

LEGIONELLA:
An Update and Statement by the
Association of Water Technologies
(AWT)

(Approved by AWT's Board of Directors, July 2000)



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by: William E. Pearson II, CWT

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Forward

The Association of Water Technologies (AWT) is an international trade association founded to serve the interests of regional water treatment companies and to advance the technologies of safe, sound and responsible water treatment practice. AWT is a non-profit organization providing education and training, public awareness, networking, research, industry standards and resource support. Association activities serve to benefit members, as well as advance the arts and sciences of the water treatment industry. Moreover, AWT makes commitment to the public as a Responsible Care® Partner Association.

Responding to the water treatment industry's concern about Legionella, AWT provides and updates a variety of position and information exchanges on Legionella and Legionnaire's disease. It has almost been a quarter century of dealing with and learning about this disease and the Legionella bacteria that cause legionellosis. Much information has been gained in this time, yet key (even crucial) questions remain unanswered. The public asks for "absolutes" in preventing and controlling the disease, and consensus on routine testing (monitoring) for Legionella. And it is, undoubtably, this precise area that most concerns the public health sector and the operations of facilities where Legionella outbreaks have occurred or have the greatest potential to occur. These issues are also a major concern to the water treatment industry, which deals with some of the types of (water) systems and equipment from which Legionella outbreaks have been (and can be) associated.

The following document is an AWT information and position statement on Legionella and Legionellosis. It is a collection and summarization of information and data available from numerous research, investigative, and authoritative sources. These include CDC (Centers for Disease Control and Prevention), OSHA (Occupational Safety and Health Agency), WHO (World Health Organization), EPA (Environmental Protection Agency), various state public health agencies, as well as associated technical trade organizations, recognized Legionella experts and commercial entities. Due to the extensive technical and medical nature of the subject, this document is directed at summarizing and presenting Legionella in an up-to-date, informative, and useful format to both the water treatment professional and end-user, as well as to the general public. Reference sources are provided for more detailed and in-depth information on Legionellosis and related topics that may benefit those with more specific interest and application or decision making needs.

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Cultured Legionella (bottom view) from Biofilm (top view).

I. Background: The Discovery of Legionnaires' Disease & Legionella

Legionnaires' Disease (LD) acquired its name by way of media reference to a mysterious pneumonia-like illness that befell many attendees of an American Legion Pennsylvania State Convention held at the Philadelphia Bellevue-Stratford Hotel in July of 1976. An outbreak occurred presenting Pennsylvania Department of Public Health officials with a recorded 221 cases of a strange respiratory illness contracted by convention and other hotel attendees. Symptoms included high fever, chills, headaches, muscle pain (flu-like symptoms) and eventually development of a dry cough and difficulty in breathing. A third of the patients developed diarrhea and/or vomiting and half of the patients became confused and/or delirious. Some patients developed patchy lesions in their lungs representative of a severe pneumonia. More than two-thirds of the patients required hospitalization and 34 died.

The CDC (in Atlanta) was called to help investigate the outbreak. Their investigations eventually lead to the discovery of the causative agent, a bacterium, in January of 1977. The bacterium was subsequently named Legionella pneumophila. While it was the outbreak in 1976 that gave the disease its name and led to the identification and naming of the causative bacteria, neither was new. Legionella bacteria have been around and causing disease for many years. The CDC reexamined fifty-year old archived, (unsolved) similar illness tissue samples and found Legionella bacteria. So, LD was not a new disease discovered in 1976 -- just an old one, finally recognized and named.

II. Background: Terms, Definitions, & General Facts

Legionella is the named genus of gram-negative, rod-shaped, aerobic bacteria that are very common to aquatic, especially warm water, environments. The plural, referring to more than one Legionella microorganism, is **legionellae**. There are some 40 identified species of Legionella, with more than half being linked to human diseases. Some species are made up of more than one **serogroup**, with over 60 serogroups presently identified for the genus. Many serogroups are further differentiated into numerous **subtypes**.

Legionellosis is any illness caused by exposure to Legionella. The exposure primarily occurs when a person inhales aerosols, fine sprays, or other microscopic droplets of water contaminated by Legionella microorganisms. Cooling towers, evaporative condensers, heat-rejection devices, humidifiers, showerheads, faucets, whirlpool baths and spas, respiratory therapy equipment, even misting machines in grocery store produce sections, have been identified as sources of Legionella in outbreak investigations.

Legionellosis (Legionnaires' Disease) is an environmental disease. The causative agent (Legionella) is transmitted from an environmental source (water) to a person. This differentiates it from communicable diseases, which are transmitted from person to person.

Legionella pneumophila (Lp) is the named species of Legionella causative to over 90% of legionellosis cases. More than 70% of these cases are attributed to a single of its 14 serogroups: Legionella pneumophila serogroup 1 (Lp-1). Within Lp-1 are at least 50 further subtypes. Lp serogroups and subtypes appear to differ in their degree of virulence. Lp-1 is the most common isolate recovered from environmental samples.

