WATER TREATMENT NEWS

Can Legionnaires Disease Occur in my Facility?

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Most facility owners, managers and engineers possess at least a general awareness of Legionnaires disease and its sources of transmission. Numerous news stories, technical papers and training classes have been published and presented that have served to further the public's knowledge about this life-threatening, building-related illness. Experts in various fields from microbiology, immunology and epidemiology to water-using HVAC equipment have conducted substantial research on Legionnaires disease over the past 30 + years, and the research continues today.

Legionnaires disease is a form of pneumonia caused by one or more of a family of bacteria called Legionella. There are more than fifty Legionella species present in aquatic environments throughout the world. Over 90% of identified Legionnaires disease cases were caused by one species, Legionella pneumophila. The great majority of these were caused by one of a sub-group, Legionella pneumophila serogroup 1 (Lp1). While Lp1 has been known for some time to cause the great majority of cases of Legionnaires disease, the general understanding of the source or sources of the illness has evolved in recent years.

Initially, and for some time after the disease was identified, cooling towers were thought to be the primary source of transmission of the disease. For the disease to occur, Legionella must be inhaled deeply into the alveola, the tiny air cells in the lungs. This requires that the bacteria be in water droplets less than 5 microns in diameter, such as those in a cooling tower plume.

The other main factor in Legionella growth and replication is temperature. They thrive and replicate rapidly in water temperatures between 35° and 37°C (95° – 99°F), which is at or near the temperature range of most towers. Further, cooling tower water is frequently rich in nutrients necessary to sustain Legionella growth, so the possibility that any cooling tower could serve as the source of a case or outbreak of Legionnaires disease is very real and needs to be considered when a program or effort to prevent occurrence of the disease is established.

Subsequently, another, perhaps even more important means of transmission has been identified - the aspiration of Lp1-contaminated water. Aspiration is the act of choking in which fluid in the mouth gets past the choking reflex and enters the lung rather than the stomach. If the aspirated droplets are small enough, the Legionella enter the alveolar spaces and infect the victim. Aspiration of potable water from a recirculating hot water system is the major means of transmission of nosocomial (hospital acquired) Legionnaires disease cases. While Legionella thrive at water temperatures in the 35° to 37°C range, they are capable of growth in water temperatures from 20° to 50°C (68° – 122°F). Hot water in many recirculating systems is supplied at temperatures within this range, making them potential source of Legionnaires disease transmission.

Whirlpool spas are a third major source of Legionnaires disease infection, although the precise number of cases associated with this source is somewhat difficult

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to determine with certainty. Whirlpool spas present a very real potential for transmission of Legionnaires disease because of the water temperature (typically around 100°F), the potential for aerosolization and the proximity of the user's nose and mouth to the aerosol mist.

Other water systems that have been associated with cases of Legionnaires disease (though far fewer in number) include indoor decorative fountains and grocery store vegetable misters.

A nutrient-rich aquatic environment at temperatures conducive to Legionella growth and a means of transmission (aerosolization or aspiration) are two major factors, then, in the occurrence of Legionnaires disease. A third factor is host susceptibility. It is quite possible for healthy individuals with normally functioning immune systems to be infected with Lp1 and not come down with Legionnaires disease. People who develop the illness tend to fall into one or more groups - the elderly, smokers, persons who have chronic lung disease, and those who have suppressed immune systems. In the latter group, hospital patients awaiting or undergoing transplants are particularly susceptible to contracting Legionnaires disease.

Efforts to mitigate the risk of an occurrence of Legionnaires disease in a facility should start with identification of potential sources of transmission of the disease. Does the facility have a cooling tower, recirculating domestic hot water system or whirlpool spa? If so, the potential exists for a case or outbreak of Legionnaires disease and a prevention strategy should be put in place that focuses on elimination of conditions favorable for Legionella amplification and dissemination.

Hospitals accredited by the Joint Commission are required by a Commission Standard to have in place a management program to "reduce the potential for organizational-acquired illness..." While this standard also targets other illnesses and infections, it is clearly aimed at trying to prevent the occurrence of Legionnaires disease in member hospitals. As most hospitals have cooling towers, these systems should be addressed in a hospital or health care facility's Legionnaires disease prevention strategy. However, since most hospital-acquired cases result from aspiration of water contaminated with Lp1, it is the domestic hot water system that should be the hospital's primary focus.

Many experts in the field recommend that a hospital's domestic hot water system be cultured on a regular basis for Legionella bacteria populations. A guideline for this calls for culturing water samples from distal sites (faucets and showerheads) throughout the facility on a regular (e.g. quarterly) basis. If greater than 30% of the sites sampled test positive for Lp1, sterilization of the system is recommended. Sterilization can be effected by the "heat and flush" method, in which super-heated water is temporarily circulated through and flushed from the system, or by introduction of an oxidant such as chlorine dioxide.

