STEPS TO PREVENT LEGIONELLA IN INDUSTRIAL COOLING WATER

Legionnaire's Disease, or Legionnellosis, is a bacterial disease caused by the bacteria Legionella pneumophila, a Gram-negative bacillus that is commonly found in water. Of the fourteen currently recognized serogroups of L. pneumophila bacteria, serogroup 1 is the one most commonly associated with outbreaks and the sporadic cases of Legionnellosis. The two most common forms of Legionnellosis are Legionnaires Disease and Pontiac Fever.

Legionella bacteria typically live in water. Hot tubs, shower heads, water faucets, air conditioning systems, water cooling towers and hot water heaters have all been implicated as sources of aerosolized water droplets contaminated with the bacteria.

Frequently asked questions

1. **How do people contract Legionnaire's Disease?** When people inhale aerosols (water mist) that are contaminated with Legionella bacteria. Any mist-producing device that is contaminated with the bacteria can carry the disease.
2. **What are the signs of symptoms?** Persons with Pontiac fever have fever and muscle aches but do not have pneumonia. These cases usually get better in two to five days without any treatment. With Legionnaire's Disease, individuals generally gets much sicker. They will have fever, chills, and a cough, which might be dry or could produce sputum. Certain individuals also have muscle aches, headaches, tiredness, loss of appetite and occasionally diarrhea. Temperatures often reach 102° F – 105°F, and chest x-ray often shows pneumonia.
3. **How soon after exposure do symptoms appear?** The time between exposure and the beginning of symptoms for Legionnaire's Disease is two to ten days. The time period for Pontiac Fever is usually a few hours to 2 days.
4. **How is Legionella diagnosed?** It is difficult to distinguish Legionnaire's Disease from other types of pneumonia using symptoms alone. This is why it is frequently not identified until after the disease has advanced. The tests that are available are the Legionella sputum test, Legionella body fluid testing, and Legionella antibody testing in the blood.
5. **Who is at risk for Legionella?** Anyone can get the disease. However, the illness often attacks middle-aged and older persons, especially those who smoke cigarettes or have

chronic lung disease. Anyone with immune system problems, or those weakened by cancer, kidney failure requiring dialysis, diabetes, or HIV infection are also at high risk of getting the disease.It stands to reason that anyone who has a weakened system, and as such is susceptible to catching a virus, is going to be a prime candidate for Legionnaire's Disease.

6. **What are the complications from contracting Legionellosis?** The primary problem is respiratory failure. Multiple organ failure and shock can lead to death. The overall death rate for those with Legionnellosis who in turn develop pneumonia is about 15%. This rate is usually higher for those people with other underlying diseases.
7. **What is the treatment for Legionellosis?** Pontiac Fever requires no specific treatment. Simply treat for the symptoms and rest, and the disease will go away. Legionnaire's Disease, on the other hand, must be treated with antibiotics. Treatment should begin as soon as the disease is identified, or even suspect; do not wait for the lab results. Erythromycin, or a related antibiotic, is the drug of choice. In some severe cases, rifampin can be added as a second drug. Penicillin is not the drug of choice and usually has limited to no activity against the bacteria.
8. **How do we prevent Legionnaire's disease from happening?** The prevention of the disease requires good housekeeping procedures, which will limit the potential for an outbreak of the disease. No one knows, however, if it is possible to actually prevent the outbreak of the disease, even if you practice every possible preventive measure.

Air conditioning maintenance

Where air conditioning units are present, it is important to clean the coils of the units annually to remove grime and oils that can act as incubation sites for Legionnaire's Disease. In addition, the drip pan for the unit must be maintained in a clean state. Drip pan biocides are available from numerous janitorial supply houses. Place the slow dissolve tablets in the pan and renew as needed. The tablet will keep the pan clean and add a biostat to the pan to deter the growth of bacteria as Legionella.

Cooling tower maintenance

Cooling Tower Cleaning

OSHA has recommended that a cooling tower should be physically cleaned at least two times per year. This will remove any potential sludge buildup that could act to harbor Legionella.