Legionnaires' Disease (LD) and **Pontiac fever** are the two most common types of legionellosis.

Legionnaires' Disease is a potentially fatal, multi-system respiratory illness, accompanied by pneumonia. It attacks some 2 to 5% of those exposed (representative of those most susceptible) and has an average mortality rate of approximately 15 to 20%. Factors influencing susceptibility include the elderly and those with suppressed or compromised immune or respiratory systems, such as: heavy smokers, alcoholics, HIV patients, cancer or organ-transplant patients, and others with lung or respiratory diseases. Underlying disease and advanced age are not only risk factors for acquiring LD, but also for dying from the illness. It incubates in human hosts within 2 to 10 days of exposure and will not abate without medication. When diagnosed and treated early, the disease responds well to the antibiotic erythromycin and many of the newer macrolide antibiotics.

Symptoms include:

- High Fever, Chills, Headache, Muscle Pain (Flu-like symptoms),
- Dry Cough and Difficulty in Breathing (eventual symptoms),
- Diarrhea and/or Vomiting are common, and
- Confusion and Deliriousness are common.

LD is a common and serious illness. It is not rare. Legionella bacteria are among the top three causes of sporadic, community-acquired pneumonia. It is also the cause of many hospital-acquired (nosocomial) cases of pneumonia. Many cases of LD go undiagnosed, as it is difficult to distinguish from other forms of pneumonia, unless specifically targeted. Even when detected, they often go unreported to the public health authority, especially if cases are sporadic (a one or two case incident) and not associated with an outbreak investigation. This under-detecting and under-reporting of the disease makes its incidence difficult to estimate and, consequently, figures vary widely. The CDC has estimated that the disease infects 10,000 to 15,000 persons annually in the United States. OSHA estimates that over 25,000 cases of the illness occur each year and cause more than 4,000 deaths. Still others have estimated as many as 100,000 annual cases.

Pontiac fever is a much milder, non-pneumonia, flu-like illness caused by Legionella pneumophila. It attacks 90 to 95% of those exposed, indiscriminately, and has a short incubation period of 1 to 3 days. Complete recovery usually occurs in 2 to 5 days without medical attention.

Because the contraction of Legionnaires' Disease represents a much more serious condition than that of Pontiac fever, our information focus will be on this disease and Legionella pneumophila (and other Legionella species) that cause it.

III. Legionella: Infectious Growth, Transmission & Host Susceptibility

Legionella pneumophila is a very common, said to be ubiquitous, organism. It is capable of being present in appreciable numbers in almost all ground and surface water sources. Legionellae tend to grow in biofilms or slime on the surfaces of lakes, rivers and streams -- and very adaptively, within water distribution systems.

Legionellae live within biofilms and uniquely within certain free-living amoeba and ciliated protozoa, as endosymbionts. This allows them, among other things, to survive typical potable water chlorination (disinfection) and appear in many finished water supplies to homes, buildings and industry. Thus, the mere presence of legionellae does not, in itself, result in infectious disease. However, it is when certain legionellae are allowed to amplify (increase in population density) and achieve transmission to a susceptible human host that they can cause legionellosis infections.

1) The legionellae must have strain-specific virulence factors to cause disease. The virulent legionellae must also be present in sufficient quantity to cause an infection.

2) The dose of Legionella pneumophila (and other Legionella species) required to infect humans is not known. It is, however, most probably influenced by host susceptibility.

3) A susceptible host must inhale an aerosolization of colonized (legionellae) water. In a respirable droplet form (less than 5 micrometers in diameter), the transmitted legionellae can reach the deepest (alveolar) parts of the lungs where they are engulfed by pulmonary macrophages. However, instead of being destroyed, the legionellae grow (amplify) within the macrophages, as they do within free-living amoebae and protozoa. This infection results in overwhelming the host's immune (defense) system and disease.

Growth & Amplification of Legionella: In order to better understand Legionella, its potential to cause disease and how better to control legionellae in water systems, we must understand the conditions that promote legionellae growth and or amplification. Major factors include:

- Stagnant water conditions and/or system design configurations that produce stagnation, such as side-arm and dead-leg piping.
- Warm water temperatures between 20 to 50°C (68 to 122°F)
- Optimal growth is at temperatures between 35 to 46°C (95 to 115°F)
- A pH range generally between 5.0 to 8.5
- Sediment, scale, deposits, biofilms - support not only Legionella growth, but also that of the very important supporting microbiota for Legionella.
- Microbiota including algae and many bacteria that supply essential nutrients for growth of Legionella.
- Certain amoebae and other protozoan that harbor Legionellae as endosymbionts -- allowing them to thrive, resist harsh environmental conditions (including biocides) and to significantly amplify.

