Legionella Management for Building Water Systems

BY LAN CHI NGUYEN WEEKES, P.ENG., MEMBER ASHRAE; DONALD M. WEEKES, CIH, MEMBER ASHRAE

Legionella is a bacterium that can be present in many different environments including soil, natural water sources, and building water systems. In some cases, human exposure to the airborne bacteria spores via inhalation of airborne-contaminated dust or aerosolized liquid droplets can cause a severe respiratory infection, commonly referred to as Legionnaires' disease and Pontiac fever. Water systems in the built environment are the primary reason for the recent (since 1976) emergence of the disease, and there has been a more recent increase of Legionnaires' disease in the United States and many other countries.[1]

In the United States, reported cases of Legionnaires' disease have grown nearly four and a half times since 2000. However, it is unclear whether this increase represents an artifact of increased awareness and testing, increased susceptibility of the population, increased *Legionella* in the environment, or some combination of factors.[2] Nevertheless, in light of recent large outbreaks of Legionellosis in Quebec City (in 2012), and the Bronx, N.Y. (in 2015), several federal[3,6,9] states/provincial[4,8] and city[5] health agencies and professional organizations[7,10] have recently reemphasized the need for primary control of Legionellosis in the built environment.

One of the first recommended steps of primary control for a large building is the creation of a *Legionella* management program,[3,6,7] which includes an inventory of all its water systems, the identification of the associated risks with each water system, and the definition of specific steps necessary for the control and elimination of the bacterium within each system. Preparing these management programs can be a challenging task as they need to be detailed enough to provide useful information yet simple enough to use by the building operators. Here are a few hard-learned lessons from our work on *Legionella* management plans.

Creating the Water System Inventory

Start by seeking out existing plumbing drawings. In many cases, the only available plumbing drawings are the "as-built" drawings that can date back from several years (if not decades) without any updates. These drawings are useful since the main water risers and the main water connections do not tend to change over time. A review of the current equipment maintenance logs will often reveal equipment that were not in the original plans. This review will find the most recently installed (or hard-to-find) equipment such as a unitary cooling system or a standalone hot water heater for an office suite.

Lan Chi Nguyen Weekes, P.Eng., is the Director of Physical Resources at La Cité College, Ottawa, ON, Canada. Donald M. Weekes, CIH, is a partner at InAIR Environmental Ltd., Ottawa, ON, Canada.

A plumbing specialist is an essential member of the inventory team, since they can help identify the water lines, determine the specifics of the water distribution arrangement, and create detailed plumbing drawings for the water management program. It is never a good assumption that the most remote fixture is in fact at the furthest water point of any water line as water supply line can sometime make surprising twists and turns.

The building operators are also invaluable to the team since they often know where cross-contamination/by-pass/dead legs in the water lines occur (*Figure 1*). This is especially useful when such a problem is located in a closet in the basement, or where most of the water systems are not located, like above the ceiling in an office. The building operators will often share their frustration due to the lack of access to certain equipment for maintenance purposes. They also will discuss peculiar maintenance practices such as throwing in a few pucks of chlorine now and then (no specific schedule) into the cooling tower water basins.

Cooling Towers

The cooling towers in a building are associated with most of the recorded *Legionella* outbreaks. A significant difficulty with addressing cooling towers is that they are generally in use when an elevated level of *Legionella* bacteria is detected. Moreover, the cooling towers are often connected to each other through shared piping and other components.

It is important that the management plan include a systematic and detailed shutdown and isolation procedure for each cooling tower. The management plan should also include photographs showing each of the components involved in each step of the shutdown, especially in a situation with a busy piping configuration. Usually, cooling towers cannot be shut down without affecting the operations in progress, for example, in critical data centers, or in buildings where there is no spare cooling capacity. As an alternative, a rolling disinfection procedure should be included in the management plan to allow for emergency disinfection when the cooling tower is operating, either as per the manufacturer's recommendations or as described by U.S. EPA.[9] The management plan should also include the acceptable running time before shutdown of the cooling tower can occur, and the acceptable off-line period for the building operations in progress. It is recommended that a cooling load transfer plan should be included in the management plan in order to explain how cooling will be provided during the shutdown.

Locations for water testing for the cooling towers should be clearly indicated in the management plan using photographs or notations on the water diagram for the cooling towers. The sampling locations should be specific to each cooling tower, such as from the water basin. The sampling location should not be an easy access common point for several cooling towers such as the point of injection for chemicals. The intent is to determine where the bacterium growth may be located in a specific cooling tower, and to limit the shut down and disinfection only to the affected cooling tower.

FIGURE 1 Dead leg (bottom) located in a closet in a basement.

