



**Biogenic Particles**  
**in**  
**Air Handling Systems**  
**and**  
**Cooling Towers**



## INDEX

Viruses	.....	page 3
Bacteria	.....	page 4
Effects of Corrosion	.....	page 5
Fungi	.....	page 6
Humidifier Fever	.....	page 7
Action Plan	.....	page 8
Operations Maintenance	.....	page 9
Biocides	.....	page 10
Disinfectants	.....	page 11
Manuals & Records	.....	page 12
Specialty Products	.....	page 13-14



## Viruses

There is evidence that viruses may be spread around an office via the mechanical ventilation system. Viruses are very small particles in the range  $0.004\ \mu\text{m}$  -  $0.08\ \mu\text{m}$ , and they can easily pass through the coarse air filters used in most ventilation systems. Viruses are active outside the body, but once inhaled, many viruses spring into action, like the common cold viruses or influenza viruses. Because colds are relatively commonplace and usually only briefly debilitating we have not given much thought to practices which will reduce the chances of infection. There is also evidence that colds and influenza are transmitted by direct contact, and the risks of infection can be reduced by good personal hygiene, especially frequent hand washing, etc.



## Bacteria

In 1976, at a convention of the American Legionnaires in a Philadelphia hotel, 182 people became ill with an unusual type of pneumonia and 29 people eventually died. Eventually the source of this outbreak was traced to a bacterium which had become entrained in the hotel ventilation system. In recognition of its dramatic entry into public health the disease became known as Legionnaire's disease and the bacterium was named *Legionella pneumophila*.

*Legionella* occurs naturally in streams, rivers, and reservoirs and it thrives in water that is about neutral in pH (6.9-7.0) and at a temperature around 35 degrees C (95 degrees F). In many air-conditioned buildings the water in the cooling towers that usually are on the roof of the office building meets these requirements and can become contaminated. If the bacterium becomes airborne in a water droplet it can be inhaled.

When inhaled into the lungs the *Legionella pneumophila* favors infecting someone whose immune system is already depressed by some other factor. Although annually some 25-30 otherwise healthy Americans die from Legionnaire's disease associated with contaminated buildings each year, Legionnaire's disease is a major killer of AIDS sufferers. The symptoms of Legionnaire's disease consist of headache, general malaise, myalgia, dry cough, and sometimes gastro-intestinal symptoms, followed by the onset of a high fever and changes in mental abilities. If unchecked it can cause lung damage, respiratory failure and death. Symptoms typically commence between 2 and 10 days after exposure. Other types of *Legionella* bacteria cause Pontiac fever, which is a flu-like illness lasting 2-5 days and it is probably more common than Legionnaire's disease, but it is not a fatal disease.

The growth of *Legionella* is promoted by the presence of other micro organisms. Certain single-cell organisms are able to amplify these bacteria in cooling towers as well as to protect them from adverse conditions, including the biocidal action of water treatment chemicals. Other bacteria and algae can provide nutrients. Sediments can stimulate the growth of the micro flora which, in turn, stimulate the growth of *Legionella*.



## Effects of Corrosion:

Investigations of the relationship between the chemical environment in plumbing systems and growth of *L. pneumophila*. has shown that low concentrations of certain metals such as iron, zinc and potassium enhance proliferation of the species.

Hence, the metal components and corrosion products of plumbing systems (eg. galvanized iron) may play a role in promoting growth of these bacteria. The constituents of certain types of rubbers used in rubber fittings in the system can also support the multiplication of *L. pneumophila*.

For rapid multiplication of *L. pneumophila*, specific conditions are required

- a wet environment;
- the presence of oxygen and carbon dioxide;
- high microbial concentration, including algae, slime
- scale and corrosion products
- a favourable temperature range.



## Fungi

We are only just beginning to realize the important effects which fungi can have on indoor air quality in offices. In a survey of over 400 office buildings fungal contamination was found to be responsible for problems in about one third of the buildings. Fungi grow outside and inside buildings and they are everywhere.