Transmission of Legionella: After growth and amplification of legionellae to potentially infectious densities, the next requirement in the chain of disease causation is to present the legionellae in an aerosol (water-mist or droplet) form. The primary transmission mode of Legionnaires' Disease then becomes the subsequent inhalation of such aerosols that provide entry of the Legionella organisms deep into the human respiratory tract.

Several different types of water systems can serve as legionellae amplifiers and (aerosol) disseminators, and thus have been associated with Legionnaires' Disease. They include:

- Cooling Towers and Evaporative Condensers,
- Domestic Hot Water Systems (tap faucets, showerheads, sprayers),
- Spas and Whirlpools (on display or otherwise),
- Humidifiers,
- Decorative Fountains,
- Supermarket Reservoir Misters,
- Respiratory Therapy Equipment,
- Dental Hygiene Equipment,
- Eyewash Stations & Safety Showers.

Whenever such devices are in use (or are to be utilized), appropriate precautions and awareness should be maintained as to their potential to harbor and transmit legionellae and to the potential health risk they pose to individuals.

IV. Domestic Plumbing, Hot-Water Systems & Legionnaires' Disease

A cooling tower was implicated as the source of Legionella in the 1976 outbreak. For many years afterwards, cooling towers were thusly designated and generally assumed to be the "official reservoir" and source of Legionnaires' Disease. This was unfortunate and became very problematic to the cooling tower and water treatment industries, which were subsequently expected to be the ones to "take care" of Legionella. Some water treaters promoted this expectation by making claims to be able to do just that with "their" products and "their" water treatment programs, advertising, "WE GUARANTEE LDB eradication!"

We have now come to recognize Legionnaires' Disease for what it is -- an environmental disease and an environmental issue. Raw (natural) waters are its source and it finds reservoir in many water-disseminating systems and devices. Cooling towers are but one such system -- and not the major one. That distinction belongs to the domestic (potable) hot and cold water plumbing system.

Domestic plumbing may serve as makeup to cooling towers, however, these systems most assuredly serve our buildings, commercial and otherwise, and our hospitals and other care facilities. These systems were first implicated in a nosocomial (acquired during a hospital stay) case of Legionnaires' Disease in 1980. Since then, they have been associated with numerous outbreaks of legionellosis. The United Kingdom reported 19 of 20 hospital Legionnaires' outbreaks, from 1980 to 1992, to be from their plumbing systems. Cases of Legionnaires' Disease have also been attributed to plumbing systems in nursing homes, workplaces, and private residences.

Hot-water systems are perfect breeding habitats for legionella, as well as other bacteria that form biofilms. Legionella can flourish in a hot-water tank, especially in the bottom warm zones that can develop with accumulated scale and sediment. The complexities of hot-water piping presents an even greater problem than tanks, because biofilm and scale that form in their valves and fittings and on the pipe walls not only feed bacteria but also protect them from hot water and chemical disinfectants. Dead-legs (unused piping) create additional problems because bacteria grow well in stagnant water.

Because the domestic plumbing system represents a major "reservoir" for Legionella and associated LD cases, especially to commercial buildings, hospitals and other care facilities, there is extensive emphasis on the risk assessment, control and prevention, and treatment to these systems. While the "water treater" may more traditionally deal with cooling towers, evaporative condensers and other heat-transfer associated water systems, he (or she) should also know about Legionella in other systems.

Matthew R. Freije's HC Special Reports #302 and #303, respectively entitled, *How to Make Plumbing Systems Less Conducive to Legionella and Other Bacteria*, and *Disinfecting Plumbing Systems of Legionella: Solving Problems Without Overspending* (1998) deal extensively with plumbing systems and Legionella. Within his text, Mr. Freije presents five common methods of Legionella disinfection for plumbing systems and gives comprehensive coverage as to their advantages, disadvantages and costs to apply. These methods are listed (in general) below and Mr. Freije's reports should be reviewed for more complete coverage and information.

Heat-and-flush (heat shock): Water in tanks is superheated and then all outlets are flushed for several minutes. The flush time required will depend on the temperature of the water when it reaches the outlets.

Chlorination: For temporary disinfection, chlorine is added to water tanks at free available levels much higher than normal for potable water and flushed throughout the system. For continuous disinfection, flow-adjusted injectors are installed to release chlorine at a drinkable concentration (1 to 2 mg/L free chlorine) throughout the domestic water system.

Ultraviolet radiation: An ultraviolet sterilizer can be installed on a water line to kill legionellae as water flows through the unit. Ultraviolet units are not effective if a system is already contaminated.

Ozonation: Ozone is dissolved into the water system to achieve a dose of about 1 to 2 mg/L, ideally via a generator that produces ozone in proportion to the water flow rather than a generator that produces ozone at a constant rate regardless of demand.

