A guide to developing risk management plans for cooling tower systems

VICTORIA State Government
Health and Human Services

A guide to developing risk management plans for cooling tower systems

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Authorised and published by the Victorian Government, 1 Treasury Place, Melbourne.

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1 Introduction

This guide is designed to assist industry to develop risk management plans (RMPs) to control *Legionella* growth in cooling towers, particularly where the system is relatively simple in design and construction. *Legionella* bacteria can be spread through aerosol spray and cause outbreaks of Legionnaires' disease, a potentially fatal form of pneumonia.

The guide was originally published in 2001 as part of the Victorian *Legionella* Risk Management Strategy. It has been updated to reflect new laws and the comments of stakeholders.

1.1 *Legionella* Risk Management Strategy

In 2001, the Victorian Government developed a comprehensive strategy to reduce the incidence of Legionnaires' disease by strengthening the regulatory framework and improving the maintenance standards for cooling tower systems. The Victorian *Legionella* Risk Management Strategy has been successful in reducing the number of cases of Legionnaires' disease. The legal responsibilities of landowners and managers of cooling tower systems have been incorporated into the *Public Health and Wellbeing Act 2008* and the Public Health and Wellbeing Regulations 2009.

The key elements of the strategy remain in place today, and the Victorian Government is committed to continuing this regulatory framework. Implementing the strategy is the responsibility of the Department of Health and Human Services.

The key aspects of the strategy are to:

- ensure that cooling tower systems are maintained at a high level
- ensure that a comprehensive register of cooling tower systems is maintained
- require the owners of any land on which there is a cooling tower system to prepare and implement an RMP for the effective maintenance of the system
- require an annual audit of each RMP
- provide for inspections of cooling tower systems on the basis of risk assessment or information received through audits
- provide an outbreak investigation service through the department.

2 *Legionella* and Legionnaires' disease

Legionnaires' disease is a potentially fatal form of pneumonia caused by the bacterium *Legionella pneumophila*. *Legionella* species can also cause less serious illnesses that are not permanently debilitating. The group of infections caused by species of *Legionella* is known as legionellosis.

Legionella bacteria occur naturally in the environment. They are commonly found in lakes, rivers, creeks and soil. People usually contract Legionnaires' disease by breathing in *Legionella* bacteria in very fine droplets of water called aerosols. Artificial water systems, including showers, spa pools, fountains, car washes and cooling towers, may provide environments that allow *Legionella* bacteria to multiply in large numbers. *Legionella* can then be spread by aerosols.

The main risk factors for an outbreak of the disease are:

- the presence of *Legionella pneumophila* bacteria
- conditions suitable for multiplication of the organism, including a suitable temperature (20–50 °C), and a source of nutrients such as sludge, scale, rust, algae or other organic matter
- a means of creating and spreading breathable droplets, such as the aerosols generated by a cooling tower, shower or spa
- exposure of susceptible people to these aerosols.

2.1 Incubation period

Legionnaires' disease has an incubation period of 2–10 days. This means that symptoms do not appear until 2–10 days after a person has been exposed to *Legionella* bacteria. It also means that cases may continue to emerge for up to 10 days after the source of infection has been successfully eliminated.

2.2 Cooling tower systems and Legionnaires' disease

Cooling tower systems can provide an ideal environment for the growth of *Legionella*. This can pose a health risk to employees, contractors, customers or members of the general public who have been in or near buildings with a cooling tower.

In the past, owners of cooling tower systems usually learned of cases of Legionnaires' disease when public health officers from the department investigated possible sources of infection associated with their location.

2.3 Who is at risk?

Most people exposed to *Legionella* bacteria do not become infected. The risk of disease increases with age, especially among smokers. People with chronic medical conditions that weaken the body's immune system – including people with cancer, lung disease or diabetes, and transplant recipients – may be at increased risk of Legionnaires' disease.

