Addressing ASHRAE 188 Through Design

Several years in the making, ASHRAE Standard 188 *Legionellosis: Risk Management for Building Water Systems* is now official. As stated in the *FOREWORD* of the standard, there are between 8,000 and 18,000 cases of Legionnaires' Disease each year with a fatality rate greater than 10 percent. Awareness of Legionella continues to be on the rise due to improved reporting statistics and high-profile outbreaks over the last few years. Most, if not all public outbreaks, are a result of modern systems that convey the bacteria through aerosolized mist such as cooling towers, decorative fountains, whirlpools and the showerheads and faucets of potable water distribution systems. Legionella develops because it is allowed to colonize and spreads to people when it becomes an aerosol, infecting people when they breathe in mist or vapor that has been contaminated. While it may not be possible to eliminate the bacteria from occurring in nature, it is possible to reduce the risk of contracting Legionnaires' Disease from modern plumbing systems. This paper will address the effects of ASHRAE 188 to professional designers of potable water systems.

The FOREWARD of ASHRAE 188 states that it is intended to aid building owners, building managers and those involved from design to service of building water systems, in establishing minimum legionellosis risk management requirements. One way to manage the risks associated with Legionella bacteria is to design a system that is less conducive to Legionella colonization. Specific design guidelines can be found in ASHRAE Guideline 12, to which 188 refers under section 7 – *Requirements for Building Water Systems*.

It's important to note that ASHRAE 188 has only just become a formal standard. It is not yet adopted by any building or plumbing code and there is no vehicle for enforcement of the content in the standard. However, because a formal standard exists and can be referenced through project requirements, the level of consideration on the topic will increase in the future. It is up to design engineers, building owners and facility operators to determine the level of risk or potential risk of legionellosis in each of the building's water systems, and how to best manage that risk, whether through design or monitoring and maintenance practices. According to 188, the specific outcomes from these risk management decisions will have to be clearly documented and adhered to in order to minimize liability should an occupant contract legionellosis from a building system.

As mentioned, the risk management and responsibility lies not only with the building owners and maintenance staff, but also with the design engineer. Specifically in the case of the potable water system, it is the plumbing design engineer's responsibility during planning, specifying and design to provide a system that is safe, meets relevant plumbing and building codes and will meet the project's performance needs. Part of the safe system includes minimizing the opportunity for pathogens to colonize in the distribution system. For example, the designer should be mindful of minimizing dead legs and other stagnant areas that don't see flow on a regular basis and employ measures that will help maintain water temperatures outside the ideal growth range for Legionella.

The designer must also clearly specify procedures and acceptable methods and timing for initial system disinfection and commissioning in ways that will reduce the likelihood of contamination during these processes. ASHRAE Guideline 12 states, "A number of outbreaks of Legionellosis associated with cooling towers and evaporative condensers have occurred after these devices have been restarted following a period of inactivity." Therefore, even if a building has been disinfected, if the water is allowed to stagnate, there is a risk of Legionella growth. This is especially important for potable water systems that were opened for repair or construction or were subjected to water pressure changes associated with construction. This subject lends itself to leak-testing with air in lieu of water so as to not introduce water, which may become stagnant if not completely drained until the system is required for use.

The simple train of thought as the industry advances is: as the industry becomes more aware of specific issues within a plumbing system, standards are developed to address these issues, thereby making systems safer for occupants or more efficient. As these standards are developed, design engineers and operators now have new considerations when designing a plumbing system. New solutions have to be evaluated and implemented properly. They can do it on their own, with help from peers and colleagues, or rely on manufacturers for guidance, industry-leading developments and information. As expectations evolve, design engineers can also reach out to academia for scientific information.

Referenced in ASHRAE 188, Guideline 12 suggests design guidelines for reducing the risk of Legionella in a building's potable water distribution system. Strategies are presented for recirculation, disinfection, eliminating dead legs and temperature management. There are pros and cons to each and every solution. Together, both ASHRAE 188 and Guideline 12 offer a comprehensive look at how to manage the presence of Legionella in new and existing systems. ASHRAE 188 is geared for building owners and managers to help them determine the type of building affected and how responsibility should be delegated. Guideline 12 is more beneficial to the designers and those who manage the system. To understand how these strategies can be implemented and what is important to address, one must review several factors and determine what solution is best for a particular situation.

Maintaining temperature

There are several ways of maintaining temperature and designing a system to maintain temperature. Legionella grows best in temperatures ranging from 77 to 113 degrees Fahrenheit. State hospitals across the U.S. require the temperature to be 120 degrees Fahrenheit or less. This temperature is often found when hot water stops flowing and starts losing heat. Therefore, one of the most effective means of controlling Legionella and other waterborne pathogens is to keep the hot water hot and the cold water cold. A domestic hot water recirculation system is a good first step, but installing a pump and a return path is not good enough. Recirculation systems must be properly balanced to ensure that flow is maintained in every riser and at every branch of the system when practical. That can be managed in several methods, including creating a flow path that is the same length and uses the same size piping.

