Government of **Western Australia**
Department of **Commerce**
Department of **Mines and Petroleum**

Code of practice

Prevention and control of Legionnaires' disease

2010

commission for occupational safety and health

MIAC

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Foreword

This code of practice is issued by the Commission for Occupational Safety and Health (the Commission) and its Mining Industry Advisory Committee under the provisions of the *Occupational Safety and Health Act 1984* (the OSH Act) and the *Mines Safety and Inspection Act 1994* (the MSI Act).

The introduction of the OSH Act enabled the establishment of the tripartite Commission. It comprises representatives of employers, unions and government, as well as experts, and has the function of developing the occupational safety and health legislation and supporting guidance material, and making recommendations to the Minister for Commerce for their implementation. To fulfil its functions, the Commission is empowered to establish advisory committees, hold public inquiries, and publish and disseminate information.

The Commission's objective is to promote comprehensive and practical preventative strategies that improve the working environment of Western Australians. This code of practice has been developed through a tripartite consultative process and the views of employers and unions, along with those of government and experts, have been considered.

The Mining Industry Advisory Committee (MIAC) was established in April 2005 under the OSH Act as a statutory tripartite advisory body on matters relating to occupational safety and health in mining. MIAC's objectives include making recommendations to the Minister for Mines and Petroleum regarding the formulation, amendment or repeal of laws under the MSI Act, and to prepare or recommend the adoption of codes of practice, guidance material, standards and specifications or other forms of guidance for the purpose of assisting employers, self employed persons, employees, manufacturers and others to maintain appropriate standards of occupational safety and health in the mining industry. MIAC may also advise and make recommendations to the Ministers and the Commission on occupational safety and health matters concerning the mining industry.

Legislative framework for occupational safety and health

Occupational Safety and Health Act 1984

The OSH Act provides for the promotion, co-ordination, administration and enforcement of occupational safety and health in Western Australia.

The OSH Act places certain duties on employers, employees, self-employed people, people in control of buildings, manufacturers, designers, importers and suppliers. It also places emphasis on the prevention of accidents and injury. In addition to the broad duties established by the OSH Act, the legislation is supported by a further tier of statute, commonly referred to as regulations, together with a lower tier of non-statutory codes of practice and guidance notes.

Occupational Safety and Health Regulations 1996

Regulations under the Occupational Safety and Health Regulations 1996 (the OSH Regulations) spell out specific requirements of the legislation.

Regulations may prescribe minimum standards and have a general application, or define specific requirements related to a particular hazard or particular type of work. They may also allow licensing or granting of approvals and certificates.

Mines Safety and Inspection Act 1994

The MSI Act sets objectives to promote and improve occupational safety and health standards within the minerals industry.

The MSI Act sets out broad duties, and is supported by a further tier of statute, commonly referred to as regulations, supported by non-statutory codes of practice and guidelines.

Mines Safety and Inspection Regulations 1995

The MSI Act is supported by the Mines Safety and Inspection Regulations 1995 (the MSI Regulations), which provide more specific requirements for a range of activities.

Scope and application of this code

In June 2010, the Minister for Commerce approved this code of practice under Section 57 of the OSH Act and in July 2010 the Minister for Mines and Petroleum approved this code of practice under Section 93 of the MSI Act.

This code of practice applies to all workplaces in Western Australia covered by either the OSH Act or the MSI Act. It provides:

- general guidance for employers, people in control of workplaces, designers, manufacturers, suppliers and workers on the identification and control of safety and health hazards and risks associated with Legionnaires' disease; and
- information on key legislative requirements in the OSH Act, the OSH Regulations, the MSI Act and the MSI Regulations as they relate to Legionnaires' disease.

Codes of practice published under the OSH Act and MSI Act

A code of practice is a document prepared for the purpose of providing:

- practical guidance on how to comply with a general duty under the OSH Act and MSI Act or specific duties under the OSH Regulations or MSI Regulations;
- without being prescriptive, practical guidance on safe work practices that can be used to reduce the risk of work-related injury and disease; and
- a practical means of achieving any code, standard, rule, provision or specification relating to occupational safety and health in Western Australia.

A code of practice may contain explanatory information. However, work practices included may not represent the only acceptable means of achieving the standard to which the code refers. Compliance with codes of practice is not mandatory but a code may be used by courts as the standard when assessing other methods or practices used. A code of practice does not have the same legal force as a regulation and non-compliance is not sufficient reason, of itself, for prosecution under the OSH Act or MSI Act.

Note that there may be additional risks at the workplace not specifically addressed in this code of practice. Under the OSH Act and MSI Act, these must be identified and control measures implemented to prevent or minimise exposure.

Disclaimer

The information contained in this publication is provided in good faith and believed to be reliable and accurate at the time of publication. However, the information is provided on the basis that the reader will be solely responsible for assessing the information and its veracity and usefulness. The State shall in no way be liable, in negligence or howsoever, for any loss sustained or incurred by anyone relying on the information, even if such information is or turns out to be wrong, incomplete, out-of-date or misleading.

In this disclaimer:

- State means the State of Western Australia and includes every Minister, agent, agency, department, statutory body corporate and instrumentality thereof and each employee or agent of any of them;
- information includes information, data, representations, advice, statements and opinions, expressly set out or implied in this publication; and
- loss includes loss, damage, liability, cost, expense, illness and injury including death.

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1. Legionnaires' disease

1.1 What is Legionnaires' disease?

Legionnaires' disease, or Legionellosis, is an infectious disease caused by bacteria belonging to the genus *Legionella*.

The term 'Legionnaires' disease' originated in 1976 following an outbreak of serious respiratory disease at a convention of the Pennsylvania Branch of the American Legion, which led to the eventual discovery and identification of the responsible bacteria, *Legionella pneumophila*. Since its discovery, over 40 species of *Legionella* bacteria have been identified, although only a handful are known to cause infections in humans. The two most common species associated with infections in Australia are *Legionella pneumophila* and *Legionella longbeachae*.

In Western Australia, there have been over 620 diagnosed cases of Legionnaires' disease since 1999. Of these, almost 87 per cent were caused by *Legionella longbeachae*, a species commonly found in potting mix. Only nine per cent of diagnosed cases were caused by *Legionella pneumophila*, an organism found in cooling towers, air conditioners and other water systems.

In Western Australia, the *Occupational Safety and Health Act 1984* (the OSH Act) and the *Mines Safety and Inspection Act 1994* (the MSI Act), the *Health Act 1911* and several regulations cover Legionnaires' disease and its prevention. For more information, refer to Appendix 1.

The OSH Act and the MSI Act place general duty obligations on employers and people in control of workplaces, including those in control of the building the workplace is within, to ensure a safe place of work. Manufacturers, designers, importers and suppliers must ensure that people who install, maintain or use plant are not exposed to hazards or risk of infection. The OSH Act is supported by the Occupational Safety and Health Regulations 1996 (the OSH Regulations) and the MSI Act by the Mines Safety and Inspection Regulations 1995 (the MSI Regulations).

This code has been produced to provide general guidance on the prevention of risks in relation to Legionnaires' disease and improve understanding on the associated responsibilities of duty holders. These include people in control of workplaces with water systems, who have a general 'duty of care' to maintain these systems.

Where required, further guidance for those with responsibilities for cooling towers and air-handling units can also be found in relevant Australian and Australian/New Zealand Standards.

1.2 Forms of infection

The mode of transmission varies depending on the particular strain of *Legionella* bacterium, but the disease is usually transmitted through the inhalation of contaminated aerosols. *Legionella* infection is known to take two distinct forms, in particular:

- Legionnaires' disease, which is a form of pneumonia caused by an acute bacterial infection of *Legionella*; and
- Pontiac fever, which is a flu-like illness with symptoms including fever, chills and headaches. The incubation period ranges from four hours to three days, and up to 95 per cent of people exposed to the disease will become ill. Pontiac fever is not usually fatal.

Where *Legionella longbeachae* causes Legionnaires' disease, via contact with soils and composts, it is caused by inhaling airborne soil particles that carry *Legionella*, and it can usually be treated with a course of antibiotics.

Infection is usually low in healthy individuals, although people with compromised immune systems are at an increased risk of infection. The mortality rate for Legionnaires' disease is about five per cent.

1.3 Symptoms of the disease

According to the Western Australian Department of Health, early symptoms of Legionnaires' disease are often 'flu like', and can include some or all of the following:

- a fever (up to 40°C);
- chills;
- aching muscles and joints;
- a dry cough;
- headaches (often severe);
- tiredness;
- gastro-intestinal disorders;
- a loss of appetite; and
- a shortness of breath.