Copper-silver ionization: A flow-through ionization chamber containing copper-silver electrodes is installed on a hot-water line. As electrical current is applied to the electrodes, positively charged copper and silver ions are released into the hot-water system. The positive ions bond with negatively charged sites on bacteria, causing the organisms to die.

In addition, ASHRAE (the American Society of Heating, Refrigeration and Air-Conditioning Engineers) has recently produced a comprehensive guideline (ASHRAE Guideline 12-2000) entitled *Minimizing the Risk of Legionellosis Associated with Building Water Systems*. This guideline is much more extensive in scope than its title may suggest. It provides broad coverage and 'minimizing the risk of Legionellosis' information for many specific water-disseminating systems including: potable and emergency water systems; heated spas; architectural fountains and waterfall systems; cooling towers including closed-circuit cooling towers and evaporative condensers; direct evaporative air coolers, misters (atomizers), air washers, and humidifiers; indirect evaporative air coolers; and metalworking systems.

V. Cooling Towers: Water Treatment & Legionnaires' Disease

Cooling towers, including evaporative condensers, have the potential to develop infectious concentrations of legionellae. Cooling tower drift (water loss) creates the mist or aerosol that can transmit the disease-causing bacteria. In addition, cooling towers can provide favorable conditions for the growth and amplification of microorganisms. The evaporative (cooling) process causes all makeup waterborne constituents, as well as system water constituents, to concentrate (i.e., remain in the tower loop according to cycles of concentration). The residence time in the water loop allows for ample growth and reproduction of organisms. With warm water temperatures and the presence of deposits and sediment debris, further growth and amplification of legionellae can be promoted.

Water quality and system maintenance should be well controlled in these systems. The chemical treatment objectives of any prudent water treatment program are to maintain corrosion, deposit, fouling, and microbiological control. These same practices will also significantly promote the control of Legionella growth and amplification. Cooling tower systems associated with ineffective cooling water treatment practices and/or neglect certainly represent a greater potential for harboring potentially infectious Legionella. However, high (even infectious) levels of Legionella have been found in otherwise well-maintained and operated tower systems.

Biocide Treatments play an important role in microbiological control programs, including those for Legionella. However, biocide treatments do not “target” specific microbiological organisms, nor are they 100% efficacious. In the case of Legionella control, it must be stressed that the efficacy of any specific biocide can only be determined by testing for the presence of legionellae in the field under actual operating conditions. Environmental legionellae cannot be reproduced in the laboratory from culture-grown organisms. Therefore, laboratory trial testing should not be relied upon exclusively for sole proof of a biocide’s efficacy against legionellae.

Total Bacterial Counts (TBC) of a cooling water system should not be relied upon for any definitive correlation to legionellae counts, control or LD risk. LD has been associated with systems where the total bacterial count was very low, yet legionellae counts high. Systems have also been found to have very high total bacterial counts, yet very low and even zero legionellae counts.

Bio-dispersants play an important role in microbiological control programs, particularly against Legionella. These chemicals act to loosen microbial deposits (sludges, etc.) and promote system cleanliness. They also enhance biocide effectiveness by penetration of the biofilm. Biofilms are where legionellae flourish within cooling and domestic hot water systems. A biofilm is a nutrient-rich (matrix) layer of microorganisms often forming slime on surfaces in contact with water. Biofilm legionellae and legionellae within protozoa are protected from concentrations of biocide and other environmental conditions that would otherwise kill or inhibit them, if they were freely suspended in bulk water.

Cooling Tower Disinfection for the purpose of Legionella control and disease prevention is generally recommended as:

- Maintenance action for startup, post lay-up or regularly scheduled tower cleaning;
- Corrective prevention and control action following tower Legionella sampling with elevated counts; and
- Required action following a confirmed or suspected system associated Legionnaires' disease case.

The following is an abbreviation of the method outlined by the CDC (1997). (You should preview the complete methodology for a full understanding of CDC's procedure.) It should be noted, however, that most cooling tower and water treatment experts differ with respect to the chlorine levels recommended and routine frequency of using this type disinfection, due to the corrosive (or otherwise damage) potential of chlorine to system materials of construction. Guidelines established by ASHRAE (1998) and by CTI (the Cooling Technology Institute) (1996) should also be considered.

1. Shut off the cooling tower fans;
2. Keep makeup water valves open and the circulation pumps operating;
3. Close outdoor air intake vents located within 30 meters of the cooling tower;
4. Achieve an initial free residual chlorine (FRC) of at least 50 mg/L;
5. Add a dispersant to tower water within 15 minutes of chlorine addition, then maintain 10 mg/L FRC for 24 hours;
6. Drain and refill the system, then repeat steps 4 and 5 at least once to remove all visible algae-like film;
7. Using a brush and water hose, thoroughly clean all water-contact areas, including the basin, sump, fill, spray nozzles, and fittings;
8. Circulate 10 mg/L FRC for one hour, then flush the system until free of all sediment; and
9. Refill the system with clean water and return to service.