2.4 Impacts on health

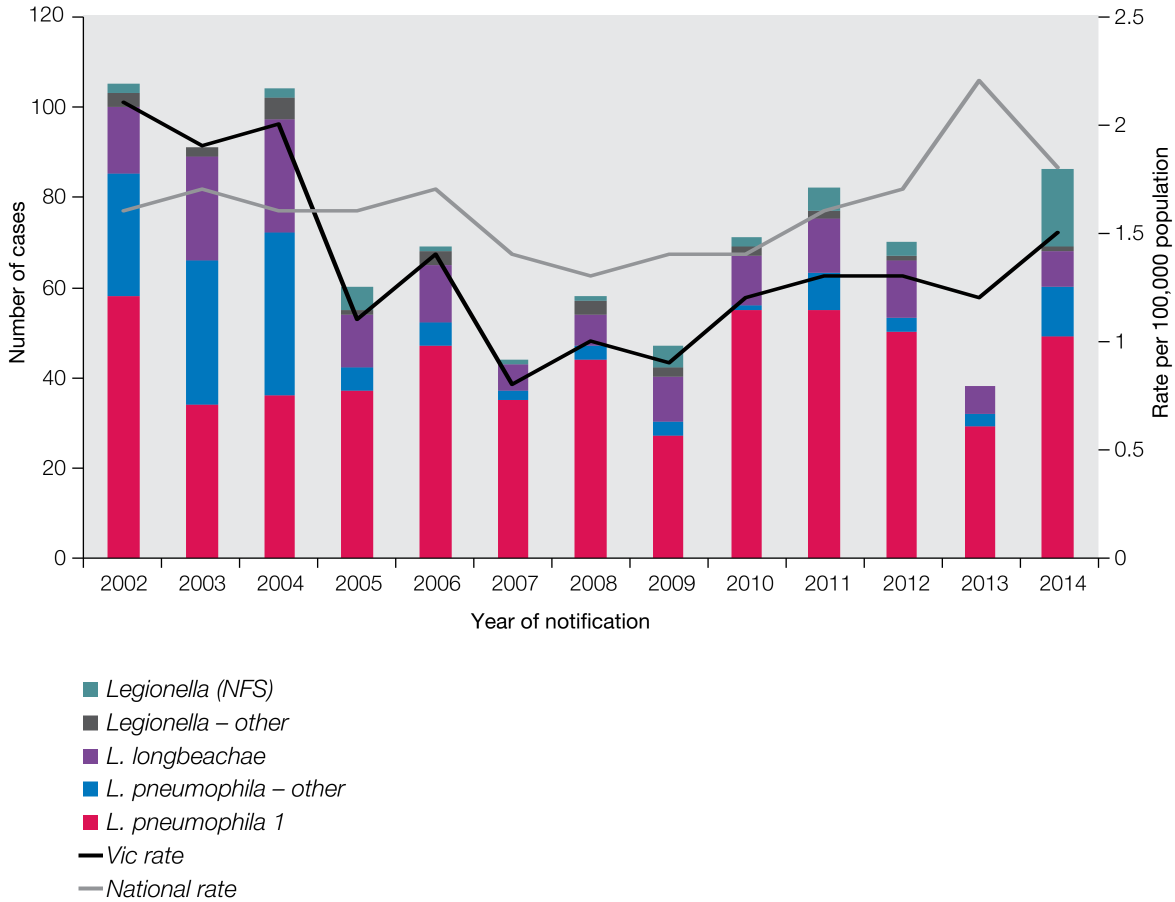
Many people with Legionnaires' disease are admitted to hospital for long periods and spend some of this time in intensive care. For a minority of sufferers, the disease is fatal. A small percentage may suffer some permanent disablement.

Since the *Legionella* Risk Management Strategy was introduced in Victoria in 2001, the number of cases of Legionnaires' disease has decreased. Since 2000, it is suspected that testing for Legionnaires' disease in patients with pneumonia-like symptoms has significantly increased as a result of increased awareness of Legionnaires' disease and the introduction of the urinary antigen test (in 1999).