Open Water Systems

More ornamental water features are being disconnected since they are perceived as a potential *Legionella* growth risk. However, other open water systems such as non-potable water storage for garden watering and recirculated water systems for biophilic walls are being introduced in the built environment. These systems should be assessed for *Legionella* growth since they are not always easy to access for cleaning. Also testing of these open water systems may be difficult because in some cases, the water system is in a confined space with the potential for drowning, or simply the water tank is too small for proper access. Chemical treatments to eliminate the *Legionella* bacteria are usually not an option since the chemicals can adversely affect the plants. The water management program should include strict monitoring of these systems to detect and control *Legionella* growth.

Domestic Hot Water Systems

Different types of devices such as tankless water heaters and point-of-use small water heaters are becoming more prevalent in new and renovated buildings (*Figure 2*). Both types

of water heaters are used as energy saving alternatives to larger centralized hot water tanks. However, they carry different risks for the growth of *Legionella* bacteria.

Tankless water heaters generally heat the water at the point of use, and therefore they are eliminating water stagnation in a reservoir, which reduces the risk of *Legionella* growth. Although small water tanks at the point of use can limit water stagnation in the water line leading to the fixture, they can still have water stagnation in the tank at infrequently used locations. Moreover, they generally do not have any means for water recirculation or water temperature control. Close monitoring of point of use equipment (especially small water tanks) is essential since they tend to be located in areas that are not visible (under kitchenette counters) or inaccessible (ceiling-mounted).

Infrequently Used Fixtures

Questions are frequently asked about the need to inventory infrequently used fixtures such as emergency eyewash and shower stations, and hose bibs in garages and outdoors. These fixtures can carry both a risk for *Legionella* growth in the water line, and they can disperse contaminated water droplets at the point of use. The current ANSI Z358.1-2014[11] requirements for weekly activation of emergency showers and eyewashes to confirm proper operation, along with a thorough annual inspection, should help reduce the risk from these fixtures. Hose bibs should be flushed weekly along with the associated water line, especially if they are made of flexible materials before using any spray nozzle. Flexible materials are not properly considered under water quality regulations, despite the fact that there is clear evidence that flexible materials result in dramatically more biofilm formation than hard plastics, stainless steel, or copper pipes.[12,13]

Communication Plan

A clear and simple communication plan with up-to-date contact information, sample collection and analysis information, as well as the actions taken to address any concerns should be included in the program. The communication plan avoids confusion, and it keeps the communication process under control.

Preparing a water management program for large buildings' water systems can be a challenging task. The program must be detailed enough to provide useful information yet simple enough to be used. This column addressed several situations that are frequently encountered and key questions that are often asked by building management about *Legionella* management plans.

FIGURE 2 Tankless domestic water heater.

References

1. Parr, Alyssa, et al. 2015. "Legionellosis on the Rise: A Review of Guidelines for Prevention in the United States." *Journal of Public Health Management and Practice*, Lippincott Williams & Wilkins, Sept. www.ncbi.nlm.nih.gov/pmc/articles/PMC4519350.

2. CDC. 2017. "*Legionella* (Legionnaires' Disease and Pontiac Fever)." Centers for Disease Control and Prevention. www.cdc.gov/legionella/surv-reporting.html.

3. Parr, Alyssa, et al. 2015. "Legionellosis on the Rise: A Review of Guidelines for Prevention in the United States." *Journal of Public Health Management and Practice*, Lippincott Williams & Wilkins, Sept. www.ncbi.nlm.nih.gov/pmc/articles/PMC4519350.

4. CDC. 2016. "Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings: A Practical Guide to Implementing Industry Standards." Centers for Disease Control and Prevention. www.cdc.gov/legionella/downloads/toolkit.pdf.

5. New York State Department of Health. 2016. Sanitary Code Volume A, Title 10, Title: Part 4-Protection Against *Legionella*.

6. New York City Department of Health and Mental Hygiene. 2016. Chapter 8 of Title 24 of the Rules of New York City. Cooling Towers.

7. PSPC. 2013. Mechanical Design -15161-2013 Control of *Legionella* in Mechanical Systems. Ottawa, ON. Public Services and Procurement Canada.

8. ANSI/ASHRAE, *Standard 188-2015 Legionellosis: Risk management for building water systems.*

9. Gouvernement du Québec. Décret 454-2014. 2014. Règlement modifiant le Code de sécurité.

10. EPA. 2016. "Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review." Office of Water. U.S. Environmental Protection Agency. EPA 810-R-16-001.

11. AIHA. 2015. "Recognition, Evaluation, and Control of *Legionella* in Building Water Systems." Kerbel, W., Krause, J.D., B.G. Shelton, and J.P. Springston, eds. American Industrial Hygiene Association.

12. ANSI. 2014. Standard Z358.1-2014, *Emergency Eyewash and Shower Equipment.* American National Standards Institute.

13. Proctor, Caitlin R., et al. 2016. "Biofilms in Shower Hoses - Choice of Pipe Material Influences Bacterial Growth and Communities." *Environ. Sci.: Water Res. Technol.*, 2(4):670–682., doi:10.1039/c6ew00016a. ■