VI. Cooling Towers: Minimizing Legionella Counts & Transmission

Because of the potential for any cooling tower to harbor, amplify and to disseminate legionellae, control measures need to be considered for all cooling tower operations. Most Legionella control measures for cooling towers and evaporative condensers encompass two objectives:

1) Minimization of Cooling Tower Legionella Counts

While keeping Legionella below detectable levels in every tower system is nearly impossible and should not be expected, attempting to **minimize** Legionella in cooling towers is reasonable and should be an ongoing control effort. Many of the measures that are generally recommended for Legionella control in cooling towers are also recommended for the efficient operation and proper maintenance of tower systems. They include: proper design, cleaning, maintenance and water treatment. Combined, they generally minimize Legionella counts in a tower, but cannot be expected to eliminate them entirely in every system. Even some properly maintained and operated cooling towers have been found to have high Legionella counts.

2) Minimization of Legionella Transmission from Cooling Tower to People

Minimizing transmission from the tower to a host is the second responsible measure to reduce the risk of disease, especially with the realization there are no guarantees to keeping a tower system Legionella-free. In this regard, the following considerations should be made: minimizing tower drift (aerosol sprays) with proper and well maintained eliminators, tower location to keep tower drift (aerosol sprays) from building or other air intake pathways to possible hosts, tower location to keep outside sources of plant life or nutrients from entry to the tower system, and utilization of appropriate facial mask (filters) for workers or others subject to tower drift (aerosol sprays).

Design Guidelines for Cooling Towers and Evaporative Condensers should take the following into consideration to minimize Legionella counts in the tower and minimize transmission of legionellae from tower to people:

- The tower's location should consider prevailing winds and proximities with respect to people populations, building air intakes and surrounding units.
- The tower's location should consider prevailing winds and proximities, which could provide nutrient sources into the tower (kitchen exhausts, industrial processes, etc.) and promote bacterial growth.
- Shield or cover the cold-water basin, distribution deck, and other wet surfaces from sunlight to prevent algae growth.
- Materials of construction should be smooth and non-porous.
- Water distribution piping should be as simple as possible and avoid dead-legs and loops that are difficult to drain.
- Towers should be easily accessible for inspection, sampling, cleaning and disinfecting.

- The system should be designed to be completely drained or pumped out.
- Provisions should be made to facilitate a water treatment program, including: chemical injection, sampling, corrosion coupon sampling, bleed and drain points.
- High efficiency drift eliminators should be used and maintained.
- Filtered water, treated with trace (or greater) halogen residual, should be used as tower make-up.
- Multiple-cell tower basins should be designed such that each cell and basin can be isolated, while the other cells remain in operation.
- The tower system's total operating volume should be known for proper chemical dosing, particularly that of biocide and dispersant treatments.

Operational Guidelines for Cooling Towers and Evaporative Condensers should take the following into consideration to minimize Legionella counts in the tower and minimize transmission of legionellae from tower to people:

- Clean tower and disinfect before start-up, especially new system start-up, and after any long shutdown period (greater than 2 to 4 weeks).
- Treat water for control of corrosion, scale, fouling and microorganisms.
- Establish a maintenance plan and log all activities, including the chemical treatment program's dosages, services and results.
- Maintain all drift (mist) eliminators in proper operation form as well as fan operations that affect drift productions.
- If dead-legs in the piping system cannot be removed, blow them down regularly and, particularly, after biocide treatments and cleanings.
- Exercise all valves in the system periodically by opening and closing them fully.
- Clean the basin when slime, algae, or dirt are visible.
- Blow down direct free cooling (chilled water) risers weekly.
- Thoroughly flush and clean the entire system at least once (preferably twice) each year -- including an oxidizing disinfection before and after each cleaning.

While both OSHA and CTI (and others) recommend continuous feed of chlorine or bromine to effect control of Legionella in cooling tower systems, there is not a consensus recommendation on what free halogen level to maintain in these systems. The OSHA Technical Manual sites maintaining less than 1 mg/L free chlorine or bromine (with continuous feed) may not be enough to control Legionella, while more than 1 mg/L may be corrosive. CTI recommends 0.5 to 1.0 mg/L free halogen. A technically prudent (water treatment) course of action may be to establish a free halogen level to maintain based on an evaluation of "technical specifics" for each system. Such considerations would include:

- System materials of construction and sensitivity to oxidant corrosion or attack,
- Water chemistry (indices) and corrosion potential for the system,
- Corrosion control history, if not new, for the system,
- Corrosion monitoring program in place,
- Microbiological and other fouling potential for the system (process or HVAC),

- Microbiological control history, if not new, for the system,
- Technical capabilities of the corrosion control and alternate microbiological control chemical treatment products, and
- A Legionella risk assessment of the system to include:
 - Design, maintenance & operation of the system,
 - Proximity of “at risk host” populations,
 - If Legionella testing is done, and
 - History of Legionella control.