The cleaning of the cooling tower should require that you:

1. Drain the entire system, including connecting piping.
2. Using a hose, wash down and flush out any foreign material from the cooling tower itself, wash down to the lowest point of the piping, and drain it again.
3. Make sure that the fans are turned off during the sanitizing and flushing steps that follow. Allowing the fans to run can cause system water to mist, and if Legionella is present, it could cause contamination and contact before the oxidizer is able to kill it. Therefore, during all of the following stages, contain the airflow in the system.

4. Fill the system with fresh water and then add an oxidizing biocide: chlorine dioxide (0.5 – 1.0 ppm), bromine (0.5 – 2.0 ppm), or chlorine (5.0 – 10.0 ppm) in that order of preference, to the system. In the case of chlorine chemistry, you should not exceed a pH of 8.0, or the efficacy of the chlorine will be dramatically reduced. Circulate this solution for 2 – 24 hours, based on the level of fouling in the system and the past history of the system in regard to corrosion rates, and if Legionella was ever identified in the system. If the cooling tower is a known site of Legionella infection, initial cleaning should follow the Wisconsin Protocol.
5. Add a penetrant to improve the kill with the oxidizer. This can be a detergent such as Cascade, or a biocide penetrating agent. Circulate the penetrant with the oxidizing biocide. Where corrosion is a concern and where chlorine is to be used, use a blend of phosphate and chlorinated phosphate to the system, or a penetrant with corrosion inhibition properties. These types of products will allow the introduction of the chlorine to the system, while adding a corrosion inhibitor for the system metal surface. Circulate this solution for up to 24 hours, and then dump the system. Test for free chlorine, and when the levels are below 1 ppm, you have flushed the system sufficiently to start up for the season.
6. Whichever oxidizer is used, dump and flush out the system, refill and initiate the water treatment program.
7. This procedure should be performed in the Fall and in the Spring, even if the cooling tower is seasonal and is to be shut down for the season.

Seasonal shut-down of the cooling tower

1. If a cooling tower system is to be shut down, it should be treated with a clean-up prior to being shut down, and then again to a clean-up when it is brought back online in the Spring.
2. Once the clean-up has been performed, drain the system for the season. If the system is not to be used, it must be drained. This means that the entire system is to be drained, including all of the piping. Any piping left filled with stagnant water over a period of months can culture bacteria like Legionella, so drain it out to prevent the potential for a problem.
3. In many cases, after the sanitizing of the system, you may wish to circulate a passivating agent containing phosphonates and gluconate before the final draining of the system. This can reduce the potential for surface corrosion while the system is down.

System operation

While a cooling tower is in operation, certain good housekeeping practices should be observed.

1. Maintain sufficient bleed in the cooling tower to prevent deposition. Contact your water treatment supplier for the proper inhibitors for your area.
2. Routinely, at a minimum weekly, check the low flow areas of the cooling tower and manually sweep any sludge buildup away. This prevents the formation of sulfur-reducing bacteria, removes a habitat for the Legionella to grow, and improves the contact of the biocide in the water. Biocides do not penetrate sludge very well.