Detection and diagnosis

The incubation period for Legionnaires' disease is usually two to ten days. However, in most cases, it will be up to five to six days before symptoms appear. Acute infections can affect many bodily systems, leading to diarrhoea, vomiting, mental confusion and kidney failure. In severe cases, Legionnaires' disease can be fatal.

Diagnosis is made by means of blood or urine tests, and/or identifying the organism in sputum and respiratory secretions.

1.4 Sources of infection

Legionella bacteria are natural inhabitants of fresh water systems such as ponds, streams, lakes, rivers, soil, mud and underground water. While low levels of bacteria are normal, *Legionella* can thrive in warm, moist conditions.

In general, the sources of *Legionella* bacteria in recorded outbreaks of Legionnaires' disease have been traced to either large air conditioning plants or hot water distribution systems that have been incorrectly commissioned or poorly maintained. Organisms can enter fixtures either through the water supply or from aerosols produced by other (nearby) affected fixtures.

Any source with the potential to create water aerosols has the potential to transmit the disease when the water is contaminated with *Legionella*.

Legionella bacteria is best known from infections of cooling towers, air-conditioning units and garden soils. However, *Legionella* has also been known to accumulate in:

- evaporative condensers;
- hot and cold water systems;
- spas;
- humidifiers or foggers and water misting systems;
- coolant in industrial milling machines;
- high pressure cooling and cleansing processes;
- potable water aerosols, such as shower heads;
- nebulisers; and
- other domestic and industrial-based water systems.

In Australia, major outbreaks have been traced to cooling towers and to evaporative condensers associated with refrigeration systems. For example, in April 2000 there was a major outbreak at the Melbourne Aquarium, in which 101 people were infected, and there were four reported deaths. This and other outbreaks were caused by *Legionella pneumophila*.

Common sources of Legionella in Western Australia

The most common strain of *Legionella* in Western Australia, *Legionella longbeachae*, can be found in potting mix, garden soils, and mulches or composts. Infection can occur with inhalation of dust or aerosolised particles from contaminated soil.

Cases of infection from *Legionella longbeachae* are usually isolated and single events, although many people can be affected in any outbreak.

Standby or backup installations can also be sources of infection if they are used infrequently and not included in the general maintenance routine. Other potential sources of infection include:

- evaporative air conditioners;
- artesian bores;
- decorative fountains;
- fire sprinklers;
- fixed garden sprinklers;
- commercial aquariums;
- emergency deluge systems;
- car washes;
- air washers or wet scrubbers;
- water-based dust suppression systems;
- above ground storage tanks, which feed aerosol generating equipment; and
- any water system that generates an aerosol and the water temperature ranges between 20°C and 45°C .

Window or wall-unit refrigerated air conditioners have not been associated with Legionnaires' disease, as they use refrigerated air instead of relying on the evaporation of water for the cooling effect.

Infection from person to person, or from animals to person, does not occur.

Conditions for growth

The proliferation of *Legionella pneumophila* in water systems is the result of interrelationships between temperature, environmental micro-organisms and sediments, and the chemical composition of waters.

The proliferation of *Legionella* is known to be promoted by:

- a wet, warm environment (temperature range of 20°C-45°C);
- stagnation or low water turnover;
- high microbial concentration, including algae, amoebae, slime and other bacteria;
- presence of biofilm, scale, sediment, sludge, corrosion products or other organic matter; and
- degraded plumbing materials, such as rubber fittings, which may provide nutrients to enhance bacterial growth.

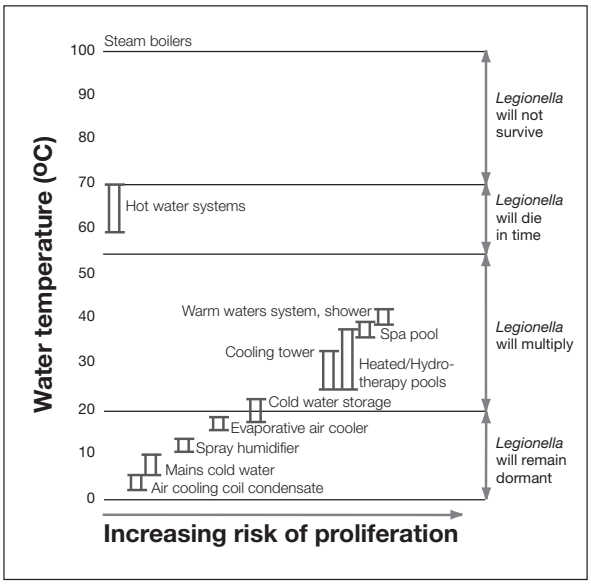


Figure 1 Relationship between proliferation of Legionella and typical water temperature of water handling systems. The above figure has been reproduced by permission from the NSW *Code of practice for the control of Legionnaires' disease* (2004).

Under laboratory conditions, the optimal temperature for *Legionella* bacteria is 37°C. Significant multiplication of the bacteria is generally restricted to temperatures between 20°C and 45°C, and maximum growth occurs within the range of 35°C to 43°C. Environments of 50°C or higher temperatures are sufficient to kill the bacteria.

1.5 Risk factors

If people are exposed to infected air conditioning, or environments generated through other water systems, inhalation of potentially harmful micro-organisms could occur.

Legionella pneumophila can be transmitted via inhalation of water droplets. Drinking and washing in water containing low numbers of *Legionella* bacteria is not known to result in infection.

As mentioned above, *Legionella longbeachae*, the most common strain in Western Australia, can be transmitted via aerosols or dust from gardening soils, such as potting mix, mulches and composts.

Rates of *Legionella* infection increase in people with lowered immune systems. This means that young, healthy people rarely get infected by *Legionella*. Factors increasing the likelihood of illness from *Legionella* infection include:

- smoking;
- chronic heart or lung disease;
- diabetes;
- HIV/AIDS;
- some forms of cancer;
- steroid use or other immunosuppressive medication;
- renal disease or kidney failure;
- being over 50 years of age;
- being of male gender; and
- excessive alcohol consumption.

The risk of contracting Legionnaires' disease can be reduced to a very low level through the careful design, installation and regular maintenance of cooling towers, air-handling systems, hot water services and other potential sources of aerosol.

In addition, the safe handling of potting mix and other garden soils will reduce the risk of inhaling contaminated aerosols.

1.6 Reducing the risk

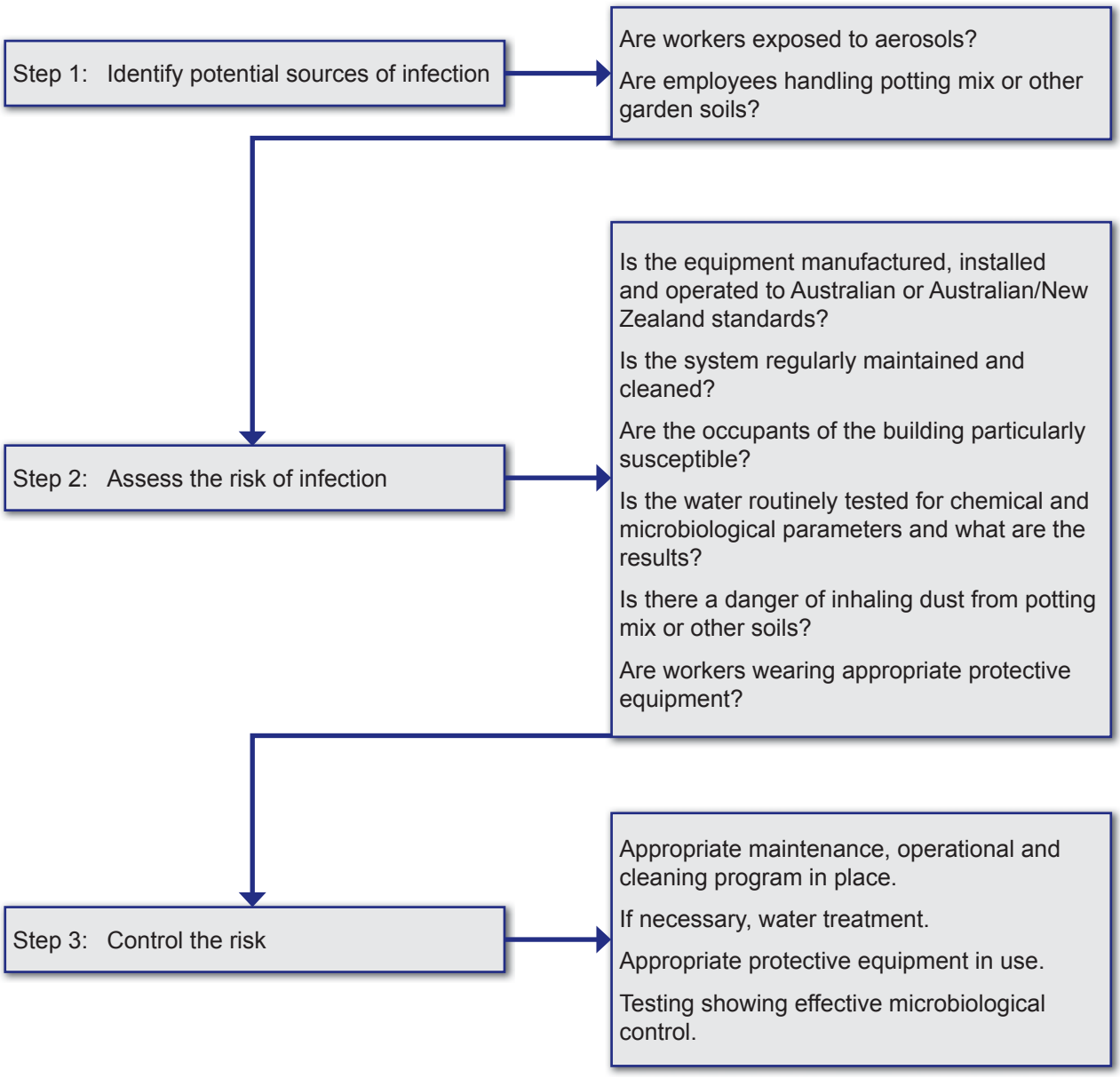
The following flow chart illustrates the process that people in control of workplaces should follow to reduce the risk of infection in the workplace. It is important that the steps implemented are regularly reviewed to ensure the controls in place are adequate.

