

COOLING TECHNOLOGY INSTITUTE

Legionellosis

Guideline: Best Practices for Control of Legionella



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This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.

Approved by the CTI Executive Board



This document has been reviewed and approved as part of CTI's Five Year Review Cycle. This document is again subject to review in 2013.

Approved by the
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Guideline: Best Practices for Control of Legionella

I. PURPOSE

The purpose of this guideline is to provide information and guidance in order to minimize Legionella in evaporative cooling water systems, specifically evaporative condensers, closed-circuit fluid coolers, and cooling towers.

II. SCOPE

This guideline provided specific environmental and operational guidelines that will contribute to the safe operation of cooling water systems to minimize the risk of occurrence of Legionellosis.

III. WHAT IS LEGIONNAIRES' DISEASE?

Following the 1976 American Legion Convention at the Bellevue Stratford Hotel in Philadelphia, 34 attendees died and 221 people became ill from pneumonia caused by the bacterium *Legionella pneumophila*. Although not recognized at the time, *Legionella* is not a new microorganism. It has since been found in many archived tissue samples at the US Centers for Disease Control and Prevention (CDC). These specimens were taken from persons with previously undiagnosed pneumonia-like illnesses.

This disease, now commonly known as Legionnaires' Disease, is a respiratory infection that strikes susceptible individuals exposed to *Legionella pneumophila*. Infection results from inhaling airborne water droplets or mist containing viable *Legionella pneumophila*, which are small enough to pass deep into the lungs and be deposited in the alveoli, the small pockets in the lungs. The dose of *Legionella pneumophila* required to infect humans is not definitively known. Ingesting *Legionella pneumophila* has not been shown to cause illness. Legionnaires' Disease can have an incubation period of two to ten days. Most reported cases have occurred in the 40- to 70-year old age group. Although healthy individuals may develop Legionnaires' Disease, people thought to be at increased risk of infection include smokers, patients with cancer, chronic respiratory diseases, kidney disease, and any immuno-suppressed condition. The fatality rate is estimated at 10 to 20% of those who contract the disease; but in immuno-suppressed persons or those with other underlying diseases, this figure can be much higher.

Legionella pneumophila is a ubiquitous organism. It appears in almost every ground and surface water. The organism survives typical chlorine disinfection for

potable water and consequently can appear in finished water distributed to homes and industry. It is important to keep the incidence of Legionellosis in perspective. For example, in the United States, the Technical Manual published by OSHA (Occupational Safety and Health Administration) estimates over 25,000 cases of the illness occur each year. More than 4,000 deaths are believed to occur, but only about 1,000 are reported. However, the CDC usually investigates less than ten community outbreaks per year (in 1995 there were three). An outbreak is considered to occur when two or more cases of the disease can be attributed to a work site.

IV. SYMPTOMS OF LEGIONNAIRES DISEASE

Initial symptoms of Legionnaires' Disease include high fever, chills, headache and muscle pain. A dry cough soon develops and most patients suffer breathing difficulty. Some patients also develop diarrhea or vomiting and can become confused or delirious. Legionnaires' Disease may not always be severe; in community outbreaks, mild cases may be recognized that would probably have escaped detection except for the increased awareness of the disease.

A common but less serious infection caused by *Legionella pneumophila* is an illness known as "Pontiac Fever." The symptoms of Pontiac Fever are similar to those of moderate to severe influenza: headache, fatigue, fever, arthralgia (joint pain), myalgia (muscle pain) and, in a small proportion of cases, nausea, vomiting and coughing. The incubation period is one to two days and the illness passes in five to ten days. No deaths have been attributed to Pontiac Fever. Since this illness generally escapes detection, statistical information about its occurrence is sparse.

V. MICROBIOLOGY

Legionella is the name given to a genus of bacteria for which at least 37 different species have been identified. *Legionella pneumophila*, for which fourteen serogroups have been identified, is the species most commonly associated with disease outbreaks. Serogroups 1, 4, and 6 are most commonly associated with human illness. *Legionella pneumophila* are rod-shaped bacteria and are widespread in natural water sources. They have been found in rivers, lakes, and streams; mud and soil samples; water and sludge from cooling towers; and in other man-made water systems. They have been

detected in many drinking water sources, including well water, resulting in the contamination of a variety of public and private systems using this water.

