COOLING TOWER WATER TREATMENT
WHO'S RESPONSIBLE or DONT SHOOT THE MESSENGER

Don't blame the person who brings bad news.

(This idea was expressed by Sophocles as far back as 442 B.C. and much later by Shakespeare in 'Henry IV, Part II' (1598) and in 'Antony and Cleopatra' (1606-07).

No one wants bad news or to believe that they have done something wrong. In today's world of responsibility and accountability everyone wants to believe that they are doing the right things to ensure that their products and services are providing a high level of performance and to be told that this hasn't been achieved bring about a whole host of responses and not the least of these is that the other person *must* be wrong!

In regard to chemical treatment of cooling towers the two areas that draw the most response of this kind is in the areas of microbiological monitoring(Legionella and Total Bacteria Counts) and corrosion levels.

The ASHRAE Journal, July, 2007 by Bill Gaines, Martin R. Orban, David R. Welch said " **the primary responsibility of a *water treatment supplier* is to manage the *water".***

What then is meant by this statement? The three potential problems associated with cooling water are:

- Corrosion
- Scale/deposits
- Microbiological activity

Controlling these three factors is critical in order to maintain clean, efficient and safe systems for all types of cooling; from comfort cooling to critical industrial process cooling. Corrosion will shorten the life of the equipment, Scale/deposits will decrease heat transfer and increase energy usage and unchecked microbiological activity will cause system blockages and potential health hazards. Further, a poorly maintained cooling water system will contribute to the growth of Legionella. Having said all this though doesn't really impact on those responsible unless they understand the true costs of poor water management.

Corrosion can be defined as the destruction of a metal by chemical or electrochemical reaction with its environment. In cooling systems, corrosion causes two basic problems. The first and most obvious is the failure of equipment with the resultant cost of replacement and plant downtime. The second is decreased plant efficiency due to loss of heat transfer-the result of heat exchanger fouling caused by the accumulation of corrosion products. – GE Handbook of Industrial Water Treatment chapter 24

Scale deposits are formed by precipitation and crystal growth at a surface in contact with water. Precipitation occurs when solubilities are exceeded either in the bulk water or at the surface. The most common scale-forming salts that deposit on heat transfer surfaces are those that exhibit retrograde solubility with temperature. Although they may be completely soluble in the lower-temperature bulk water, these compounds (e.g., calcium carbonate, calcium phosphate, and magnesium silicate) supersaturate in the higher-temperature water adjacent to the heat transfer surface and precipitate on the surface. - GE Handbook of Industrial Water Treatment chapter 25

Microbiological fouling in cooling systems is the result of abundant growth of algae, fungi, and bacteria on surfaces. Once-through and open or closed recirculating water systems may support microbial growth, but fouling problems usually develop more quickly and are more extensive in open recirculating systems.
Cooling water systems, particularly open recirculating systems, provide a favourable environment for the growth of microorganisms. Microbial growth on wetted surfaces leads to the formation of biofilms. If uncontrolled, such films cause fouling, which can adversely affect equipment performance, promote metal corrosion, and accelerate wood deterioration. These problems can be controlled through proper biomonitoring and application of appropriate cooling water antimicrobials. - GE Handbook of Industrial Water Treatment chapter 26

The microorganisms that form slime deposits in cooling water systems are common soil, aquatic, and airborne microbes. These microbes may enter the system with makeup water, either in low numbers from fresh water sources or in high numbers when the makeup is wastewater. Significant amounts may also be scrubbed from the air as it is drawn through the cooling tower. Process leaks may contribute microorganisms as well.

Bacteria. A wide variety of bacteria can colonize cooling systems. Spherical, rod-shaped, spiral, and filamentous forms are common. Some produce spores to survive adverse environmental conditions such as dry periods or high temperatures. Both aerobic bacteria (which thrive in oxygenated waters) and anaerobic bacteria (which are inhibited or killed by oxygen) can be found in cooling systems.

Fungi. Two forms of fungi commonly encountered are moulds (filamentous forms) and yeasts (unicellular forms). Moulds can be quite troublesome, causing white rot or brown rot of the cooling tower wood, depending on whether they are cellulolytic (attack cellulose) or lignin degrading. Yeasts are also cellulolytic. They can produce slime in abundant amounts and preferentially colonize wood surfaces.

Algae. Algae are photosynthetic organisms. Green and blue-green algae are very common in cooling systems (blue-green algae are now classified with the bacteria and are called cyanobacteria). Various types of algae can be responsible for green growths which block screens and distribution decks. Severe algae fouling can ultimately lead to unbalanced water flow and reduced cooling tower efficiency. Diatoms (algae enclosed by a silicaceous cell wall) may also be present but generally do not play a significant role in cooling system problems.

Usually, cooling waters are not nutrient-rich, so microbes must expend a great deal of energy transporting and concentrating nutrients inside the cell. This process may spend energy resources already in short supply, but it is necessary to allow the biochemical machinery to run at top speed. Because there is strong competition for the available nutrients, those species most efficient at concentrating their essential nutrients will have the opportunity to grow most rapidly. The rate of growth will ultimately be limited by the nutrient which first falls below an optimal concentration, but this will not necessarily be the nutrient in the lowest concentration.

Chemicals applied to cooling systems may, at times, provide added sources of the limiting nutrient and thus contribute to microbial growth in the systems. Alterations of pH may shift a stable population balance to an unbalanced, troublesome state. Although bacteria may be under control at neutral pH, a shift to an acid pH may result in domination by moulds or yeast. Because many algae grow most abundantly at an alkaline pH, an attempt to reduce corrosion by raising the pH can lead to an algal bloom.