Sections 2, 3, 4, 5, and 6 of this code discuss control measures to implement in order to control the risks with water cooling systems, air-handling systems, water services, other equipment and potting mix.

Personal protective equipment (PPE) including respirators

Where it is recommended in this code that respirators be used as a control measure, these should be selected in accordance with Australian Standard, *AS1715 Selection, use and maintenance of respiratory protective equipment* and Australian/New Zealand Standard, *AS/NZS 3666.2 Air-handling and water systems of buildings – Microbial control: Part 2: Operation and maintenance*, and may include half face Class P2 (particulate) respirators or powered air purifying respirators with a P2 filter.

If there is also a risk of inhalation of low levels of chlorine, a combination acid gas and particulate respirator may be suitable. Where aerosol sprays are created, personal protective equipment to protect the eyes should also be worn, eg goggles, face shield or a full-face respirator.



1.7 Notifiable disease

Given the serious nature of Legionnaires' disease, and its potential to impact on a large number of people, notification of the disease is required under Western Australian law. In particular, employers and self-employed people in control of workplaces are required to notify the WorkSafe Western Australia Commissioner or, in the case of mines, the District Inspector for the region in which the mine is situated, and the Department of Health, as soon as possible after a case occurs.

See section 23I of the OSH Act.

Legionnaires' disease is a prescribed disease under the OSH Regulations. The OSH Act requires that the employer or self-employed person at a workplace where a worker becomes affected by a prescribed disease must notify the WorkSafe Western Australia Commissioner as soon as possible.

Notification of a disease outbreak to WorkSafe can be made via its website at **www.worksafe.wa.gov.au**

See regulation 3.39 of the MSI Regulations.

In relation to mines, the MSI Regulations require that if an employer at a mine receives advice that an employee has an occupational disease, the employer must, as soon as is practicable, notify the Mines Occupational Physician on a 'Notification of occupational diseases' form available on the Resources Safety website at **www.dmp.wa.gov.au/ResourcesSafety**

See section 276 of the *Health Act 1911*.

The *Health Act 1911* also classifies Legionnaires' disease as a notifiable disease, and covers circumstances in which a medical practitioner, nurse or responsible pathologist should report an infectious disease, including Legionnaires' disease.

2. Potting mix, soils and mulch

Legionella longbeachae, which has been related to several deaths, is commonly found in gardening soils, potting mix and mulches in Western Australia. To prevent *Legionella* infection from potting mix and other compost materials, people should take precautionary steps such as:

- opening potting mix bags with care to avoid inhaling airborne potting mix;
- moistening the contents of the bag on opening by making a small opening and inserting a garden hose to dampen the potting mix;
- avoiding potting plants in unventilated areas, such as enclosed greenhouses;
- wearing gloves;
- avoiding transferring potting mix from hand to mouth, eg rubbing face with a soiled hand;
- wearing a face mask;
- always washing hands after handling potting mix, even if gloves have been worn, as *Legionella* bacteria can remain on hands contaminated by potting mix for up to one hour;
- storing potting mix in a cool place, away from the sun;
- keeping soils and potting mix damp;
- avoiding raising soil near evaporative coolers;
- watering gardens and composts gently, using a low pressure hose; and
- when handling bulk quantities of potting mixes or other soil products, using procedures that minimise dust generation.

The same precautions should be taken when handling soil, peat, mulch and garden composts.

Face masks should be either P1 or P2 particulate masks, as specified in Australian Standard, *AS 1715 Selection, use and maintenance of respiratory protective equipment,* or Australian Standard*, AS 1716 Respiratory protective devices.*

Bulk handling

Regardless of the quantity of soil being handled, basic control procedures such as those outlined above should be implemented. However, when handling bulk products, remember to:

- keep the soil damp, to minimise the spread of particles;
- wherever possible, avoid practices that promote double handling of soil;
- if working in an enclosed vehicle, ensure that the cabin is sealed and air-filters are cleaned regularly;
- plan the work to minimise the need to move bulk soils to reduce the risks of creating dust; and
- if exposure cannot be prevented in another way, wear protective equipment, such as gloves and face masks.

These regulations are available at www.slp.wa.gov.au

Potting mix and garden soils must be correctly labelled in one of the following two ways, as specified in the Health (Garden Soil) Regulations 1998. Suppliers of potting mix and other garden soils must ensure that warnings are clearly displayed on bags and where bulk products are sold.

Warning Notice 1

Health Warning
Garden soils contain micro-organisms that may be harmful to your health. Always wear gloves, keep damp while in use, avoid inhaling the mix and wash your hands after use.

Warning Notice 2

Health Warning
This product contains micro-organisms that may be harmful to your health. ■ Avoid breathing dust or mists from this product. ■ Wear gloves and keep product moist when handling. ■ Wash hands immediately after use.

3. Water cooling systems

Cooling towers and associated equipment encompass devices used for lowering the temperature of water by evaporative cooling, where the atmospheric air passes through spray water resulting in an exchange of heat. This includes a device incorporating a refrigerant or water heat exchanger.

Commissioning, operating, maintaining, cleaning, decontamination and other procedures should be designed to minimise the risk to people working on or in the vicinity of cooling towers and other potential sources of *Legionella* bacteria. The installations should be examined under normal working conditions for:

- signs of microbial growth;
- algae;
- water leaks;
- splashing; and
- blockages or restrictions at air inlets.

Design and installation

Design features should facilitate cleaning, control bacterial growth and minimise drift carryover. The design and installation considerations for water cooling systems should take into account:

- a suitable location so that exhaust is discharged away from occupied areas, pedestrian thoroughfares, air intakes (including lift vents), building openings and areas of traffic movement;
- the direction of prevailing winds;
- the height and design of adjacent structures;
- future planned developments;
- suitable and automatically controlled systems for effective management of corrosion, scaling, fouling and microbial growth;
- that there should be no 'dead legs' (see the definition in Appendix 3);
- that the materials used as system components should not foster microbial growth, nor react adversely during treatment, cleaning, disinfection or decontamination;
- that the cooling towers should be made from corrosion-resistant materials, and designed for ease of maintenance. Internal surfaces should be smooth-faced, and designed to facilitate cleaning;
- the provision of efficient drift eliminators (typically two- or three-pass plastic eliminators), installed to facilitate inspection, cleaning and maintenance;
- fitting of the pumps, pump seals and casings with drain outlets and separately drained to discharge;
- the sumps can be readily drained and sediment easily removed;
- a location to avoid contamination by the exhaust discharges from other air-handling systems, such as kitchen exhaust or other cooling towers;
- the cooling tower enclosures do not interfere with the required airflow through the tower nor result in the recirculation of discharge air;
- a location and orientation so that the wetted areas of the cooling tower are out of direct sunlight as far as practicable;
- the tower pond may require screening, depending on site conditions, to prevent entry by birds, vermin, leaves or other contaminants;
- easy and safe access for maintenance, particularly for cleaning purposes, including safe access for tasks done at heights;
- the provisions for shutdown to facilitate maintenance;
- accessible water treatment units, where installed;
- rapid draining facilities;

- automatic or permanent bleeds to waste, to limit the build-up of dissolved and non-dissolved solids in the water. Chemicals should be added, when needed, to limit the build-up of non-dissolved solids and minimise scaling, corrosion and fouling;
- adequate standby facilities when continuous operation is necessary; and
- the cooling towers and associated equipment are chemically cleaned and thoroughly flushed before being brought into service.