A cooling tower system can present an ideal environment for growth of *Legionella pneumophila*. Cooling tower drift in the form of aerosols can be easily inhaled. Showers, wash stands, sinks, air scrubbers and air washers / handlers can also provide a good growth environment and possible means of transmission of *Legionella pneumophila* bacteria.

VI. ECOLOGY

The ecology of *Legionella pneumophila* in water systems is not fully understood; however, the following conditions have been found to affect its growth rate:

- Sediment, sludge, scale and organic materials can harbor the bacterium and promote growth. The formation of a biofilm within a water system is thought to play an important role in harboring and providing favorable conditions in which *Legionella pneumophila* can grow. A biofilm is a layer of microorganisms contained in a matrix that may form a thin layer of slime on surfaces in contact with water. *Legionella pneumophila* grows within biofilms and within protozoa acting to shield *Legionella pneumophila* from concentrations of biocides that would otherwise kill or inhibit *Legionella pneumophila* when freely suspended in water.
- Water temperatures in the range of 68°F (20°C) to 113°F (45°C) favor growth. It is uncommon to find proliferation below 68°F (20°C), and it does not survive above 140°F (60°C). The optimum laboratory temperature for the growth of the bacterium is 99°F (37°C). Organisms may, however, remain viable and dormant in cool water, multiplying only when the temperature reaches a suitable level and when growth and reproduction are not inhibited by adequate bio-control.
- *Legionella pneumophila* have been shown to colonize certain types of water systems that may have stagnant areas, e.g., water heaters, tanks, reservoirs, and basins. Fittings, piping, and various gasket materials used in these systems can also be colonized. Stagnant conditions promote growth of *Legionella pneumophila* and make eradication difficult.
- Commonly encountered microorganisms (such as algae, amoebae and other bacteria) in untreated or ineffectively treated water may promote *Legionella pneumophila* growth. Some protozoa serve as hosts for *Legionella pneumophila*, which can enable rapid proliferation of *Legionella*.

VII. BEST PRACTICES AND RECOMMENDATIONS FOR MINIMIZATION OF RISKS ASSOCIATED WITH LEGIONELLA

The following best practices for microbiological control are recommended to promote and maintain clean heat transfer surfaces and a healthy work environment around open recirculating cooling systems. The practices outlined in this document are a description of the consensus of existing best practices as recommended by various authoritative bodies worldwide. Halogen oxidizers have been proven to control *Legionella* when applied properly. Evidence exists that other compounds, such as ozone, peroxides, and non-oxidizing biocides are effective against *Legionella* bacteria in limited circumstances. Treatment techniques such as ultraviolet light or ultrasonics have also shown the ability to kill *Legionella* bacteria in limited circumstances.

The CTI reviewed publications and interviewed representatives from authorities such as OSHA, CDC, ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers), the UK HSE (United Kingdom Health and Safety Executive), the UK BACS (British Association of Chemical Specialties), and the health & safety agencies of Japan, Australia, Singapore, and Taiwan, among others. *In no way, however, should these recommendations be interpreted to guarantee the absence of Legionella bacteria or any other particular pathogen, and consequently that these measures will prevent illness (e.g. Legionellosis).*

Nevertheless, we believe these measures can be effective in fostering the safety of cooling systems. This is accomplished directly by destruction of planktonic (free-swimming) bacteria including *Legionella*, and indirectly by eliminating conditions that favor *Legionella* amplification (multiplication), i.e. the elimination of biofilms and amoebae and other protozoa that feed on biofilms and which serve as *Legionella* hosts. Research continues on effective means for control of protozoan cysts, which can also harbor and protect *Legionella* for extended periods.

These best practice recommendations focus on chemical control parameters. Halogens serve as the primary disinfectants in these recommendations. Sources of halogens include chlorine gas, hypochlorites, chlorine dioxide and stabilized halogen donors. It must be recognized, however, that chemical treatment is only one aspect of risk minimization. Design, operation, and maintenance practices are also crucial to reducing health risks associated with cooling systems.

Monitoring *Legionella* in Cooling Water Systems

Evaluate system cleanliness and the effectiveness of microbial control by visual inspection as well as through regular monitoring of bulk water (planktonic) and surface (sessile) microbial populations.