PREVENTION OF LEGIONELLA GROWTH IN WATER SYSTEMS

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Legionella pneumophila is a waterborne pathogen found in natural and man-made water systems.

The Legionella bacteria was first identified by the Centers for Disease Control (CDC) in 1976, following an outbreak of pneumonia-like symptoms among a number of attendees at an American Legion conference in Philadelphia. This outbreak led to the name of both the bacteria and the illness it causes: Legionnaires' Disease.

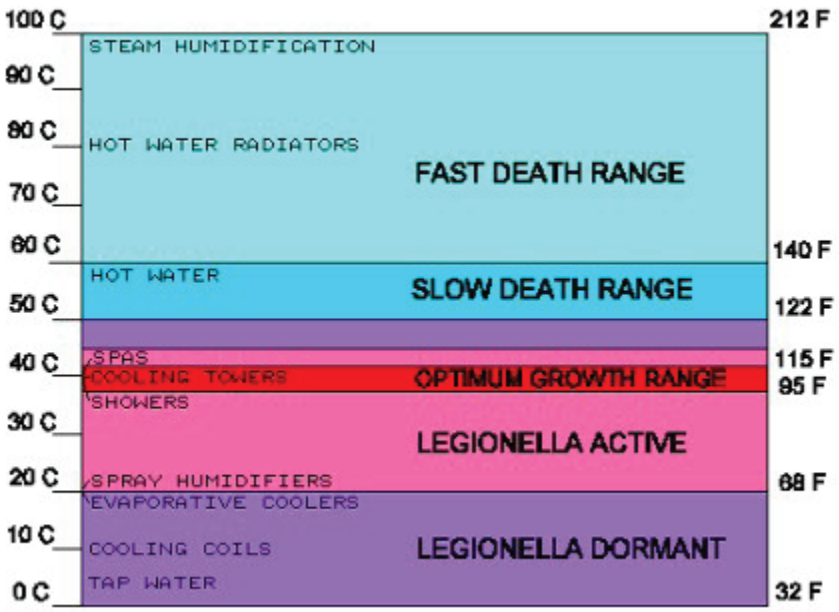
The CDC has retrospectively reviewed outbreaks and determined that Legionella-related illness can be traced back at least as far as 1959, to an outbreak of what was called "Pontiac Fever" in Pontiac, MI. The CDC estimates that there are between 8,000 and 18,000 cases of Legionella and Pontiac Fever every year. Health departments reported nearly 10,000 cases of Legionnaires' disease in the United States in 2018.1 However, Legionnaires' disease is likely underdiagnosed, and this number may underestimate the true incidence.

About one in 10 people who gets sick from Legionnaires' disease will die.2 Death occurs through progressive pneumonia with respiratory failure and/or shock and multi-organ failure.

Both potable and non-potable water supplies harbor Legionella bacteria, and have been linked to outbreaks of Legionnaires' disease. According to the World Health Organization, the most common form of transmission of Legionella is inhalation of contaminated aerosols produced in conjunction with water sprays, jets, or mists. Sources of aerosols that have been linked with transmission of Legionella include both open- and closed-loop cooling towers, misters, evaporative coolers, humidifiers and whirlpool spas. Infection can also occur by aspiration of contaminated water or ice, particularly in susceptible hospital patients. There is no direct human-to-human transmission.

PREVENTION AND CONTROL

As building water supplies are a prime source of Legionella,



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keeping Legionella out of water systems in buildings is key to preventing infections or outbreaks. A variety of internal and external factors can lead to a Legionella problem in a building, including:

- Construction
- Water main breaks
- Changes in municipal water quality
- Biofilm
- Scale and sediment
- Water temperature fluctuations
- Water pH fluctuations
- Inadequate levels of disinfectant
- Changes in water pressure
- Water stagnation

According to the Occupational Safety and Health Association (OSHA), water management programs that effectively prevent Legionella growth in water systems rely on specific measures, including good system design, proper facility and equipment maintenance, and routine cleaning and disinfection. Effective maintenance and regular visual inspections should prevent scale buildup, sediment, and gradual water organism accumulation on structural surfaces (i.e., biofouling)—processes that support Legionella growth. OSHA recommends activity records to help ensure proper maintenance. These may include operating system descriptions for all components in the system and the make-up water supply to the system; written procedures for the system's proper operation and maintenance covering scale and corrosion inhibitor use, antifoaming agent use, and biocide or chlorine use; inspection, cleaning, and disinfection dates; test results from any water sampling that has been performed; and system maintenance/monitoring dates and work description/results.