Systems where Legionella risk and/or history are great (bad) would opt for the higher free halogen levels (1-2 mg/L, or more), even if corrosion potential or failures were higher than desirable. Systems with less tolerance for corrosion failures and having a low Legionella risk assessment would operate at the lower free halogen levels (0.5-1 mg/L). The ability to monitor corrosion and/or Legionella control gives an added benefit to closer control and “fine-tune” what free halogen levels work best to achieve treatment and protection objectives. Finally, if corrosion control is a MUST and unacceptable with the free halogen levels felt necessary or needed for Legionella control, then an alternative Legionella control program should be designed. Chlorine dioxide, a proven biocide effective against Legionella without posing the corrosion problems associated with halogen biocides, could be considered. Using multiple non-oxidizing biocides, along with bio-dispersants, at their maximum allowable dosages may be considered, accepting the higher treatment cost of such programs.

VII. Sampling (Testing) for Legionella: The Big Debate

Water sampling for Legionella can be useful in helping assess risks and in determining whether or not preventive and corrective measures are working. Having an action plan based on results of Legionella sampling can alert you to increased risks and whether or not disinfection procedures should be implemented. Not sampling obviously tells you nothing about your programs -- until a case of LD occurs. The aforementioned sounds quite logical and simple, and is an assumption that Legionella sampling should be routine for any monitored system. Such is not the case.

Legionella experts have debated the issue of sampling and routine testing for years. CDC advocates sampling after LD has been found (confirmed) so as to locate the source of legionellae that caused it and take remedial action. They do not encourage sampling in the absence of confirmed LD cases. Other experts disagree with this and advocate a more proactive approach of conducting periodic sampling (so-called "routine sampling"), even if no cases of LD have been detected.

What has stood in the path of any real consensus being achieved amongst the experts are the following current facts and understanding of Legionella and LD:

- There is no specific infectious density known for Legionella or clearly established correlation between test culture or direct fluorescent antibody (DFA) test results of Legionella and risk of contamination.
- Legionella is frequently present in water supplies without causing disease, so routine testing and obtaining a positive count does not mean LD will occur and may even produce a false sense of alarm and lead to costly corrective actions being undertaken. On the other hand, obtaining negative results does not assure that LD cannot occur and may even provide a false sense of security and lead to relaxation of preventive maintenance.
- Interpretation of results in routine Legionella sampling is still questionable due to: (a) use of different bacteriologic methods amongst laboratories; (b) variable results between culture and direct fluorescent antibody methods; (c) variable culture results from differing sites within the same system; and (d) variations in the counts of legionellae isolated from a single site. In addition, potentially infectious Legionella in some water samples may not grow on the microbiological medium specifically formulated to grow Legionella.
- The risk of illness following exposure to a given Legionella source is influenced by a number of variables and factors other than just the concentration of organisms in a sample. Host susceptibility, Legionella strain virulence, and efficiency of legionellae transmission (to host) are integral to LD risks and disease progress.
- Routine testing can be a double-edged "liability sword:" testing and getting positive results may establish a legal liability if a disease case occurs; yet the testing may prevent negligence charges from applying. However, not testing in the presence of other factors may leave you guilty in the face of defending a responsible LD case.

Those in favor of routine sampling believe that since the risk of Legionnaires' Disease is greater when there are high levels of legionellae in water, it makes sense to take measures that will minimize legionellae in water and to check legionellae levels periodically to make sure the preventive measures are working. They contend that sampling results, although sometimes inconclusive, may at other times provide life-saving information.

Most experts, however, including those in the "anti-routine" sampling group, would agree that there should be a consideration to routinely test any system that presented enough LD risk factors or other pertinent information. This would be based on a thorough review and assessment of the system, its operations and surroundings. Relevant factors would include: raw water quality, system design and operations, fouling history and potential, host population and susceptibility, LD case history, etc.

James R. Watson, Ph.D., provides the following Legionella sampling and testing information in his LEGIONELLA UPDATE – 2000 as reported by Microbiological Consultation Services, Inc. (MCS):

"Although small numbers of *legionella bacteria* probably pose a very low risk to healthy individuals, corrective action should be kept in mind whenever legionellae are isolated from a water sample. Although the scientific community cannot agree on what number of *legionella bacteria* is acceptable, we believe colony counts, as expressed in colony forming units (cfus) per ml of water, can be used as a loose guide for deciding when to implement corrective action. *Legionella pneumophila* colony counts for cooling tower specimens may be interpreted as follows:

- **>100 cfus/ml = large number of legionella bacteria.**
- **10-100 cfus/ ml = moderate number of legionella bacteria.**
- **<10 cfus/ml = small number of legionella bacteria."**

VIII. Legionella Is 'DIGITAL'

There is a great deal of international and multi-disciplined information on Legionnaires' Disease, Legionellosis and Legionella available via the Internet. This section is provided as a "Digital Reference" section for seeking such (additional) information on Legionella.