Providing there is sufficient water, fungi can grow on almost anything, from glass to jet fuel. Most of the fungi responsible for problems inside buildings belong to a group commonly called molds. Unfortunately, the interior spaces in office buildings and especially the ventilation systems often provide ideal conditions for rapid mold growth.

Once mold growth has started each mold can produce millions and millions of spores in a very short time. Inhaling these mold spores can produce respiratory reactions of varying severity. Molds also can produce over 500 different VOCs while there is active growth. The Northeast Center for Environmental Medicine, has found that almost two thirds of patients suffering from "environmental illness" show symptoms of exposure to indoor fungi.

Studies of office buildings show that dust from the air filters in the ventilation system contains between 70 and 3,400 fungi per gram of dust and the dust from the ventilation ducts contains between 70 and 6,200 fungi per gram of dust.



## Humidity Fever

These are respiratory diseases caused by an immune reaction to inhaling aerosols containing various organic materials. It can occur as an acute problem and symptoms of fever, chills, coughing, myalgia, shortness of breath, lethargy and malaise begin some 4 to 6 hours after breathing the contaminated aerosol. These symptoms can persist for another 18 to 24 hours unless re-exposure occurs. With repeated exposures workers symptoms become increasingly severe and eventually lung damage can occur.

Humidity fever disease is thought to be one type of hypersensitivity pneumonitis that can occur inside buildings when workers breath the aerosol from a contaminated humidifier. Various micro-organisms found inside buildings can cause this problem, and these include the thermophilic actinomycetes, a group of filamentous bacteria that like to live in warm temperatures on moist and dirty building materials, a bacterium called Flavobacterium and its endotoxins, molds, and single-celled animals called amoebae that like to live in stagnant water.

Humidifier fever is not caused by Legionella, yet it is often considered, incorrectly, as a form of Legionnaires' disease. This influenza-like fever may result from the inhalation of micro-organisms that cause allergic reactions. The potential source is often the humidifier of an air conditioning system.

It should be noted that the presence of fungi, algae, protozoa and other bacteria in air-handling and water systems may contribute to the:

- multiplication of the Legionella bacteria;
- emergence of diseases in addition to those associated with the Legionella bacteria.



## **Action Plan**

- Step 1: Identify potential sources of infection
- Step 2: Assess the risk of infection
- Step 3: Plan preventative action
- Step 4: Implement control measures
- Step 5: Check effectiveness



## Operation and Maintenance

The following information sets out the minimum requirements for the correct operation, regular routine maintenance and disinfection for cooling towers, air-handling systems and humidification systems.

### **Air-handling Systems**

- Air intakes and exhaust outlets inspected at least annually and cleaned when necessary;
- The supply air filter inspected and changed as required.
- it is important to ensure that all parts of the system are disinfected, not just those which are readily accessible.
- Ensure proper functioning of drainage facilities

\* Studies of office buildings show that dust from the air filters in the ventilation system contains between 100 and 6,700 bacteria per gram of dust (approximately 2,800 - 190,000 bacteria per ounce of dust), the dust from the ventilation ducts contains between 50 and 50,000 bacteria per gram of dust (approximately 1,400 to 1,400,000 bacteria per ounce of dust), and the floor dust contains similar numbers of bacteria . Endotoxins from the cell walls of dead, gram-negative bacteria may be a cause of sick building syndrome symptoms in some people.

### **Cooling Towers**

- inspected at least monthly as part of the regular maintenance routine;
- cleaned regularly as necessary but at intervals not exceeding six months;
- flushed and cleaned before start-up if only used seasonally;
- all internal wetted surfaces, particularly their sumps and fill, cleaned by high pressure water, steam or other effective methods; and
- treated with free chlorine levels of 5 parts per million to be circulated for 8 hours before draining and cleaning, if the system is contaminated.