The Public Health and Wellbeing Regulations 2009 require that all cases of legionellosis are notified to the Victorian Department of Health and Human Services. The department publishes these data on the internet.[1]

Figure 1 shows the incidence of legionellosis in Victoria over the past decade. *Legionella pneumophila* cases are commonly associated with cooling tower systems.

Figure 1: Notified cases of Legionellosis, Victoria, 2002–2014



* Not further specified

1 http://ideas.health.vic.gov.au/surveillance/tabulated-summaries.asp

2.5 Impacts on businesses

Outbreaks of Legionnaires' disease associated with a particular cooling tower system can have devastating effects on a business.

Owners and occupiers of land may face prosecution for not complying with the *Public Health and Wellbeing Act 2008*, the Public Health and Wellbeing Regulations 2009, and occupational health and safety legislation. Legal action for damages suffered by individuals or companies as a result of an outbreak of Legionnaires' disease is also likely.

During an outbreak, the normal operation of a business is likely to be severely disrupted. In some cases, the business may have to suspend all operations until the source of the outbreak is located and treated. Negative media attention is likely, and the business may suffer significant loss of trade and customer goodwill for a long time after the outbreak has been contained.

3 This guide

This guide has been designed to help landowners, and owners and managers of cooling towers to provide a safe environment for their staff, contractors, customers and the public, and comply with their responsibilities under Victorian law.

The guide demonstrates the relationship between the risks associated with a cooling tower system and the development of an appropriate maintenance program for that system. It will help users develop maintenance programs for cooling tower systems and improvements within an RMP framework.

The guide follows a risk management approach (see Figure 2), describing the actions necessary to meet the challenges associated with risks of Legionnaires' disease from cooling towers. Figure 3 provides further details of the risk management process, including cross-references to the relevant sections of this document.