The following Internet addresses are provided as representative sites from which to obtain Legionella information. The list is far from all there is, but you can "search & surf" from them:

<http://www.hcinfo.com>. A "dedicated to Legionella information" site. Articles from noted experts and authorities on Legionella covering all the issues are available for viewing and or download. Many are free; others have very modest charges.

<http://www.osha.gov>. OSHA home page: where you can search and get OSHA LD information, including their latest 40+ page OSHA Manual (Section III, Chapter 7) on LD.

<http://www.cdc.gov>. CDC (The Centers for Disease Control and Prevention) home page: where you can search and get their latest guidelines and information on LD.

<http://www.ashrae.org>. ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.) home page: where you can download their latest position and guideline papers on Legionellosis.

<http://www.cti.org>. Cooling Technology Institute (CTI), formerly the Cooling Tower Institute, home page: where you can download their latest position papers on Legionella.

<http://pathcon.com>. PathCon Laboratories, a leading laboratory specializing in Legionella testing, investigations and expertise – get their Legionella Technical Bulletins.

<http://www.legionella.org>. The Pittsburgh VA HealthCare System's dedicated Legionella site with access to leading Legionella experts and LD information – email Dr. Janet Stout.

<http://www.legionella.com>. GTI, a dedicated Legionella testing company in business since 1981, where you can get their Legionella facts, publications and information sheets.

Simply navigate throughout the sites listed above and use their search function(s) to access their information on Legionnaires' disease. For other Internet sites on Legionella (not listed above), use your ISP or Internet browser's search engine (function) and search (using) key words such as Legionella, Legionellosis, or Legionnaires' disease, etc.

IX. AWT Position Statement – Legionella & Legionellosis

The Association of Water Technologies (AWT) makes the following recognition and position statements regarding Legionnaires' disease, water treatment and related practices of water treaters. They are based on the significant and prevailing information from ASHRAE, CDC, OSHA, EPA, CTI, the medical community, leading experts and other authoritative agencies that study, investigate and deal with Legionella and Legionellosis.

1. AWT recognizes the potential hazard for Legionella contamination in cooling towers and evaporative condensers, as well as other water disseminating devices, systems, or equipment that may or may not be a part of water treatment programs.
2. AWT recognizes that prudent operational and water treatment practices for cooling towers, evaporative condensers and other recirculating water systems, are consistent with reducing Legionella contamination within them and include:
 - Corrosion, scale and deposit control programs that promote operational efficiency and system cleanliness and reduce microorganism-breeding areas.
 - Dispersant, bio-dispersant and antifoulant programs to reduce biofilm, sludge, debris, and dirt accumulations -- further reducing microorganism-breeding areas.
 - Biocide programs, including oxidizing and non-oxidizing treatments, used in accordance with proper labeling, to control the growth and proliferation of microorganisms.
 - Maintaining best available mist elimination technology in evaporative systems and eliminating or minimizing stagnant (dead-leg) zones and areas.
 - A minimum annual (twice annual preferred) thorough wash-out and cleaning of cooling towers and evaporative condenser cooling water systems -- including an oxidizing disinfection before and after each cleaning.
3. AWT recognizes the microbiology and environmental ecology of Legionella includes many variables associated with transmission, organism virulence, human host susceptibility and disease contraction; and (that) even prudently applied water treatment programs cannot guarantee 100% Legionella eradication or disease prevention.
4. AWT recognizes the value of Legionella testing for various **risks evaluated** systems, i.e., those representing an increased risk of Legionella within the system or those representing an increased risk of transmission to a population of susceptible hosts.
5. AWT recognizes that Legionella testing be **considered** for all potential Legionella-source water systems, with a decision to test or not to test based on an assessment and review of the specific water system (and site) for LD risks. This would include an understanding of the relevant facts on Legionella, Legionnaires' disease, Legionella sampling and an action plan for test results. AWT does not, however, recommend the **routine** sampling (testing) of all systems without due consideration or assessment.

6. AWT will continue to investigate and evaluate, as well as promote and report, the latest findings, research and technologies relevant to the control and prevention of Legionella and legionellosis. This includes independent research, as well as liaison and joint exchanges with government agencies, other organizations, associations, and related professional entities.

