not make recommendations about sampling and test methods, number of test sites, and how often to test.[17]

In addition, Legionellosis outbreaks can be difficult to identify, particularly with travelers who get exposed to Legionella and then return home before showing any symptoms, according to the CDC.[18]

State and local health departments offer information about specific outbreaks and usually lead outbreak epidemiological investigations to the source of illness. When an outbreak occurs, these health departments will also typically recommend building owners hire an engineering expert to investigate causes of Legionella colonization, recommend remediation procedures for short-term control of the bacteria, and develop long-term solutions to root causes that led to the issue. The CDC is called in when those departments request additional assistance.

Are there any federal guidelines or industry standards dictating "safe levels" of Legionella in public or building water supply systems?

There are no EPA regulations specifically for Legionella levels in municipal water. The Revised Total Coliform Rule[19] and the Ground Water Rule[20] include treatment technique requirements addressing risks from bacterial contamination and may provide some control of Legionella. In addition, there are no federally mandated guidelines established on managing Legionella in water supply systems.

ASHRAE is an industry organization responsible for creating key Legionella standards seeking to control the spread of Legionella in water supply systems. The ASHRAE Standard 188 has been

endorsed by the CDC and is a Centers for Medicare and Medicaid Services (CMS) requirement for all CMS healthcare facilities in the U.S.[21]

ASHRAE 188 (Legionellosis: Risk Management for Building Water Systems) is the American National Standards Institute (ANSI)-approved national standard. Developed by an international committee and considered an international document, ASHRAE 188 establishes minimum risk management requirements to control the transmission of Legionellosis in water supply systems. While no city or state has adopted the entire standard into law, New York City has adopted portions of the standard for controlling Legionella in cooling towers.[22]

Another standard being developed called NSF 444 (Prevention of Injury and Disease Associated with Building Water Systems) also deals with Legionellosis risk management, along with other microbial contamination hazards.[23] This standard will be based on Hazard Analysis Critical Control Point (HACCP) methodology,[24] which has been used to ensure food safety by U.S. government agencies, identify hazardous agents, and specify measures to control such agents within a building water system. This standard will be incorporating the principles and concepts of ASHRAE 188 into the section that will cover Legionellosis.

Another U.S. Legionella control document titled "Recognition, Evaluation and Control of Legionella in Building Water Systems" is published by the American Industrial Hygiene Association (AIHA).[25] Like ASHRAE 188, this document recommends a systems approach and does not use a HACCP or process control approach.

In addition, the ASSE/IAPMO/ANSI 12000 Series Standards for the "Health and Safety of Construction and Maintenance Personnel" have been established to help train and certify construction and

maintenance personnel, including plumbers, pipefitters and mechanical systems workers, in how to safely work in an environment with potentially infectious diseases and bacteria, including water-borne pathogens like Legionella.

Should there be concern about the aging U.S. underground water infrastructure and Legionella?

Older water infrastructure can be more vulnerable to contamination through leaks and breaks. When a leak or break occurs, it increases the possibility of OPPPs like Legionella entering the infrastructure, forming in biofilms, and then being released into the water supply.[26]

Approximately 240,000 water main breaks occur annually in the U.S., wasting more than 2 trillion gallons of treated drinking water, according to the 2017 Infrastructure Report Card by the American Society of Civil Engineers. In addition, the report card noted that many of the 1 million miles of pipes delivering drinking water across the country have either reached – or are fast approaching – the end of their lifespans.[27] In addition, maintenance, repair and replacement of water mains has been associated with multiple large outbreaks of Legionella.[14]

Are there energy efficiency and water conservation measures that can cause unintended consequences and conditions to support Legionella growth?

Building more sustainable water supply systems with the best intentions can still result in unintended consequences, such as Legionella contamination, if proper precautions are not taken.[7]

For example, states dealing with severe water shortages have lowered or have considered lowering the required flow rates or flush volumes of plumbing products, including faucets, showerheads, urinals and toilets. However, concerns have surfaced that lower flow velocities may yield a greater proliferation of OPPPs, such as Legionella, in potable water and create unsafe conditions.[28]

Another example can be found with the increasing number of buildings being built or retrofitted with new kinds of plumbing systems, such as those that keep water in pipes longer. Recent research by Dr. Marc Edwards points to potential consequences to public health with these new plumbing systems. His research found that these systems may increase water stagnation and water age in premise plumbing because of reduced water demand. The resulting high water age, a generally overlooked aspect of water conservation, has possible implications for OPPPs, including Legionella, which are more likely to grow when water lies stagnant in pipes leading to the tap. His research also showed that the quick rate of disinfectant loss in buildings with high water age needs to be studied further.[7]

Additional Resources to Learn More About Legionella and Legionnaires' Disease

The CDC's website section covering Legionnaires' disease: https://www.cdc.gov/legionella/

CDC fact sheet on Legionnaires' disease: https://www.cdc.gov/legionella/downloads/fs-legionnaires.pdf

The EPA's website section covering Legionella - Ground Water and Drinking Water: https://www.epa.gov/ground-water-and-drinking-water/legionella

To purchase a copy of ANSI/ASHRAE Standard 188-2015 - Legionellosis: Risk Management for Building Water Systems: https://www.ashrae.org/resources--publications/bookstore/ansi-ashrae-standard-188-2015-legionellosis-risk-management-for-building-water-systems

Article in Waterborne Pathogens, "Opportunistic Premise Plumbing Pathogens: Increasingly Important Pathogens in Drinking Water," by Joseph O. Falkinham, III; Amy Pruden; and Marc Edwards: http://www.mdpi.com/2076-0817/4/2/373

Alliance to Prevent Legionnaires' Disease website: http://preventlegionnaires.org/

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World Health Organization Legionellosis Fact Sheet (Updated June 2016) in the Media Centre. http://www.who.int/mediacentre/factsheets/fs285/en/

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[20] "EPA Drinking Water Requirements for States and Public Water Systems: Ground Water Rule." https://www.epa.gov/dwreginfo/ground-water-rule

[21] "Requirement to Reduce Legionella Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD)" Centers for Medicare & Medicaid Services memorandum to U.S. State Survey Agency Directors, June 9, 2017

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[24] U.S. Food & Drug Administration "Hazard Analysis Critical Control Point (HACCP)" Guidance Regulation. https://www.fda.gov/Food/GuidanceRegulation/HACCP/

[25] "Recognition, Evaluation, and Control of Legionella in Building Water Systems," edited by William Kerbel, J. David Krause, Brian G. Shelton and John Springston; published by the American Industrial Hygiene Association; May 1, 2015; ISBN: 978-1-935082-47-7. https://www.aiha.org/marketplace/Pages/Product-Detail.aspx?productid=%7b3A823505-FEF3-E411-A28B-005056B20848%7d

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