WATER MANAGEMENT PRINCIPLES

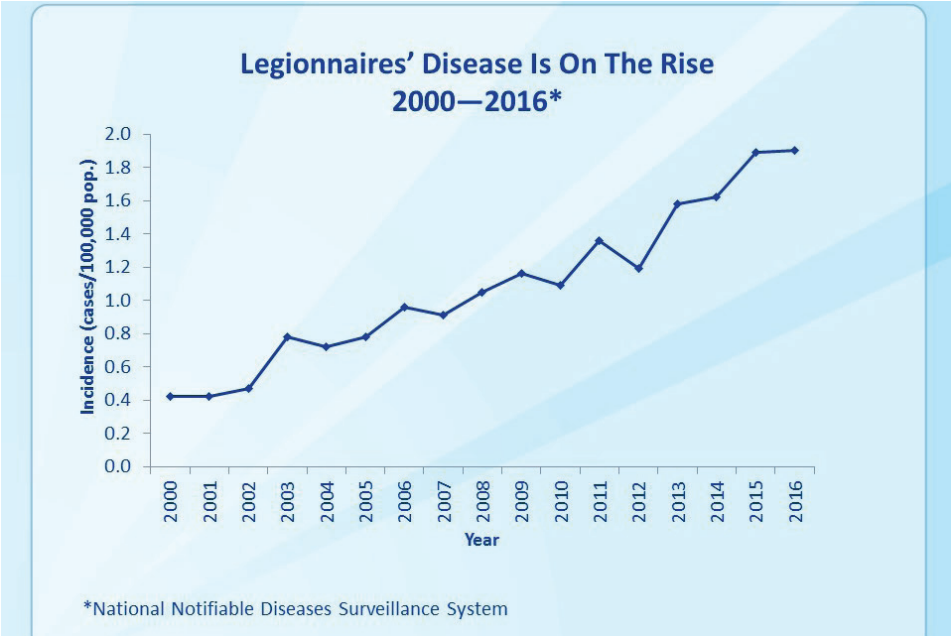
According to the CDC, the principles of effective water management include:

- Maintaining water temperatures outside the ideal range for Legionella growth
- Preventing water stagnation
- Ensuring adequate disinfection
- Maintaining devices to prevent scale, corrosion, and biofilm growth, all of which provide a habitat and nutrients for Legionella

Once established, water management programs require regular monitoring of key areas for potentially hazardous conditions and the use of predetermined responses to remediate such conditions if they are detected.

Water management programs must be tailored for each particular building at a particular point in time. Building factors to take into consideration include structure and size, age, location and surrounding conditions, unique areas of risk for Legionella growth and spread, and the susceptibilities of the people found within (i.e., the elderly, individuals with comprised immune systems, and those who have certain health conditions, such as chronic obstructive pulmonary disease or emphysema, are at increased risk from Legionella).

Water system management options may vary depending upon state and local building codes, water treatment regulations, healthcare accreditation and survey requirements, and public health reporting requirements. In some settings, such as hospitals and other large buildings with complex water systems, a water management program may need to encompass the entire building. Smaller buildings with simple water systems may only need a water management program to cover the devices that aerosolize water, such as fountains, hot tubs, and cooling towers.



Cannabis growing facilities use a lot of energy and generate a lot of heat, making a reliable cooling system essential.

ADDRESSING LEGIONELLA GROWTH

According to the CDC, maintaining and operating a building's equipment effectively will help prevent biofilm, organic debris, and corrosion from contaminating the water system; all of these provide a habitat and nutrients for Legionella.