Operation and maintenance

Cooling towers should be operated and maintained using a risk based approach, which includes:

- inspections at least monthly as part of the regular maintenance routine;
- applicable water treatment;
- regular microbiological monitoring; and
- cleaning regularly as necessary at intervals not exceeding six months.

Cleaning should include the physical cleaning of the cooling tower, disinfection where practicable and draining of the entire water cooling system. This should include:

- flushing and cleaning before start-up if the system is only used seasonally; and
- high-pressure cleaning of all internal wetted surfaces, particularly their sumps and fill.

Drainage systems should be operated and flushed on a monthly basis, and the operating conditions for the system operating pumps and the cooling tower fans reviewed. Reducing the system operating water temperatures to the lowest practicable value improves control of micro-organisms, including *Legionella*, and usually improves operating efficiency.

Water systems should be disinfected, drained, cleaned and then disinfected again when the installation:

- is being started up for the first time;
- has been out of use and has not been dry; or
- has been extensively modified or disturbed.

Cleaning may also be necessary at regular intervals if the system, the state of the premises, or the results of microbiological monitoring indicate it is necessary. In such cases, it is important to ensure that all parts of the system, including storage or makeup tanks and associated filter systems, are disinfected, not just those which are readily accessible. To reduce the risk to maintenance workers, cooling tower water may be chlorinated prior to physical cleaning.

If aerosol sprays are created, then the installation should be switched off when inspecting or carrying out maintenance. If this is not practicable, respiratory protection should be worn to minimise the risk of inhaling water droplets contaminated by *Legionella* bacteria. See Section 1.6 of this code for guidance on selection of respirators.

If there is also a risk of inhalation of low levels of chlorine, a combination acid gas and particulate respirator may be suitable. Where aerosol sprays are created, PPE to protect the eyes should also be worn, eg goggles, a face shield or a full face respirator.

If work in a confined space is necessary, regulations 3.82 to 3.87 of the OSH Regulations apply. A risk assessment must be conducted to determine the safe working procedure and necessary protective equipment. However, a supplied-air respirator may be required, particularly if there is a risk of exposure to an unknown concentration of a hazardous substance, such as chlorine.

Work carried out in a confined space at a mining operation must comply with Australian Standard, *AS 2865 Confined spaces*. Refer to the General Exemption dated 23 November 2009, available at **www.dmp.wa.gov.au/ResourcesSafety**

Systems are necessary to minimise the risk of scalding and reduce the *Legionella* risk associated with the storage of warm water. These include:

- heat exchange systems;
- ultraviolet light systems;
- anti-scald safety valves; and
- self-draining valves.

Water cooling systems should be provided with automatically regulated water treatment systems for effective management of corrosion, scaling, fouling and microbial growth.

The effectiveness of the water management system, including water treatment and microbiological control, should be assessed at least monthly.

Cooling water systems that have been shut down on a seasonal basis, or for more than 30 days, should be cleaned and suitable water treatment reinstated before start-up.

Manuals and records

Operating and maintenance manuals and maintenance records should be available for workplace equipment and systems. The operating and maintenance specifications and manuals should be provided by the manufacturer, designer, supplier or importer.

Where applicable, manuals and records should include:

- a risk assessment and associated system specific management plan;
- physical details, including drawings of the equipment and systems, including associated pipework;
- manufacturers' recommendations on maintenance, including water treatment maintenance and management;
- recommended cleaning methods and dismantling instructions;
- operating and shutdown procedures;
- date, item of equipment or system and nature of service performed;
- water treatment reports and records;
- microbiological reports and records;
- roles and responsibilities associated with system operation;
- a defect and corrective action log;
- evidence of awareness training for individuals responsible for management and maintenance of the system; and
- the name of the person or company performing the service.

These manuals and records should be readily available to workers who may require the information.

4. Air-handling systems

As defined in Australian/New Zealand Standard, *AS 3666.1 Air-handling and water systems of buildings*, an 'air-handling system' refers to a system designed for directing air in a positive and controlled manner through specific enclosures by means of air-handling plant, ducts, plenums, air distributing devices and automatic controls. An air-handling system does not include simple or mounted exhaust fans, window mounted or split system air conditioners, but refers to any system in which air is circulated through ducts.

Commissioning, operating, maintaining, cleaning, decontamination and other procedures should be designed to minimise the risk to people working on or in the vicinity of cooling towers and other potential sources of *Legionella* bacteria. The installations should be examined under normal working conditions for signs of microbial growth, algae, water leaks, splashing and blockages or restrictions at air inlets.

The design, installation and commissioning of air-handling systems should be in accordance with Section 2 of Australian/New Zealand Standard, *AS/NZS 3666.1 Air-handling and water systems of building.*

Design and installation

The design and installation considerations for an air-handling system include:

- building it from plans submitted for approval to building authorities, including a site survey that shows details of the proposed installations, the adjacent buildings and prevailing wind conditions. The site survey information should show details of existing cooling towers, air intakes and natural ventilation openings of buildings adjacent to or facing the proposed new installation;
- the location of building air inlets, including windows, that open;
- the proximity of other discharges such as kitchen exhausts;
- the design of any enclosures;
- any future planned developments;
- easy and safe access for maintenance including the air filter. Where installed, air filters should be selected and located so that access is available for maintenance and moisture does not accumulate. Filter bypass should be avoided. Provision should be made for shutdown to facilitate maintenance;
- exhaust discharges that minimise cross-contamination with air intakes in the same building or adjacent buildings. These should be located to avoid cross-contamination with air intakes of cooling towers or any windows or doors that may be opened in the same building or a nearby building. Prevailing wind directions and wind effects should be taken into account when locating exhaust outlets;
- the design of air intakes to eliminate the collection of airborne pollution or dust, and drain away any rainwater that may enter the system. Intakes should prevent the entry of vermin, birds, rodents and other material, such as leaves. External lights should not be situated near air intakes, as lights attract insects, which could be drawn into the system;
- the use of trays, sumps, condensate and equipment drainage fan assemblies and duct work, as required, to drain effectively any accumulating moisture in any air-handling systems;
- the collection and discharge of moisture from sprays, atomisers or sponge pipes by grading to an outlet to prevent water from pooling;
- location of humidifiers to prevent the accumulation of airborne debris and optimise the mixing of water vapour with the air being humidified. A control system should be arranged so that the humidifier cannot be operated when the air-handling system is switched off;
- use of a steam spray and avoidance of over-humidification or water stagnation in humidifiers;
- the heat exchange coils are constructed from corrosion-resistant material, and cooling coils are designed to ensure the effective removal of airborne moisture. Heat exchange coils should be constructed to allow removal during cleaning or maintenance. Spray cooling coils should be fitted with spray collectors, which extend across the airstream;

- trays or sumps are provided for the collection and discharge of condensate from humidifiers and accessible for inspection and cleaning and graded to the outlet to prevent pondage. These should be constructed from corrosion-resistant materials with all internal corners and edges constructed to facilitate cleaning. The trays and sumps should extend beyond all sides and corners of the humidifier to enable collection of condensate or water under all operating and maintenance conditions;
- the drain lines are uniformly and continuously graded downwards to prevent collection of water. They should be trapped to seal against airflow. Drain discharges should be located close to the equipment being served;
- the provision for shutdown to allow for maintenance;
- the use of components that minimise corrosion and can be easily removed;
- the protection of wetted surfaces from direct sunlight; and
- adequate standby facilities where continuous operation is necessary.

Evaporative coolers should be fabricated with access for maintenance and ease of cleaning. Air intakes should be located away from exhaust outlets, and designed to eliminate the collection of airborne pollution, dust or organic matter. When not in use, evaporative coolers should be kept dry.

Heat exchange coils should be constructed of corrosion-resistant materials and installed in such a way that they can be easily cleaned. Coils should be designed to effectively remove airborne condensate by grading to outlets to prevent pondage.

Terminal units should have a condensate tray and adequate drainage, so moisture is not re-evaporated by the airflow through the system. The units should be accessible for maintenance.

Operation and maintenance

Air-handling systems should be operated and maintained with:

- air intakes and exhaust outlets inspected at least monthly and cleaned when necessary; and
- where installed, air filters should be inspected monthly and cleaned or replaced where necessary in accordance with the manufacturer's specifications.