This method is ideal for closed loop systems but is less effective in open systems, such as those used for domestic hot water recirculation.

Manual pressure balancing is complicated and often requires a balancing specialist, and similar to creating equal length loops, works best in standalone systems. A dynamic version of manual pressure balancing is automatic pressure balancing, where the system is constantly balanced as valves adjust. The con of auto pressure balance is the valves are more complicated and have a lot of moving parts. Thermostatic balancing valves maintain the temperature by allowing water to flow through the valve if the temperature is below a set point.

As you can see, there are many design decisions that can either help or hinder water temperatures. Hot water piping can be insulated to prevent excessive heat loss. Depending on the ambient temperature near the piping, insulating cold water piping may also be considered. In large buildings, vertical piping is often installed with hot, cold and waste piping in a single pipe chase. By grouping insulated pipes of similar temperature in one area – ranging from hottest water to coldest water – you can help reduce unwanted heat transfer.

Seeing the demand to eliminate the need for a separate hot water recirculation return and associated fittings, the Viega SmartLoop™ system places the return line inside the hot water supply line, a concept referred to as internal recirculation. The total system heat loss is lower because only the supply side loses heat. Insulating the return line with the supply line also reduces the heat loss. In addition to reduced water and energy consumption because a smaller circulator can be employed, Viega SmartLoop dramatically reduces installation labor by reducing core penetrations, pipe supports and fire stops. This system is ideal for long or tall structures such as hotels, hospitals or schools.

Disinfection

There are situations when good design practices can be used to maintain clean, safe water, however, building owners still choose to disinfect the potable water. There are varying types of disinfection methods, again each with their own pros and cons. Many studies have been conducted to determine which disinfection methods are the most effective against certain bacteria, or which methods are the most cost effective or have less effect on the environment. Another consideration of disinfection is maintaining disinfection by-products within acceptable limits, themselves considered regulated contaminates. The risk of over-disinfecting also exists, which can lead to corrosion and premature system failure. Although no studies have been done, prevention via design is the common sense answer to help control waterborne pathogens.

This is where engineers come into play. With good design practices, there are many ways plumbing system designers and installers can help maintain the high quality of potable water inside the building. This doesn’t eliminate the need for disinfection, potable water is continuously disinfected prior to being delivered to the public. Some facilities also disinfect water inside the building, and are required to be flushed and disinfected following repairs. Combined with good design, disinfection can be beneficial to maintaining clean, safe water.

Innovative Systems

There are many ways to improve hygiene in potable water systems through good design practices. Reducing dead legs is one design strategy. A dead leg occurs when water doesn't run through a section of piping. This typically occurs in the traditional branch and tee design where water is distributed to each fixture at a usable pressure and flow. Since the introduction of ASHRAE 188, designers have started seeking out products that improve efficiency and lower operating costs. There is, and will continue to be, a growing market for products that improve the efficiency and hygiene of a building's potable water system.

Manufacturers have introduced several life-changing products to the plumbing market. These products change the way contractors do their jobs and affect the lives of the people who rely on them to provide a system that keeps the water clean and safe to drink. Three products in particular have influenced the design of potable water systems in a way that keeps water safe and delivered to the tap at consistent temperatures.

As we have shown, temperature and design are the key factors to reduce the risk of Legionella. By transitioning from a branch and tee method to a series or ring installation water is able to flow through every fixture, every time. Designing to these systems requires unique tools to increase flow through seldom-used pipes. In addition, each lead-free solution offers a professional appearance.

Double Drop Elbow

Traditional branch-and-tee designs distribute water to each fixture at usable pressure and flow, but the last length of supply piping to every fixture becomes a dead leg when that fixture is not used. By moving the "tee" closer to the fixture this type of dead leg is drastically reduced. For instance, connecting one fixture to the next in lieu of individual drops to each fixture will provide an installation that results in flow to all fixtures up to the point of connection anytime one of the fixtures are used, thereby reducing stagnation in that part of the system. There are fittings available that allow for such a connection that can dramatically reduce dead leg fixture drops. This is accomplished with the use of a double drop elbow. The double drop elbow is a threaded fitting that keeps water closer to each fixture in a series installation. By allowing flow up to the point of connection, water quality can be improved and dead legs can be minimized.

Series (Daisy Chain) Installation

With a series installation, water flows to every fixture upstream of the one being used. With this form of installation, periodically operating the fixture farthest from the supply can reduce stagnation in the piping to all of the remaining fixtures in a series. This is created by using tees or double drop elbows in lieu of drops or branches, especially to remote fixtures.