Seasonal changes also affect growth patterns in cooling water systems. Natural algal communities in a fresh water supply are quite dynamic, and the dominant species can change rapidly with changing temperatures, nutrients, and amounts of sunlight. Cyanobacteria can often be primary colonizers in a cooling system. Seasonal changes which increase their numbers in the makeup water can lead to an algal bloom in the system. In autumn, as falling leaves increase the nutrient level and depress the pH, the bacterial population can increase at the expense of the algal population. - GE Handbook of Industrial Water Treatment chapter 26
Your open recirculating systems are prime environments for microorganisms. If uncontrolled, the resulting bio-films can result in microbiologically influenced corrosion and other system efficiency issues that can cause equipment failure, unscheduled downtime, reduced heat transfer, lost production, and increased risk of Legionella. – GE Water & Process Technologies

The importance of monitoring microbiological levels in your cooling waters can't be stressed enough. The risks attached to your business should an outbreak of Legionellosis occur can be catastrophic. Everyone is aware of the many outbreaks that have occurred around the world and the events surrounding death to those that were unfortunate enough to contract this disease. Hospitals, Hotels and Shopping Centres are especially vulnerable due to their exposure to peoples meeting the high risk categories.

Legionnaires' disease was first identified in the United States in the mid 1970s after a large outbreak of pneumonia among war veterans in Philadelphia. Since then outbreaks have been identified worldwide. Outbreaks in Australia have been mainly caused by contaminated aerosols generated by cooling water systems (CWSs)(the aquatic environment within the cooling towers that are part of air conditioning systems on large buildings are conducive to the proliferation of L.pneumophila) and other sources of misted water such as shower heads and spa pools. Although exposure to Legionella is fairly ubiquitous, some people are at high risk for overt disease, including people with pre-existing lung disease or immune suppression, smokers and people with a history of substantial alcohol use. An ageing population and increased use of immunosuppressive therapy may increase the number of vulnerable people within the community over time. – Australian National guideline for public health units 2009.

With all of the information known about Legionella and the need to maintain a sound water management programme in cooling water systems especially one that establishes strong KPIs (Key Performance Indicators), Managers must know that simply accepting whatever the chemical treatment service provider offers can result in greatly reduced life of the cooling systems, and potentially high risk to everyone at, in or around their properties. The need for independent monitoring and testing in addition enables them the ability to assess performance criteria's and safety levels on a non conflict of interest basis.

Selection of who tests the cooling water and on what frequency should be a simple process. Thoughts of using the water treatment service company should be dismissed immediately due to the conflict of interest (a situation in which decisions are influenced by personal interests).

Experienced businesses specialising and practised in proper sample collections independent of any involvement with the system treatment or Service Company should be chosen. Such companies have strict procedures in place to collect and transport samples to the testing laboratory under controlled temperature conditions using sterile sampling containers spiked with a small amount of chemical compound designed to remove any concentrations of chlorine to ensure that the sample isn't compromised.

The testing laboratory must be accredited and competent to perform all testings and have in place a fixed schedule of Proficiency testing practises that they can produce to prove their competency. (This testing is similar to schools requiring students to sit for regular tests and exams to prove that they are capable and knowledgeable on the subject matter).

And, lastly how often should the sampling and testing be performed? Legionella is a ubiquitous aquatic organism, widespread in the environment, found in lakes, rivers and other bodies of water as well as soils and thrives in temperatures between 25 and 45 °C (77 and 113 °F), with an optimum around 35 °C (95 °F) it can be found in cooling towers. These conditions allow the bacteria to multiply in large numbers. Most OHS Legislations require proper investigation and remedial actions to protect persons from exposure to biological contaminants. Properties at higher risk are Hospitals, Hotels and Shopping Centres because of the high numbers of people over 50 years of age(predominantly males), heavy smokers, heavy drinkers, diabetics, people with chronic lung disease and people with impaired immune systems. Based on experience and current practices many of these properties perform monthly monitoring to evaluate and manage the risk.

Independent Monitoring Consultants is a professional sampling and accredited testing consultancy business with more than 17 years experience in sampling, testing and consulting to major Hotels, Property Management, Shopping Centres and Hospitals throughout Australia and Asia. IMC provides independent sampling of cooling tower water systems, swimming pools, spas, potable waters, indoor air quality and foods.

At the opening of this paper we made the statement that, no one wants bad news or to believe that they have done something wrong. We also ask that you don't blame the messenger when a report comes to you with detection for high Legionella or Total Bacteria Count. Responsibility and accountability for what happens in the cooling water system belongs to the treatment supplier.

Detections in cooling systems do occur but if you have the correct procedures and action plan to respond when there is detection the risk is minimised. Major concerns for most authorities is when sampling and testing is performed by the chemical treatment supplier, and when testing reports consistently come back with no detections.

Testing facilities are accredited to International laboratory quality system ISO17025 by their respective country organisations. Like all quality systems they are only as good as the people implementing them. Proper evaluation and assessment should always be undertaken by the client to ensure that the service provider is competent and able to provide the services offered. Understanding the standards and procedures applicable to any testing is a must.

Don't take the risk or become complacent that everything with your cooling system is good just because the supplier produces a good report. Set proper KPIs, independently measure corrosion rates to insure that corrosion is under control and employ independent microbiological sampling and testing to ensure that the system is protected all the time. The costs in replacing a heat exchanger/chiller or repairing broken pipework can be substantial. The death of an employee, guest or customer from an outbreak of Legionella can devastate your business.