Air-handling systems should be disinfected, drained, cleaned and then disinfected again when the installation:

- is being started up for the first time;
- has been out of use and has not been dry; or
- has been extensively modified or disturbed.

Cleaning may also be necessary at regular intervals if the system, the premises or the results of monitoring indicate it is necessary to do so. In such cases, it is important to ensure that all parts of the system are disinfected, not just those that are readily accessible.

If aerosol sprays are created, then the installation should be switched off when inspecting or carrying out maintenance. If this is not practicable, then particulate filters or equivalent respiratory protection should be worn to minimise the risk of inhaling water droplets contaminated with *Legionella* bacteria. See guidance on selection of respirators in Section 1.6 of this code.

If there is also a risk of inhalation of low levels of chlorine, a combination acid gas and particulate respirator may be suitable. Where aerosol sprays are created, PPE to protect the eyes should also be worn, eg goggles, a face shield or a full face respirator.

If work in a confined space is necessary, regulations 3.82 to 3.87 of the OSH Regulations apply. A risk assessment must be conducted to determine the safe working procedure and necessary protective equipment. However, a supplied-air respirator may be required, particularly if there is a risk of exposure to an unknown concentration of a hazardous substance, such as chlorine.

Work carried out in a confined space at a mining operation must comply with Australian Standard, *AS 2865 Confined spaces*. Refer to the General Exemption dated 23 November 2009, available at **www.dmp.wa.gov.au/ResourcesSafety**

Other ways to reduce the risk to maintenance workers include decontamination and routine cleaning of the system via disinfection of the system water prior to any physical cleaning being undertaken.

The effectiveness of the water management system, including water treatment and microbiological control, should be assessed at least monthly.

The air-handling installations and components listed below should be operated and maintained using the following procedures.

Humidifiers should have:

- monthly inspections, including the tanks, trays and discharge devices of boiling and pan-type humidifiers, and cleaning when necessary;
- cleaning, including the use of a suitable biocide, before start-up if the system is shutdown on a seasonal basis;
- a location that prevents accumulation of airborne debris and optimises the mixing of water vapour with the air being humidified;
- an arrangement of the control system so that the humidifier cannot operate when the air-handling system is switched off;
- a means to avoid over-humidification and prevent precipitation of moisture within the ducting; and
- monthly inspections and cleaning of line strainers, valves, sparge pipes, spray nozzles and components of steam and spray humidifiers discharging moisture into the airstream, where necessary. Associated sensors and controls should be maintained and calibrated by qualified people in accordance with the suppliers' requirements.

Evaporative coolers, including ducted and mobile air, should have:

- components and ducts inspected at least annually and replaced or cleaned as appropriate;
- more frequent inspections and cleaning for mobile units and dusty conditions;
- evaporative air coolers fabricated from corrosion-resistant materials;
- all internal corners and edges of trays and sumps constructed to facilitate cleaning;
- evaporative air coolers located to avoid the ingress of contaminants from flues, air exhausts, cooling towers, sewer vents, waste containers, and other sources of airborne pollution. Prevailing wind directions, wind effects, multiple roof levels and arrangement of adjacent structures should be taken into account in locating air intakes;
- other than for sole occupancy dwellings, an inspection schedule in which the following components are inspected at least every three months while the system is in use, and maintained as indicated. In particular:
  - the sump drained and cleaned;
  - wetted pads cleaned every three months and replaced, when necessary;
  - the water strainer cleaned, when necessary;
  - where fitted, the air filter replaced;
  - the drainage system flushed with clean and fresh water; and
  - the evaporative air coolers drained when not in use for periods greater than one month; and
- where air conditioners are to be switched off for an extended period, eg during the offseason, all water drained out and the filter pads and unit itself cleaned and dried.

Exposed units should be fitted with protective covers when not in use.

Coils, trays, sumps and terminal units should have:

- monthly inspections, with annual inspections for terminal units, and cleaning when necessary;
- heat exchange coils constructed from corrosion-resistant materials suitable for the environment. Cooling coil design should ensure effective removal of airborne condensate;

- trays or sumps provided for the collection and discharge of condensate and spray water from cooling coils. These should be accessible for inspection and cleaning and graded to the outlet to prevent pondage; and
- in cooling coil applications, trays and sumps extending beyond all sides and corners of the coil, eg extending under flanges and control valves, to enable the collection of condensate or water under all operating and maintenance conditions.

Condensate drains, tundishes and traps should be:

- checked monthly for effectiveness and flushed; and
- serviced as indicated, other than sole occupancy dwellings. Unless otherwise specified, servicing should include :
  - monthly inspections of coils, trays and sumps, and cleaning when necessary;
  - condensate drains, tundishes and traps checked monthly for effectiveness, and drainage lines flushed clean;
  - ductwork inspected annually in the vicinity of moisture-producing equipment and selected access points, and cleaned when necessary. Also, the functioning of drainage facilities should be checked annually, and drains cleaned when necessary;
  - fans and fan coil units inspected annually for evidence of corrosion, wear on flexible connections and drive belts, and for other deterioration, and cleaned or repaired when necessary; and
  - terminal units components inspected annually, and cleaned when necessary.

Manuals and records

Operating and maintenance manuals and maintenance records should be available for workplace equipment and systems. The operating and maintenance specifications and manuals should be provided by the manufacturer, designer, supplier or importer.

Manuals and records should include:

- physical details, including drawings, of the equipment and systems;
- manufacturers' recommendations on maintenance, including water treatment maintenance and management;
- recommended cleaning methods and dismantling instructions;
- operating and shutdown procedures;
- date, item of equipment or system and nature of service performed; and
- the name of the person or company performing the service.

These manuals and records should be readily available for workers who may require the information.

5. Hot and cold water services

5.1 General design features

Commissioning, operating, maintaining, cleaning, decontamination and other procedures should be designed to minimise the risk to people working on or near water services.

The design and installation considerations for water services include:

- provision, in any water storage vessels, for inspection, cleaning, rapid drainage, rapid refilling and measures to prevent the entry of foreign matter;
- provision for shutdown for maintenance;
- easy and safe access for maintenance, including for water treatments;
- components that minimise corrosion and can be easily removed;
- minimal internal components, such as structural brackets, that can collect sediment;
- materials compatible with the use of disinfectant and hosing with water jets;
- sumps that can be readily drained;
- height and design of adjacent structures;
- proximity of other discharges such as kitchen exhausts;
- surfaces that can be readily cleaned;
- protection of wetted surfaces from direct sunlight;
- adequate standby facilities for when the normal continuous operation is stopped for maintenance;
- components made with materials that do not foster microbiological growth or react adversely to chemicals; and
- suitable screens, such as overflow pipes, to prevent entry by vermin, insects and other foreign objects.

Design of heated water systems

A hot water system is designed to heat and deliver water at or above 60°C at each outlet point. Warm water systems deliver water between 30°C and 60°C.

The design of hot water systems should:

- ensure easy and safe access for cleaning, inspection and maintenance;
- have provision for inspection, cleaning, rapid drainage and refilling of water storage tanks. Tanks should be equipped with close-fitting lids, and insect-proof lids or covers;
- have no 'dead legs'; and
- prevent stratification of temperature, both in the design and the installation.

Warm water services should be designed to include one tank that heats water to at least 60°C and another tank that holds cold water and is protected from sunlight or excessive local heat sources, such as hot vessels or pipes. If the water is used for showering or similar purposes, preset thermostatic mixing valves should be installed to avoid scalding.

Design of cold water systems

Cold water services should have storage of cold water protected from sunlight or excessive local heat sources such as hot vessels or pipes. Cold water services should hold only one day's water supply to prevent stagnation.

5.2 General operation and maintenance principles

All installations should be examined under normal working conditions for signs of microbial growth, algae, water leaks, splashing and blockages or restrictions at air inlets. All plant, equipment and components should be serviced and maintained in accordance with the manufacturers' instructions and best practice.

Water systems should be disinfected, drained, cleaned and then disinfected again when the installation:

- is being started up for the first time;
- has been out of use and has not been dry; or
- has been extensively modified or disturbed.

These water services should be cleaned either chemically or with hot water and thoroughly flushed before being brought into service.

Cleaning may also be necessary at regular intervals if the system, the premises or the results of microbiological monitoring indicate it is necessary to do so. In such cases, it is important to ensure that all parts of the system are disinfected, not just those that are readily accessible.

Some cleaning methods may create large amounts of spray, eg high pressure water jetting. If aerosol sprays are created, then the installation should be switched off when inspecting or carrying out maintenance. If this is not practicable, or there is also a risk of inhalation of low levels of chlorine, then PPE including respiratory protection should be worn to minimise the risk of inhaling water droplets contaminated by *Legionella* bacteria. See Section 1.6 of this code for guidance on the selection of respirators.