Ring Installation

Similar to the series installation, the ring design adds supply piping that allows flow in either direction. This induces flow up to the point of connection by utilizing multiple double drop elbows. Compared to a series, a ring installation uses more tubing, but provides fresh water up to the stop valve of each fixture in the ring every time a fixture in the ring is used.

Venturi Press Insert

The Venturi Press Insert is a fitting that manipulates pressure to alter the path of least resistance and induce flow to infrequently used fixtures. This fitting goes inside the supply main or riser, creating an increase in velocity and a decrease in pressure that induces flow in a loop, thereby maximizing the water exchanged.

Viega SmartLoop™ System

Exclusive to Viega, the SmartLoop system is a proprietary internal recirculation system that works in the same manner as a conventional hot water recirculation system except the return line is inside the supply line. This means only the supply side loses heat. Because the return line is smaller, a smaller circulator can be employed, reducing energy and water consumption. The supply riser insulates internal PEX return piping which reduces the installation of insulation to the supply riser. This type of installation can create an energy savings of up to 40% over a conventional system completely eliminating the need for a return pipe and the additional core drilling and hangers for that return line.

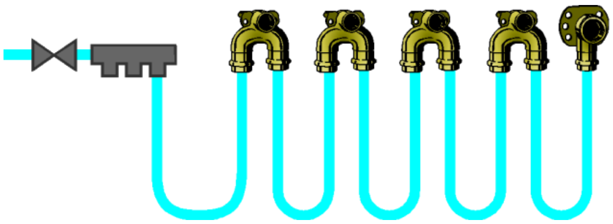
Conclusion

Together, plumbers, designers and product manufacturers can address the challenge of ensuring water quality for commercial potable water systems with increased knowledge and innovation. The bottom line is that in order to reduce the risk of Legionella growth, temperature needs to be maintained and water must maintain flow in all sections of piping. This sounds simple, but maintaining temperature can be difficult with traditional branch and tee designs. Depending on your situation, there are several products already available that can aid in the flow and temperature maintenance of a buildings piping system. As we have shown, everything from recirculation systems to insulating and grouping pipes of similar temperature will help reduce heat loss and maintain temperature.

Ideally, a building will be designed in such a way as to minimize the risk of bacteria growth throughout the potable water system. A well designed hot water recirculation system will maintain temperature and minimize stagnation, greatly improving the hygiene and efficiency of a potable water system. As these systems become more commonplace, designers and installers will look for products in the plumbing industry that simplify and expedite installation such as thermostatic balancing valves. On top of simplified installation, designers will seek out innovative products that improve efficiency and lower installation costs, adding solutions to the designer’s toolbox.

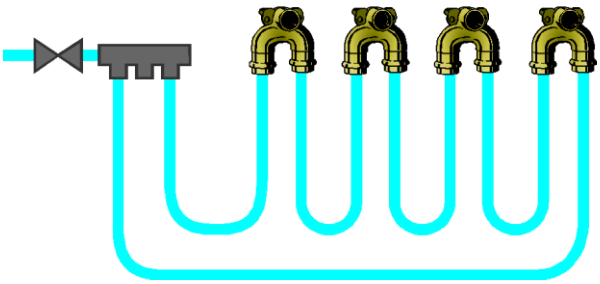
About the author:
As Product Director, Metal Systems at Viega LLC, Derek Bower brings more than 15 years of industry experience to his position. He joined Viega in 2010 as senior product engineer and was promoted to associate product manager in 2011 before his current role. Bower received his bachelor’s degree in science, mechanical engineering from the University of Illinois. He holds the title of Professional Engineer (PE) and LEED AP.

Illustrations:



Series Installation

The Series (Daisy Chain) Installation method uses flow-through fittings in a series compared to the standard branch and tee.

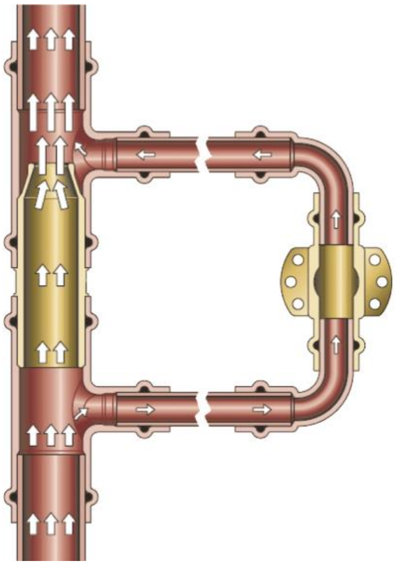


Ring Installation

Utilizing the same flow-through fittings, ring installations help circulate fresh water through supply piping of other unused fixtures.

Viega ProPress® Venturi Press Insert

The Venturi induces flow in remote, seldom-used fixtures using the same principle used to balance single loop radiant systems.



Viega SmartLoop™ System

This proprietary recirculation system keeps water hotter longer, reducing water waste and increasing energy savings and maintaining temperature.