Other facilities such as office buildings, hotels, universities and other public buildings will find a guideline published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE) helpful in establishing a Legionnaires disease prevention strategy. ASHRAE Guideline 12-2000 presents that organization's recommendations for "minimizing the risk of Legionellosis asociated with building water systems." This Guideline, published in 2000, presents a discussion of the means of transmission of Legionnaires disease by potable water systems, cooling tower systems, whirlpool spas, decorative fountains and waterfalls, evaporative air coolers, misters and fire sprinkler systems. It also presents recommended treatment programs for each type of system to help mitigate the risk of an outbreak or occurrence of Legionnaires disease.

ASHRAE continues its Legionella research through a committee of scientists and engineers who are drafting a prospective ASHRAE Legionella Standard. Richard D. Miller, PhD., Vice President and Director of Laboratory Services for Environmental Safety Tech-

nologies, Inc. of Louisville, KY and a member of the ASHRAE committee, is consulting on writing the proposed Standard. Dr. Miller, who is also a professor of Microbiology and Immunology at the University of Louisville School of Medicine and a noted expert on Legionella and Legionnaires disease, recently published a paper in which he cited the basic principles that will serve as the foundation for the prospective ASHRAE Standard. These principles, referred to as Hazard Analysis and Critical Control Point (HACCP), have been used in the food industry to control the risk of food-borne illness in processed food. The HACCP process has been highly effective in the food industry when correctly implemented, and would lend itself well to controlling the occurrence of Legionnaires disease in public buildings.

As Dr. Miller suggests in his recent paper, building owners or managers should establish an HACCP plan using the following outline:

- Assemble an HACCP team
- Conduct a hazard analysis to identify Legionella-risk water systems in the facility
- Develop flow diagrams for each of the identified water systems, including how the water is received, and how it is processed and delivered to the end points in the building
- Use the flow diagrams to identify critical control points (CCPs) in the process where Legionella can be controlled
- Establish critical limits for each CCP (e.g., temperature, concentration of chlorine or other oxidant, etc.)
- Establish a system to monitor control the CCPs (usually a measure of the control limit as well as the Legionella population)
- Establish corrective actions to be taken when a particular CCP is not under control
- Develop and implement validation and verification procedures to confirm that the HACCP system is working to effectively control Legionella

As noted earlier, domestic hot water systems are the major source of Legionnaires disease transmission in hospitals, so they should always be included in a hospital's HACCP process. A CCP for the process in a hospital would be a positive Lp1 test in 30% of distal sites tested, for example, and the corrective active action might be super-heat and flush of the system, or sterilization with chlorine dioxide. As potable water is less of a risk to healthy individuals, whether it should be included in the HACCP plan for an office building or other public facility would be a decision of the HACCP team.

Any public building that has a cooling tower should include the tower system in its HACCP plan. Because it is designed to reject heat from a building by evaporating water, a cooling tower naturally creates an aerosol mist, referred to as a plume. A tower plume can drift long distances, potentially carrying Lp1 bacteria to infect susceptible persons up to hundreds of yards from the tower. And, since a tower acts as an effective air washer, airborne contaminants in the vicinity of the tower are washed into the tower water, where they can serve as nutrients to bacteria, including Legionella. Combined with the fact that tower water temperatures are ideal for Legionella growth, these factors make cooling towers an ideal source for transmission of Legionnaires disease.

An HACCP plan for cooling tower systems comprises the regular system maintenance program plus regular monitoring for Legionella, particularly during times when the tower water temperatures are within the range for Legionella growth. The centerpiece of a good tower maintenance program is the regular use of chemical biocides, whose function is to control overall microbial populations and prevent the development of biofilm. The primary purpose of this is to maintain efficient heat transfer and prevent under-deposit corrosion, but a good biocide program can also control Legionella growth. Thus, the biocide program would be the main Critical Control Point in the tower system HACCP plan.

A regular tower maintenance program often includes the use of dipslides or other means to

monitor total bacterial populations, but it should be noted that good *total* bacterial control does not always assure good *Legionella* control, so the plan should also include Legionella monitoring, with control limits established by the HACCP team.

The other aspect of a good system maintenance program, tower hygiene, is also helpful in controlling tower water Legionella populations. Legionella can thrive in accumulations of dirt and other debris that collect in the tower basin and other parts of the system. Further, Legionella are parasitic to certain amoebae that inhabit biofilms. The Legionella can live inside the amoeba, where they multiply rapidly until they are released into the tower water in large numbers. By controlling general microbial populations and biofilm development, the biocide program can keep the numbers of amoebae down, helping to control overall Legionella growth.

The development and implementation of a good HACCP plan for Legionella control is sound policy on several levels. Protection of human life is, of course, of paramount importance. Maintaining water using systems in clean condition and free of biofilm and other contaminant material improves system efficiency and lowers operational costs. And preventing the occurrence of Legionnaires disease helps the building owner or manager avoid what could be crushing legal costs associated with an outbreak of the disease in his facility.

The answer to the question, "Can Legionnaires disease occur in my facility?" is…… "YES – if you're not prepared." Take the steps now to make sure you are.

Need help in developing an HACCP plan for Legionella control in your facility? Ask your Chemtex Representative for help.