Where there is a risk of inhalation of low levels of chlorine, a combination acid gas and particulate respirator may be suitable. Where aerosol sprays are created, PPE to protect the eyes should also be worn, eg goggles, a face shield or a full face respirator.

If work in a confined space is necessary, regulations 3.82 to 3.87 of the OSH Regulations apply. A risk assessment must be conducted to determine the safe working procedure and necessary protective equipment. However, a supplied air respirator may be required, particularly if there is a risk of exposure to an unknown concentration of a hazardous substance, such as chlorine.

Work carried out in a confined space at a mining operation must comply with Australian Standard, *AS 2865 Confined spaces*. Refer to the General Exemption dated 23 November 2009, available at **www.dmp.wa.gov.au/ResourcesSafety**

The effectiveness of the water management system, including water treatment, should be assessed at least monthly.

Operation and maintenance of heated water systems

If not properly maintained, heated water systems are capable of supporting *Legionella* growth to the extent that there may be a risk to public health in certain cases.

Systems are necessary to minimise the risk of scalding and reduce the *Legionella* risk associated with the storage of heated water. These may include:

- heat exchange systems;
- ultraviolet light systems;
- anti-scald safety valves;
- self-draining valves; and
- thermal disinfection.

Heated water services should be:

- inspected and, when not in regular use, flushed before re-use; and
- inspected monthly where water treatment units are installed.

Warm water services should be heated to at least 60°C once each month for a period of one hour.

Operation and maintenance of cold water systems

Cold water services should be inspected and cleaned annually by disinfection and flushing.

The frequency of cleaning may need to be adjusted, depending on the levels of microbiological control, corrosion, sludge and sedimentation and the normal operating temperature.

5.3 Manuals and records

Operating and maintenance manuals and records should be available for workplace equipment and systems. The operating and maintenance specifications and manuals should be provided by the manufacturer, designer, supplier or importer. It is recommended that maintenance records are also kept by householders for their domestic air conditioners, water systems and spas.

Manuals and records should include:

- physical details, including drawings, of the equipment and systems;
- manufacturers' recommendations on maintenance, including water treatment maintenance and management;
- recommended cleaning methods and dismantling instructions;
- operating and shutdown procedures;
- date, item of equipment or system and nature of service performed; and
- the name of the person or company performing the service.

These manuals and records should be readily available for workers who may require the information.

6. Other equipment

Investigations of outbreaks of Legionnaires' disease, especially in the USA and UK, have identified several sources of epidemic infection, which have been discussed earlier in this code. This section addresses other sources of Legionnaires' diseases that have been identified and resulted in sporadic infection. Information is provided on the minimum operation and maintenance procedures required for these systems.

6.1 Spas (whirlpools)

Spas, also known as whirlpools, utilise warm water at about 38ºC, with air and water jets producing turbulence and creating aerosols. These aerosols are in the breathing zone of spa users and therefore are likely to be inhaled. Inadequately maintained public spa facilities have the potential to infect large numbers of people, as do natural hot-spring spa pools.

The recommendations for the safe operations of spas include:

- testing the spa water before use and maintaining the water conditions with a pH of 7.2-7.8, and a free chlorine residual of 3-5mg/l or a free bromine level of 4-6mg/l;
- operating the filter pump when dosing biocides, but not the air blower or venturi;
- using a test kit to check water conditions and biocide levels;
- filtering the water for at least two hours every day, even if the spa is not in use. Always run the filter for at least one hour after use;
- checking and cleaning the filter regularly;
- removing at least 10 per cent of the water weekly and replacing it with clean tap water. Heavily used spas will require the removal of more water;
- keeping spa surfaces clean, including the surrounds, tiles and cover;
- ensuring spa baths comply with Australian Standard, *AS 3861 Air-handling and water systems*; and
- not using the spa or operating the water jets if either the water is not treated properly or the spa has not been maintained in accordance with the minimum maintenance schedule set out in Section 8 of this code of practice.

Spa pools on display in a showroom environments may become a habitat for *Legionella* and present a risk of infection. The risk of infection increases if the water jets of display spas are operated, ie produce aerosols, when the water has not been properly treated.

6.2 Water-based metal working fluids

Metal working fluids are specially developed coolants and lubricating fluids used in the grinding, cutting and drilling of metals. These coolants support the growth of micro-organisms. Any equipment shutdown may lead to proliferation of micro-organisms, which can occur more rapidly when the coolant is not circulated and the oil-water emulsion separates.

The growth of micro-organisms can be controlled by regular cleaning, following the directions for use of the metal working fluid. This includes the correct use of biocides and reduction of aerosol generation and exposure.

All testing, monitoring, including microbiological monitoring, and maintenance requirements should be determined via a risk assessment to ensure system specific risks are addressed.

6.3 Respiratory therapy equipment

Portable room humidifiers and oxygen nebulisers (spray generators) are commonly used on patients with underlying lung disease, most of whom have a weakened defence against infection. There have been instances in which tap water, from which *Legionella* was subsequently isolated, had been used in both pieces of this equipment.

Recommendations for safe operation of the devices include:

- using only sterile water;
- using disposable parts in oxygen nebulisers. If not, the nebulisers should be emptied after each use, the parts dismantled and washed with soapy water. The parts should then be washed and dried in a dishwashing machine where the temperature of the hot water is over 70ºC. They should then be stored dry and never rinsed with tap water; and
- if the equipment is used continuously by a long-term patient, disinfecting in the above manner at least weekly.

6.4 Decorative fountains

Aerosols are created by splashing or spraying of water in a fountain. Fine droplets or mists present a greater risk than larger droplets. The recirculating water in such systems may be inadvertently heated, eg submerged lighting, direct sunlight or high ambient temperatures, producing conditions that may favour the growth of *Legionella*. These factors should be considered during the design and installation phases, and when planning cleaning and maintenance schedules.

All testing, monitoring, including microbiological monitoring, and maintenance requirements should be determined via a risk assessment to ensure system specific risks are addressed.

6.5 Washing systems

Washing systems using recycled water, particularly as a spray, are a potential source of infection. These systems may be found in crate washing systems, powder coating systems and even vehicle wash systems.

There are several risk factors that typically contribute to the growth of *Legionella* bacteria in these systems, including:

- winding pipes and tanks that provide reservoirs for bacterial growth;
- the presence of 'dead legs';
- water that can reach optimal temperature for bacterial growth;
- high nutrient loading;
- the build-up of biofilm, or the presence of lime-scale or rust within tunnels and tanks; and
- infrequent usage.

Safety considerations for washing systems include:

- considering whether the processes can be kept either below 20°C or above 60°C to discourage bacterial growth;
- evaluating flow rates of water through tanks or pipeworks to eliminate stagnation and material build-up; and
- implementing a regular regime of cleaning, disinfection and maintenance based on inspection and microbiological monitoring.

6.6 Other spray systems

Due to the diverse nature of industry, a range of aerosol-generating water systems is likely to be encountered. Any water-based system that generates an aerosol and operates within the 20°C - 45°C temperature range at any stage has a potential *Legionella* risk.

All testing, monitoring, including microbiological monitoring, and maintenance requirements should be determined via a risk assessment to ensure system specific risks are addressed.

7. Water treatment and testing

7.1 Water treatment

The most effective measures for reducing the risk to people of contracting Legionnaires' disease from water are achieved by good design and regular inspection, maintenance and monitoring. Biocides should never be used as substitutes for good housekeeping, and should always be used in conjunction with microbiological monitoring to evaluate the efficacy of the dosing program.

Biocides are an integral component of an effective risk mitigation program within cooling systems. General, broad-spectrum biocides, which are used to control algae and slime, will control organisms associated with the growth of *Legionella*. Chlorination, for example, can be used if disinfection is necessary.

The selection of a system-specific water treatment program is important as the use of biocides may have negative impacts such as affecting workers handling the chemicals or the general public, reducing the system longevity and potential environmental consequences. The selection of chemicals used in open cooling towers should therefore be undertaken by, or in conjunction with, competent individuals and potential impacts assessed prior to introduction of any chemical.

Biocides used in regular cleaning and disinfection should have a range of properties and ideally they should:

- be effective against a wide spectrum of bacteria, algae, protozoa and fungi;
- maintain effectiveness when in contact with contaminants or substances in the systems;
- be quick acting, with long lasting effect;
- have a low toxicity for mammals;
- be environmentally acceptable in tower drift and water discharge;
- be effective at a low concentration over the range of pH encountered in cooling tower water;
- be compatible with other chemicals used;
- not cause deterioration of materials they come into contact with;
- penetrate foam, sludge, slime and scale within the system without foaming;
- be inexpensive; and
- be easily transported and handled and able to be applied on-site.