Other Legionella control strategies recommended by the CDC include:

- Maintain proper disinfectant amounts. A reduction in disinfectant levels in a building water system can open the door for Legionella growth. In some buildings, processes such as heating, storing, and filtering can reduce the amount of available disinfectant, allowing Legionella to grow if steps are not taken to stop it.
- Maintain proper water temperatures. Legionella grows best within a specific temperature range (77°F-108°F). To keep water outside the range for Legionella growth, it is important to keep cold water cold and keep hot water hot.
- It's important to remember

STANDARD

ASHRAE®

ANSI/ASHRAE Standard 188-2018
(Supersedes ANSI/ASHRAE Standard 188-2015)
Includes ANSI/ASHRAE addenda listed in Annex D

Legionellosis: Risk Management for Building Water Systems

See Informative Annex D for approval dates.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE® website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

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that in warm climates, water in pipes that carry cold water may reach a temperature that allows Legionella to grow. In hot water systems, water heaters must be maintained at appropriate temperatures while following local and state anti-scald regulations. Maximum temperatures allowed by some states may be too low to limit Legionella growth. Engineering controls that mix hot and cold water together at or near the point of use can reduce the risk of scalding while allowing water in pipes to remain hot enough to limit Legionella growth.

- Prevent stagnation. When water does not flow well, the resulting areas of stagnation encourage biofilm growth, reduce water temperatures to levels that allow Legionella to grow, and reduce levels of disinfectant. It is important to understand the flow of water in a building in order to identify areas of risk where water may become stagnant.

WATER SYSTEM TREATMENT OPTIONS

A number of standards and practices have been created to address control of Legionella. Jim Paschal, P.E. LEED AP, Chief Technology Officer at Aquatherm North America, a manufacturer of polypropylene piping systems for

aquatherm
we've got a pipe for that

commercial and industrial HVAC systems, noted that most of these materials follow what is known as a Hazard Analysis and Critical Control Point (HACCP) protocol. The control points for Legionella in water systems include:

- Hyper/super chlorination
- Chlorine dioxide
- Monochloramines
- Copper-silver ion generation
- Heat
- Ultraviolet light

All of these treatment methods have their pros and cons, and no one method is perfect for all applications. Here are the pros and cons of these water treatment methods, according to Paschal. Hyper/super chlorination has been shown in a number of studies to not be a very reliable technique for a number of reasons. The high concentration of chlorine does not necessarily penetrate the biofilm in the piping, it can be costly, and it is not very reliable as a day-to-day method.

Chlorine dioxide is very effective at killing Legionella. Unfortunately, as a byproduct it also creates chlorates and chlorites, and the combination of the three is regulated by the Environmental Protection Agency (EPA). The EPA also is setting up standards by which a building's management — if they are performing any on-site treatment of the water system — can be held accountable for maintaining those EPA requirements in their own systems.

Monochloramines have been found to be very effective. They are very effective against Legionella, and maintain a residual in the water longer than either the free chlorine or chlorine dioxide. Unfortunately, they are not as effective against some other types of bacteria, so their use must be evaluated based on how they are being used — possibly in other facilities similar to the one where this treatment method is being considered.

The copper-silver ions in copper-silver ion generation have been found to be very effective against Legionella, and they do provide a longer-term effect, so if the system goes down due to a mechanical failure, the piping system will still continue to be effective against Legionella because of the presence of the copper ions over an extended period of time. However, Paschal cautions that the combination of chlorine and copper can be detrimental to certain plastic piping systems.

A non-chemical option is heat. Heat treatment will destroy Legionella, and the temperature