7. AWT, as a Responsible Care® Partner Association, further commits to sharing with the water treatment industry, related industries and the general public the information gathered and produced from their extensive resources addressing Legionella and Legionellosis.

References

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Atlanta, GA (404-636-8400). *Minimizing the Risk of Legionellosis Associated with Building Water Systems. ASHRAE Guideline 12-2000*, February 2000.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Atlanta, GA (404-636-8400). Legionellosis Position Paper, 1998.

Anderson, L.J., Arden, N.H., Breiman, R.F., Butler, J.C., McNeil, M.M., Tablan, O.D. and the Hospital Infection Control Practices Advisory Committee. (1994). *Guideline for Prevention of Nosocomial Pneumonia*. Atlanta: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, (404-639-3311).

Androkites, A., Berube, M., Carpendale, N., Dillon, S.B., Gilpin, R.W., Hurley, J., Kaplan, A.M., Keyser, P., and Skorina, J. (1985). Disinfection of circulating water systems by ultraviolet light and halogenation. Water Res., 19:839-848. (GTS's direct fluorescent antibody test method.)

Barbaree, J.M., Breiman, R.F. and Dufour, A.P. (1993). *Legionella: Current Status and Emerging Perspectives*. American Society for Microbiology, (ASM), Washington, D.C. (202-737-3600).

Breiman, R.F., Butler, J.C. and Fields, B.S. (1997). Prevention and Control of Legionellosis. Infectious Diseases in Clinical Practice 6, 458-464.

Control of Legionella in Cooling Towers - Summary Guidelines (1987). Wisconsin Division of Health. A copy of this document may be obtained from the Wisconsin Division of Health, Madison, WS 53701; telephone (608) 267-9003.

Cooling Technology Institute (CTI), formerly the Cooling Tower Institute, Houston, TX (281-583-4087). Legionellosis Position Statement, 1996.

Freije, Matthew R. (1998). Disinfecting Plumbing Systems of Legionella: Solving Problems Without Overspending: HC Special Report 303, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). Getting Help with Legionella Problems: Guidance for Good Decisions: HC Special Report 307, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). How to Make Plumbing Systems Less Conducive to Legionella and Other Bacteria: HC Special Report 302, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). Legionnaires' Disease: Facts, Legal Issues, Risk: HC Special Report 301, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). Legionella Environmental Sampling Guide: HC Special Report 306, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). Minimizing the Risk of Legionella in Cooling Towers and Other HVAC Equipment: HC Special Report 304, HC Information Resources, Inc. (760-451-1020).

Freije, Matthew R. (1998). Sample Water for Legionella? Weighing the Benefits Against the Costs: HC Special Report 305, HC Information Resources, Inc. (760-451-1020).

Fiore, A.E., Kool, J.L., Carpenter, J. and Butler, J.C. (1997). Eradicating *Legionella* From Hospital Water. Journal of the American Medical Association, 1404-1405.

Flanders, W.D., Morris, G.K. and Shelton, B.G. (1994). Legionnaires' Disease Outbreaks and Cooling Towers with Amplified *Legionella* Concentrations. Current Microbiology 28 , 359-363.

Goetz, A., Liu, Z., Stout, J.E. and Yu, V.L. (1993). *Legionella* Disinfection of Water Distribution Systems: Principles, Problems, and Practice. Infection Control and Hospital Epidemiology 14:10 , 567-570.

Harris, A. and Rendell, M. (1999). The Elimination of Legionella in Local Hot and Cold Water Systems Using a Novel Chlorine Dioxide Technique. International Water Conference (IWC) Paper No. 99-18. Pittsburgh, PA. (412-261-0710).

Millar, J.D., Morris, G.K. and Shelton, B.G. (1997) Legionnaires' Disease: Seeking Effective Prevention. ASHRAE Journal, 22-29. (404-636-8400).

OSHA Technical Manual, Section III, Chapter 7: Legionnaires' Disease. Occupational Safety and Health Administration, Department of Labor, Washington, D.C. (202-693-1999 or via the internet www.osha.org).

Point/Counterpoint: Surveillance Cultures for Legionella, a debate between Victor L. Yu, M.D. and Robert F. Breiman, M.D., about the pros and cons of sampling water for *Legionella*. Recorded at the 1996 Annual Scientific Meeting of the Society for Healthcare Epidemiology of America.

Stout, J. E., Yu, V.L. (1997). Legionellosis. New England Journal of Medicine , 682-687.

U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. (1997). Transmission of Nosocomial Legionnaires' Disease. Morbidity and Mortality Weekly Report 46, 416-421.

Watson, James R., *Legionella Update – 2000 Report*. Microbiological Consultation Services, Inc. (MCS), La Grange Park, IL (708-482-9117).

Yu, V.L. (1997). Prevention and Control of Legionella: An Idea Whose Time has Come. Infectious Diseases in Clinical Practice.