It should be noted that the ideal biocide probably does not exist and different biocides are typically used for different functions. The selection of biocides should be system specific.

7.2 Disinfection

Disinfection is typically required as part of the routine maintenance of water systems. However, it may also be required as part of an emergency procedure to disinfect a system in order to re-establish the system's microbiological control and reduce the associated risks. Both the routine and emergency disinfection requires set procedures developed by or in conjunction with competent individuals. Specific procedures for disinfection are provided within Australian/New Zealand Standard, *AS/NZS 3666.3 Air-handling and water systems of buildings – Microbial control: Part 3: Performance-based maintenance of cooling water systems.*

The two most commonly used biocides for disinfection of cooling towers are free chlorine and quaternary ammonium compounds. New biocides continue to be developed and all biocides should be used in accordance with the manufacturers' directions.

Ongoing maintenance should occur according to the procedures outlined elsewhere in this code. One of the difficulties associated with biocides is the lack of biofilm penetration. It may be necessary to incorporate a dispersant to assist in the disinfection of cooling tower systems.

Any water treatment should be carried out by, or under the direction of, suitably trained and experienced people. Chemicals should be handled with care with workers wearing appropriate protective clothing, including goggles and gloves, to prevent contact with these agents. Chemicals such as biocides, cleaning agents, corrosion inhibitors, anti-sludging chemicals, acids and alkalis may be used in operating, cleaning and decontamination procedures. Material Safety Data Sheets should be obtained for each chemical agent used and the recommended procedures followed.

The workers involved in the above procedures should be adequately trained in safety procedures, including the use, limitations and maintenance of protective equipment.

Caution must also be exercised so that occupants of the building and others in the vicinity are not put at risk by the work undertaken or the handling of chemicals.

7.3 Water testing

Sampling for *Legionella* and the interpretation of results are specialised processes. Further advice should be sought before sampling is done. It should also be noted that environmental water testing is not always successful in detecting organisms such as *Legionella* if they are present.

Since *Legionella* is widespread in nature, sampling often yields positive results. Many water systems are colonised with *Legionella*, however, without being associated with infections. The dose of *Legionella* required to infect people, the variation between individuals and the pathogenicity of the different strains are not fully understood. Together with the dynamic nature of *Legionella*, this makes it difficult to determine the risk solely based on water sampling results.

For these reasons, routine water sampling for *Legionella* is of limited value if viewed in isolation and should, therefore, be interpreted in the context of the system-specific risks, following a system inspection by a competent individual.

Periodic *Legionella* sampling is an effective means of checking the efficacy of the water treatment regime and a vital component of the overall *Legionella* risk management program. *Legionella* testing is also useful as part of an:

- investigation of an outbreak;
- validation of effectiveness of control measures; and
- verification of the effectiveness of decontamination.

Currently, the analysis of water for the presence of *Legionella* takes seven to ten days, so the implementation of any corrective measures based on culture results would be delayed.Consequently, any decision to sample should not divert resources from precautionary measures, and negative results should not lead to complacency or a relaxation of standards. Bacterial counts are a useful practical tool for assessing microbiological control and should be used in conjunction with *Legionella* sampling and as part of the overall *Legionella* risk management plan.

Cooling towers and associated water systems should be subject to routine microbiological 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.

Further information on water testing for buildings can be obtained from Australian/New Zealand Standard, *AS/NZS 3666.3 Air-handling and water systems of buildings – Microbial control: Part 3: Performance-based maintenance of cooling water systems.* For other water systems, a risk assessment should be conducted.

8. Minimum maintenance

System	Task	Frequency of inspection
Cooling towers and evaporative condensers	Monitor water quality, water use and chemical component of water treatment program	At least monthly
	Microbiological monitoring – total count	At least monthly
	Microbiological monitoring – *Legionella*	At least quarterly
	System inspection including observation of internal condition of sump, packing and water	At least monthly
	System component inspection including dosing equipment, bleed control and drift eliminators	At least quarterly
	Clean and disinfection of system	At least annually
Air-handling systems	System inspection, including valves, pipes, spray nozzles, air-intakes and exhaust outlets	At least monthly
	Inspection of humidifiers	At least monthly
	Inspection of tanks, trays and discharge pipes	At least monthly
	Clean and disinfection of system	At least annually
Heated and cold water systems	Assess effectiveness of water management system	At least monthly
	Inspection of water treatment units	At least monthly
	With warm water systems, raise water temperature to 60°C	At least one hour per month
	Clean and disinfection of system	At least annually
Spas	Replace at least 10 per cent of water	At least once per week
	Filter water through system	Two hours per day
	Filter water after use	One hour after use

8.1 Interpretation of microbiological results

Before discussing the interpretation of microbiological results, it must be emphasized that any once-off *Legionella* sampling exercise should not be regarded as conclusive. Rather, it provides a snapshot and should be likened to taking a photo of the sampled litre of water at the specific time of sampling.

Sampling results should be regarded as useful management tools as they provide an insight into the presence of *Legionella*, as well as a limited insight into the conditions endemic within the sampled system. A negative result from a sample should not lead to a false sense of security because any system with suitable conditions can quickly become colonised. The true risks associated with any system can, and should, only be evaluated in context of the overall risks or circumstances surrounding the sampled system (a holistic view) with particular attention given to causation. Testing is not a substitute for sound maintenance and effective water treatment.

It is important to note that the risk of illness following exposure to a given source of *Legionella* is influenced by a number of factors including, but not limited to, strain virulence, host susceptibility and droplet size in relation to the size required (< 5 micrometers) to reach the deep alveoli within the exposed individual's lungs.

Laboratory testing is an important component of the overall risk evaluation, with selection of the method to identify Legionella and the species that affect humans being crucial.

Control strategies for the presence of *Legionella*

Test result (cfu*/mL) (*Legionella*)	**Required control strategy**
Not detected (<10)	System under control. Maintain monitoring and treatment program.
Detected as <1,000	Immediate online decontamination (alternative or higher dose biocide than usual). Review control strategy. Re-test water within three to seven days of plant operation, and assess if further remedial action** is necessary.
Detected as ≥1,000	Immediate online decontamination (chlorine based biocide). Review control strategy. Re-test water within three to seven days of plant operation, and assess if further remedial action** is necessary.

* cfu = colony forming units

** Adapted from Australian/New Zealand Standard, *AS/NZS 3666.3*. Refer to this standard for further information

Control strategies for the presence of other heterotrophic microorganisms

Test result (cfu*/mL) (*heterotrophic*)	**Required control strategy**
<100,000	System under control. Maintain monitoring and treatment program.
≥100,000 to <5,000,000	Immediate online decontamination (alternative or higher dose biocide than usual). Review control strategy. Re-test water within three to seven days of plant operation, and assess if further remedial action** is necessary.
≥5,000,000	Immediate online decontamination (alternative or higher dose biocide than usual). Review control strategy. Re-test water within three to seven days of plant operation, and assess if further remedial action** is necessary.

* cfu = colony forming units

** Adapted from Australian / New Zealand Standard, *AS/NZS 3666.3*; refer to this standard for further information.

Appendix 1 Relevant legislation

All legislation discussed in this appendix is available online at www.slp.wa.gov.au

Occupational Safety and Health Act 1984

General duties at the workplace

Health and safety is the responsibility of all people at a work site.

The employer's general 'duty of care' obligations for safety and health under the OSH Act include:

- providing a workplace and safe system of work so workers are not exposed to hazards, and risks of contracting Legionnaires' disease;
- providing workers with information, instruction, training and supervision to enable them to work in a safe manner; and
- consulting and cooperating with workers and safety and health representatives, where they exist, in matters related to safety and health at work.

Workers also have obligations under the OSH Act. They must take reasonable care to ensure their own safety and health at work and that of others who could be affected by their work. They must report any situations that may be hazardous. These duties are complementary to the employer's duties and workers will need adequate information, instruction, training and supervision to fulfil their duties.

For further information on the 'duty of care' obligations, see the Commission's *Guidance Note: General duty of care in Western Australian workplaces.*

People who engage contractors and their workers, have a labour arrangement or hire labour have the above responsibilities of an employer towards their workers in relation to matters over which they have the capacity to have control. Crew in these arrangements have the above duties of a worker.

Self employed people, under the OSH Act, must:

- take reasonable care to ensure their own safety and health at work; and
- ensure their work does not affect the safety and health of others.

People who have, to any extent, control of a workplace must ensure that as far as practicable, there are no hazards that could arise due to the state of the workplace. People with control of a workplace could include a building owner or the agent for a building owner.