Mist in Grocery's Produce Section Is Linked to Legionnaires' Disease

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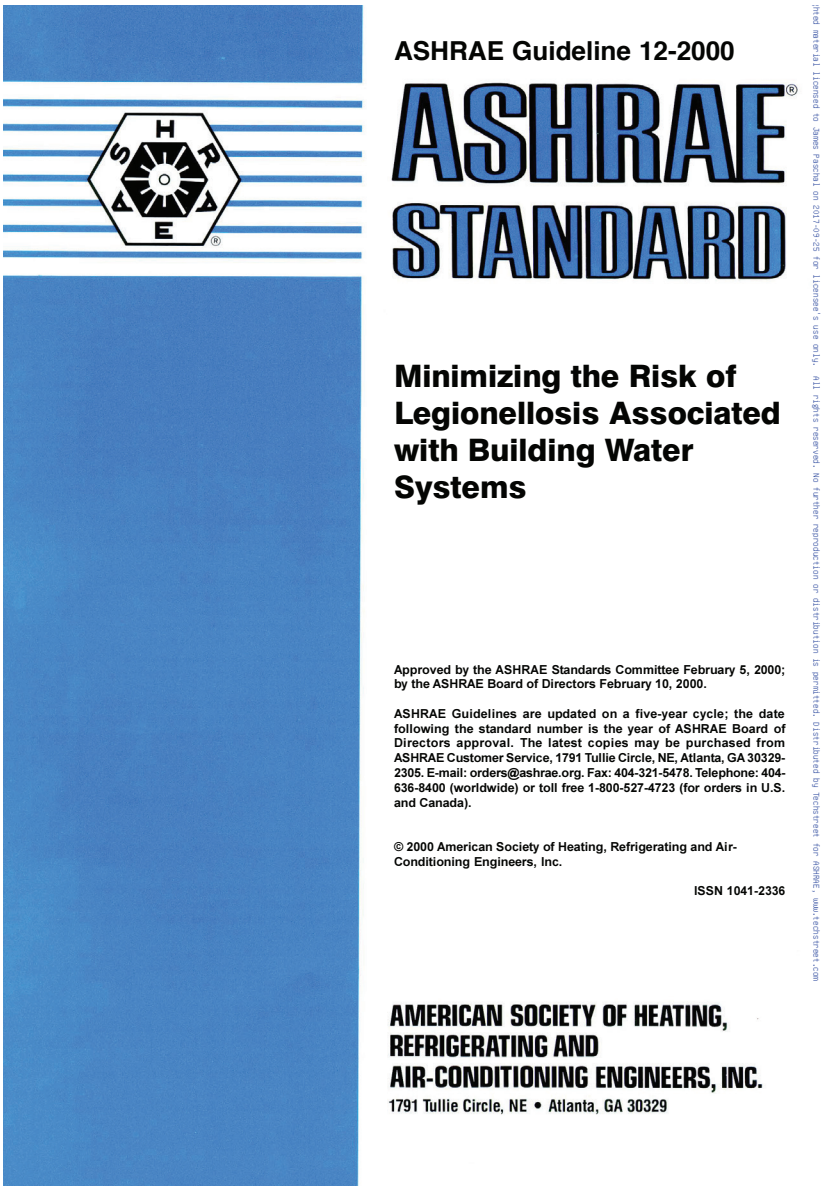
and exposure time are directly related: the higher the temperature the shorter the exposure time. A number of facilities have incorporated options such as heating the water in the system up to 160°F for one hour each day, or running the system continuously at 140°F. Although both of these methods can be done properly, the concern is that the temperature must be maintained throughout the entire system, so the water must be kept circulating as much as possible.



ASHRAE Guideline 12-2000

ASHRAE® STANDARD

Minimizing the Risk of Legionellosis Associated with Building Water Systems

Approved by the ASHRAE Standards Committee February 5, 2000; by the ASHRAE Board of Directors February 10, 2000.

ASHRAE Guidelines are updated on a five-year cycle; the date following the standard number is the year of ASHRAE Board of Directors approval. The latest copies may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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ISSN 1041-2336

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Another non-chemical treatment is ultraviolet (UV) light. UV light works very well in eradicating Legionella bacteria, and it can also be very cost-effective. It does have the downside of being a one-pass system that does not maintain a residual in the water. However, if the system is designed and operated properly, the use of UV light can be very successful. Paschal added that the choice of pipe material in water systems is not a factor in controlling Legionella and should not be relied upon by facility maintenance staffs for this purpose. For example, several Legionella prevention methods can be used successfully with polypropylene pipe (such as the use of high temperature for short periods, UV disinfection, or chloramines) while other methods (such as chlorine dioxide and copper-silver ion generators) may be detrimental to any piping material and must be carefully evaluated.

"Care must be taken in the method(s) of Legionella control to ensure the control method doesn't damage the piping system," Paschal said. "However, Legionella is a system issue and more important than the piping material type is proper system design, operation, and maintenance, such as avoiding 'dead legs' or stagnation points."

CONCLUSION

In conclusion, although not identified until the 1970s, it's likely that Legionella has been around for much longer. Thanks to our growing knowledge of it we are now better equipped than ever to control it and to prevent the illnesses it causes. Following proper control protocols and closely monitoring the results will help ensure the safety and health of building occupants and those who may inhale aerosolized droplets from building water sources.