3. Add a product to penetrate the biofilm in the system. Up to 98% of the Legionella in a system can be found in the biofilm, instead of in the water. This means that even if you have a biocide that kills on contact in the water, it can only kill about 2% of the Legionella in the system, if it cannot penetrate the biofilm. Penetrants are: DTEA, Chlorinated paraffin/limelidene, DMAD, ethoxylated alcohol-based products. Biocides are: Isothiazolin, DBNPA, Tris Nitro, Bronopol, Glutaraldehyde, Chlorine Dioxide (due to its slow oxidizing reaction) and any blended biocide that uses a penetrating agent. Oxidizing biocides used in conjunction with the above are: Chlorine Dioxide, Chlorine, Bromine, and Hydrogen Peroxide (usually used with Peracetic Acid).
4. In most cases, it requires more than one biocide to keep a system clean. It is important that biocides are to be used at all times while the cooling tower is in operation. A lack in biocide feed will result in a potential for any bacteria to grow. A cooling tower is a dynamic system, which is constantly infecting itself from the incoming air.
5. Removal of algae is important for the prevention of Legionella. Algae will provide Legionella with enzymes needed for growth. Therefore, the removal of algae will reduce the potential for Legionella growth. Cover all distribution decks. This will cut off sunlight to the internals of the cooling tower. Algae growth through photosynthesis, so removing sunlight will reduce the potential for their growth. Manually wash off algae that have grown on the exterior of the fill. As a cooling tower operates, mist flows out over the fill. Evaporation of this mist occurs, leaving behind solids from the cooling water. These solids contain organics, which can now be used by Legionella bacteria that pass over the solids with the incoming air as a food source. Algae can also form, as there is moisture, food, and sunlight at this point. Most biocides do not carry out of the system, so a cooling tower that has good in-system control can have a problem on the fill. Tris Nitro has been found to carry to a limited degree out over the fill and dramatically reduce this problem. Manually washing down the fill periodically will also reduce the potential of system contamination.
6. Testing for biological fouling is also recommended. The standard tests for biological growth are usually culture pads or dipsticks. These are incubated for 48 hours, and based on the results, the biocide usage is either increased or decreased. They are not specific to any single bacteria, so you are just checking for a general kill rate. Usually 1,000 to 10,000 total colony count is considered good control with 100,000 colony count considered as acceptable, but high. ATP testing is also used. This measures an enzyme present in all biological matter. By testing for the different levels of this enzyme in the water, you can determine in a few minutes if the biological growth in the system is being controlled by the biocide. Again, this is not specific to Legionella, and will only determine overall biological levels. Binax has a test that in 15 minutes will test specifically for serogroup type 1 of Legionella. The test costs 30 times the cost of the dipsticks and will not give a specific count. It will determine if the bacteria is present, and then if it is, if it is above 100 colonies. This test is new, and is the start of more sophisticated field testing. The most effective test to determine if Legionella is present is to send a sample to a certified testing lab. This, unfortunately, will take up to two weeks to get results. Sometimes this result is after the horse has left the barn, and is used more

as documentation than as a tool for prevention. In any case, testing for Legionella specifically is very difficult. Normal augers used for other bacteria testing will not grow Legionella unless an iron-impregnated auger is used.

Incoming water disinfection

The water coming to a facility from the potable water supplier can contain Legionella bacteria.

1. Chlorine levels used in drinking water for disinfection of bacteria are not sufficient to kill Legionella bacteria in the water.
2. Legionella can enter the cooling tower with the makeup water. In this case, the cooling water is constantly being infected.
3. Legionella will enter the facility potable water system, and where the hot water is not kept over 133°F, the bacteria will thrive.
4. Legionella bacteria, once in the potable water system, will propagate on the internals of the pipes where the pipes have become rough or some corrosion has occurred.
5. Legionella will become an aerosol and infect people at showerheads, from humidification, and in any whirlpools or hot tubs in the facility.
6. If Legionella is present in the potable water system, the entire system will have to be decontaminated via:
    1. Chlorination of the entire potable water system with a minimum of 50-ppm chlorine.
    2. Removal and replacement of the piping system
    3. Silver anode showerheads to deter the bacteria at the showerhead.
    4. Constant introduction of 0.1 to 0.5 ppm of chlorine dioxide into the bulk water system. This product is used in potable water systems where iron, manganese or trihalomethane is a problem, so it is accepted for use in potable water systems. It will effectively kill Legionella and can penetrate a biofilm.

Filtration of cooling water system

1. The lower the solids level in a cooling water system, the lower the potential for scale, corrosion, or biological growth, so filtration can keep a cleaner cooling tower system.
2. Side stream filtration down to 20 micron will dramatically reduce the solids loading in the cooling tower. Size the unit for 5 – 10% of the system circulation
3. Cyclonic filters will help remove solids. They only remove down to 70 micron, so some silt will still drop out in the system. Use these filters where you need to filter the entire system circulation, or where there is significant solids fouling due to high levels of solids in the intake air: construction, rubber production, farm areas, refineries, and locations near roads. In general, the prevention of Legionella in a facility requires maintaining a clean system. Filter the water, maintain sufficient biocide, maintain the correct biocide, and manually clean and disinfect the system twice a year.