The responsibilities of the employer or the person in control of the workplace under the OSH Act are not absolved by contracting out the maintenance, cleaning and testing. The employer or the person in control of the workplace should monitor the contractor's performance.

Section 23(1) of the OSH Act requires that manufacturers, designers, importers and suppliers ensure that people who install, maintain or use the plant are not exposed to hazards, or at risk of infection, as far as practicable.

See Section 23I of the OSH Act.

As discussed in Section 1 of this code, the OSH Act requires that, if an employee is affected by a notifiable disease, then the employer or self-employed person must notify the WorkSafe Western Australia Commissioner as soon as possible.

See regulation 2.5 and form 2 in Schedule 2 of the OSH Regulations.

Under the OSH Regulations, an employer or self-employed person must notify the WorkSafe Western Australia Commissioner of details where they or an employee contracts Legionnaires' disease from work exposure.

The OSH Regulations also require employers to identify and assess atmospheric hazards, such as gases, vapours, dust or other airborne contaminants, and consider appropriate controls so that the safety and health of employees is not at risk. Regulation 3.39 provides some methods for reducing the risks, such as effective ventilation, or exhaust systems that remove contaminants.

See regulations 3.38 and 3.39 of the OSH Regulations.

Mines Safety and Inspection Act 1994

On mines, as defined by 'mining operations' in section 4 of the MSI Act, general duties exist for all employers (principal, contractor, hire agencies and self-employed), employees, and manufacturers. These duties are the same as those outlined in the OSH Act, and are described in Part 2 of the MSI Act.

See sections 9-15 of the MSI Act.

Further information on the 'duty of care' obligations is available from Resources Safety's *General duty of care in Western Australian mines* guideline.

Section 79 of the MSI Act requires that if a manager has reason to believe that an occurrence at the mine has the potential to cause serious injury or harm to health, the manager must inform the district inspector for the region in which the mine is situated of this occurrence even if no injury or harm has been confirmed. In addition to reporting the occurrence, the manager is required to ascertain the facts and circumstances of the events contributing to this occurrence. If there is a suspected case of an employee with Legionnaires' disease, the district inspector must be notified and an investigation into the circumstances be undertaken as soon as practicable.

Mines Safety and Inspection Regulations 1995

The MSI Regulations outline a number of general duties relating to items of plant. At a mine, there are statutory responsibilities to maintain and operate plant in a safe manner for designers, manufacturers, importers, suppliers, installers or erectors, and employers. This includes normal risk management strategies, including identification of hazards, assessment of risk, reduction of risks from exposure, provision of information to contractors and employees and record-keeping.

See regulations 6.2-6.25 of the MSI Regulations.

If an employer is advised that an employee has an occupational disease, regulation 3.39 requires that the employer notify the Mines Occupational Physician, as soon as is practicable after receiving the advice.

See regulation 3.39 of the MSI Regulations.

Regulation 9.25(2) requires that each responsible person at a mine must ensure that if cooling towers, evaporative condensers, warm water systems or other plant or devices that may promote the growth of micro-organisms are used, or proposed to be used, at the mine, precautions are taken in accordance with Australian/New Zealand Standard, *AS/NZS 3666 Air-handling and water systems of buildings – Microbial control*, to prevent the growth of such organisms. The mining industry has extensive requirements under the MSI Act and the MSI Regulations in respect to health surveillance of employees. Further information is available in a guideline on Risk-based health surveillance and biological monitoring available from the Resources Safety website at **www.dmp.wa.gov.au/ResourcesSafety**

Health Act 1911

Under the *Health Act 1911*, *Legionella* infection, including Legionnaires' disease and all other Legionellosis, is prescribed as a notifiable infectious disease.

The *Health Act 1911* provides details on who is to provide notification, and the circumstances for making the notification. For example, section 276(1) requires a medical practitioner, on the day of diagnosis of such a disease, to inform the Department of Health.

See section 276 *Health Act 1911.*

The Department will then inform the local government authority and the occupier of premises with which the patient has had contact in the last two to ten days (both homes and workplaces where applicable).

The Communicable Diseases Unit of the Department of Health advises WorkSafe of reported cases of Legionnaires' disease that can be traced to workplaces.

Health (Air-handling and Water Systems) Regulations 1994

The Health (Air-handling and Water Systems) Regulations 1994 have effect throughout Western Australia and apply to all buildings classified by the *Building Code of Australia*, with the exception of classes 1, 2 and 10 (ie domestic residences and non-habitable out-buildings).

These regulations apply to the operation and maintenance of air-handling and water systems and cooling towers whether installed before or after the gazettal date. Provisions applying to the design and installation of such systems are not, however, retrospective. The regulations adopt Australian/New Zealand Standard, *AS/NZS 3666 Air-handling and water systems in buildings – Microbial control, Parts 1 and 2,* and must be read in conjunction with this standard.

Health (Garden Soils) Regulations 1998

The Health (Garden Soil) Regulations 1998 declare garden soil to be a hazardous substance and require a warning notice to be displayed on packaging or at point of sale for unpackaged garden soil (under Schedule 1).

People dealing with potting mix or other compost materials should be familiar with the provisions of these regulations.

Appendix 2 Other sources of information

Standards Australia

Australian/New Zealand Standard, *AS/NZS 1715 Selection, use and maintenance of respiratory protective equipment*

Australian/New Zealand Standard, *AS/NZS 1716 Respiratory protective devices.*

Australian Standard, *AS 3500.4 Plumbing and drainage: Part 4 Heated water services*

Australian/New Zealand Standard, *AS/NZS 3666.1 Air-handling and water systems of buildings – Microbial control: Part 1: Design, installation and commissioning*

Australian/New Zealand Standard, *AS/NZS 3666.2 Air-handling and water systems of buildings – Microbial control: Part 2: Operation and maintenance*

Australian/New Zealand Standard, *AS/NZS 3666.3 Air-handling and water systems of buildings – Microbial control: Part 3: Performance-based maintenance of cooling water systems*

Australian Standard, *AS 3861 Spa baths*

Standards Australia Handbook, *SAA/SNZ HB32:1995 Control of microbial growth in air-handling and water systems in buildings.*

Australian and Australian/New Zealand Standards are developed and published by Standards Australia and available from SAI Global Limited.

Contact details for SAI Global Limited are available at **www.saiglobal.com**, or by telephoning 131 242.

Appendix 3 Glossary of terms

aerosols – airborne water particles less than 10 microns in diameter.

air filter – a device designed to remove particle matter from air passing through it.

air-handling system – a system designed for the purpose of directing air in a positive and controlled manner to and from specific enclosures by means of air-handling plant, ducts, plenums, air distribution devices and automatic controls. Does not include a dry system, which does not use water or other liquids to operate, humidify, clean, maintain, heat or cool the air.

biofilm – a film formed on solid surfaces and containing biological flora.

cfu – colony forming units.

cooling-tower –

a) a device for lowering the temperature of water or other liquid by evaporative cooling;

b) an evaporative condenser that incorporates a device containing a refrigerant or heat exchanger; or

c) any other liquid cooled heat rejection or liquid cooling equipment.

cooling water system – a heat exchange system comprising a heat-generating plant, a heat-rejection plant and interconnecting water recirculating pipework and associated pumps, valves and controls. Cooling water systems include cooling towers and evaporative condensers.

dead leg – a section of a water system that does not permit the circulation of water.

garden soil – any composted organic material produced with or without soil made to be used in or around a house. It includes potting mixes, composts, soil conditioners, mulches and soils for landscaping and general garden use.

hot-water system – a system designed to heat and deliver water at a temperature of at least 60°C at each outlet point.

Legionella / Legionellosis – the term denoting clinical diseases (pneumonic and non-pneumonic) caused by *Legionella* species of bacteria.

plenum – receiving chamber for air that has been heated or cooled to be distributed to inhabited areas.

ppm – parts per million, equivalent to milligrams per litre (mg/L).

proliferation – self-reproduction, or a growth in number.

tundish – a fitting into which pipework can discharge with an air gap.

warm-water system – a system designed to heat and deliver water at a temperature of less than 60°C at each outlet point.

water-cooling system – a cooling-tower (and evaporative condenser) and its associated equipment and pipework.

water system – a piped water system within a building that is designed to deliver water to outlet points.

Government of **Western Australia**
Department of **Commerce**
Department of **Mines and Petroleum**

commission for occupational safety and health

MIAC

2010
ISBN 978-1-920836-49-8
ISBN 978-1-920836-50-4 (web)

Comprehensive work safety and health information, provided by the Department of Commerce and the Department of Mines and Petroleum can be found at:
www.worksafe.wa.gov.au
and **www.dmp.wa.gov.au/ResourcesSafety**

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DP0486/2010/ July 10/ 3800