### **Spray Wash Humidifiers:**

- inspected monthly
- cleaned where necessary including coils
- corrosion of sumps and pans corrected or cured
- a disinfection program instituted
- cleaned before start-up if the system is shutdown on a seasonal basis.



## Biocides

The most effective measures for reducing the risk to persons of acquiring Legionnaires' disease or others, can be achieved by good design, regular inspection and maintenance. *Biocides should never be used as substitutes for good housekeeping.*

Generally, broad-spectrum biocides which are used to control algae and slime, will control organisms associated with the growth of Legionella. Chlorination is used for disinfection. One of the difficulties associated with oxidising biocides is the lack of penetration of biofilms and it may be necessary to incorporate a dispersant to assist in the disinfection of cooling tower systems.

There are many biocides available for cooling towers:

- free chlorine
- bromine
- peroxide
- quaternary ammonium compounds
- isothiazolin
- carbamates
- gluteraldehydes
- etc

Biocides for internal uses such as air handling systems and spray washes, present great concerns in terms of irritation /sensitization and chronic toxicity effects.



## **Disinfectants & Sanitizers**

Disinfectants and sanitizers are used in closed environments such as air handling systems and humidification spray wash systems.

- Chlorine
- Glyols
- Peroxide
- Bromine
- Quaternaries
- others

The properties of some of these disinfectants and sanitizers lend themselves to misting dispersion to combat bacteria, viruses and fungi in down wind areas of the systems. Selection should be for those products that provide the greatest effectiveness with the least irritation /sensitization and chronic toxicity effects.



## **Manuals and Records**

Air handling humidification, cooling towers and associated water systems should be subject to routine monitoring as part of the water treatment program designed to control scaling, corrosion and fouling. Monitoring of pH, total dissolved solids and/or conductivity, bacterial counts and disinfectant or biocide concentration will indicate when the water treatment program requires modification and the point at which thorough cleaning and disinfection are necessary.

Operating and maintenance manuals and maintenance records should be available for all workplace equipment and systems which are the subject to this Code of Practice.



## Specialty Products

### **TRL 03 - Air Sanitizer**

A glycol based air disinfectant and sanitizer for use in spray systems, air handling units, plenums as well as rooms and open spaces. Registered DIN.

### **Germex:**

A blended air spray and hard surface disinfectant (hospital grade) for viruses, bacteria and fungi. Registered DIN.

### **TRL 31 -Quaternary Sanitizer:**

An aqueous quaternary ammonium compound for water systems and hard surface sanitizing. Registered CFIA.

### **TRL 488 -Sodium Hypochlorite:**

Sanitizer and water disinfectant. Registered CFIA.

### **Coilex:**

Penetrating coil and fin cleaners. Designed for dust, dirt, grime, smoke, oils, etc. Free rinse characteristics for auto flushing.

### **Flo Tabs:**

Condensate pan tablets designed to control the build up of algae, rust and scale. Quaternary ammonium fortified.



### **Rust Coat:**

Rust convertor coating for ferrous metals. Converts rust in spray pans to an inert stage. Converted surfaces may be refinished.

### **Instant Zinc:**

Cold zinc galvanizing treatment to replenish corroded galvanized surfaces in cooling towers and spray wash sump systems. Available in aerosol or liquid bulk.

### **Tro-Coat 4:**

A totally synthetic coating to treat highly corroded metal surfaces. Available in aerosol or liquid bulk.

### **Tro-Brite:**

A stainless steel coating used to treat pumps, shafts, piping etc. Stainless steel pigment in clear resin. Aerosol.

### **Liquidate:**

Liquid live bacteria & enzymes designed to degrade waste products in drain line systems. Non pathogenic, aqueous solution. Odour control agents built in.

### **Odorite:**

Odour control agent for air systems. Aqueous based, readily dilutable in spray wash systems. Imparts cinnamatic – spice fragrance to combat malodours.