Figure 2: Risk management approach for cooling tower systems

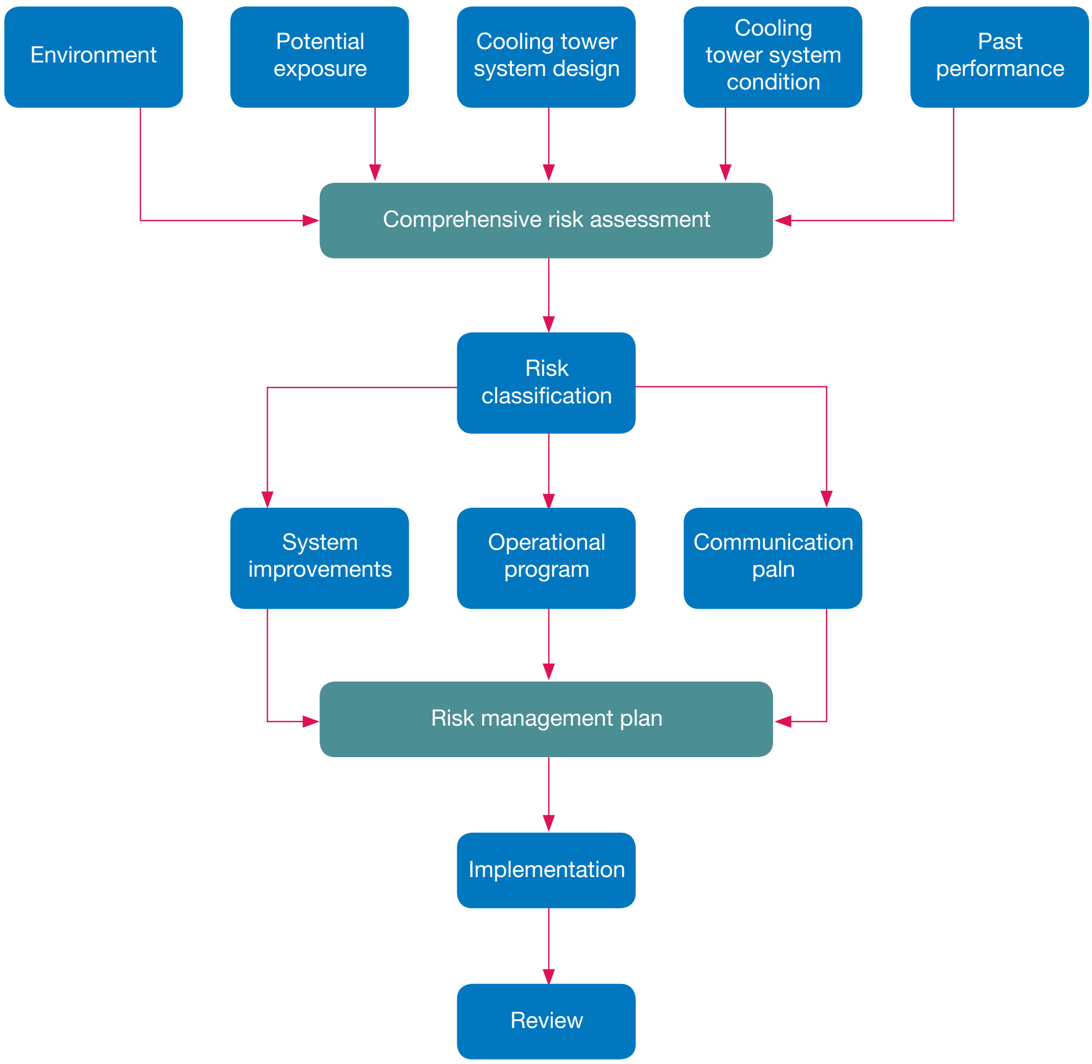
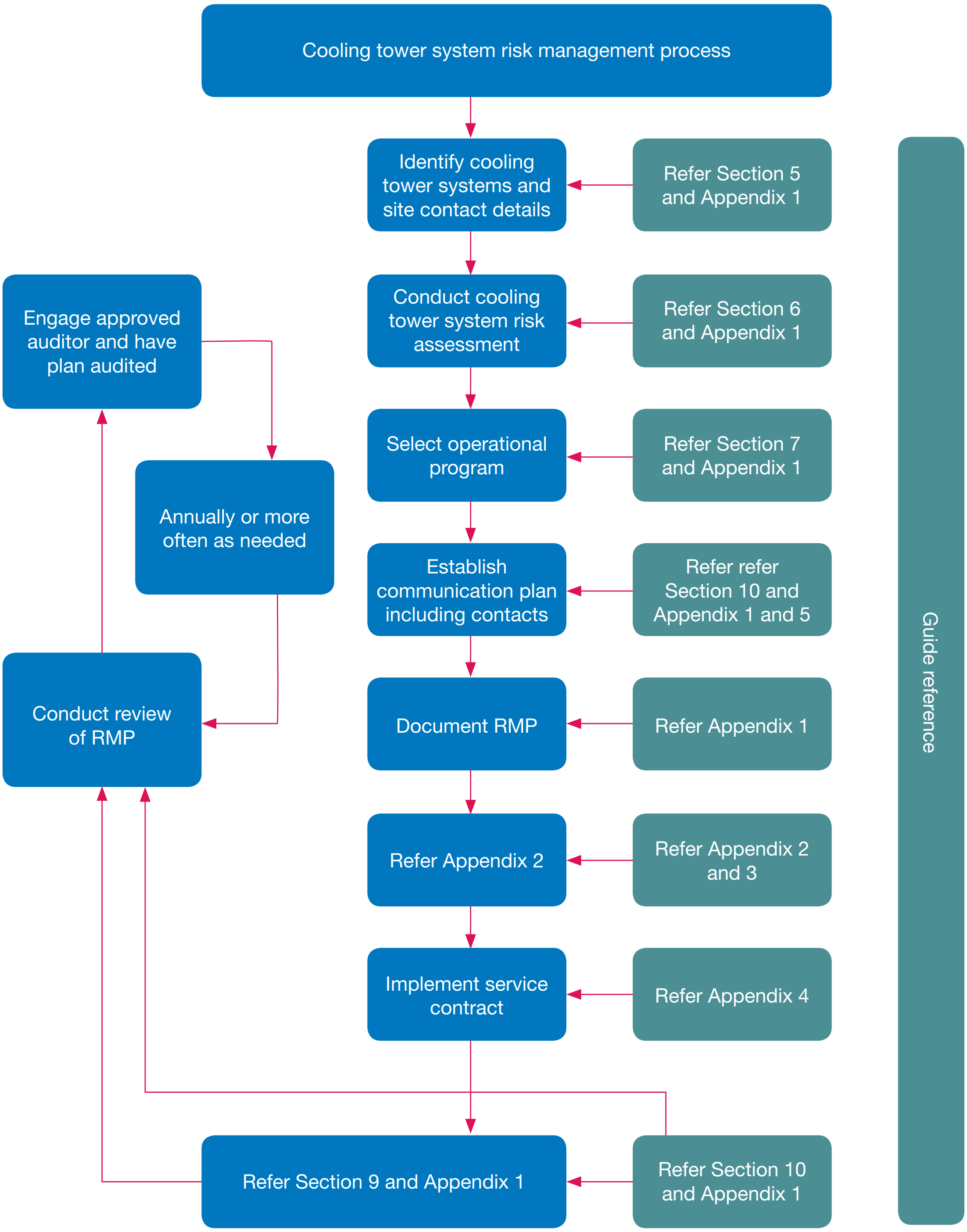


Figure 3: Risk management process for cooling tower systems



RMP = risk management plan

The methodology used to develop this guide considers:

- the **context** for cooling tower systems and *Legionella*
- the **potential** impact of an outbreak of Legionnaires' disease
- the **legal responsibilities** of site owners and those responsible for cooling tower systems
- **identification, analysis, evaluation** and **treatment** of critical risks for cooling tower systems
- **monitoring** and review of the RMP
- the importance of communication in the event of problems with a cooling tower system.

The guide incorporates an RMP template (Appendix 1) that can be filled in quickly **once the necessary information has been obtained during a comprehensive risk assessment** and decisions have been made about necessary improvements to the system.

The guide, including its appendixes and tables, is available at <www.health.vic.gov.au/legionella>.

Cooling tower system: A series of inter-connected cooling towers that form part of a cooling tower system.

4 Responsibilities

Landowners who have a cooling tower system on their property and every business that owns or operates a cooling tower system need to understand their responsibilities under Victorian law and carefully consider the risks relating to their cooling tower system and business.

We have prepared this guide and a template of an RMP to help businesses comply with Victorian law, but ultimately the responsibility rests with the owner of the land and the businesses involved to maintain a safe environment for staff, contractors, customers and the general public. The recommendations in the guide will assist owners and managers to comply with the laws, but individual business needs and environmental conditions may require different or more stringent maintenance regimes, based on individual risk assessments. The responsibilities of the various stakeholders of a cooling tower system are summarised in Appendix 2.

4.1 Responsibilities of landowners

The *Public Health and Wellbeing Act 2008* (see Section 4.4) places a number of obligations on the owner of any land on which there is a cooling tower system. These include registering that system with the department, developing an RMP and having that plan independently audited by an approved auditor.

4.2 Responsibilities of owners and managers of cooling tower systems

The Public Health and Wellbeing Regulations 2009 (see Section 4.5) describe the minimum requirements for maintaining a cooling tower system. Testing for total bacterial counts is required monthly. *Legionella* must be tested for at least 3-monthly, at a minimum; in the event of adverse results, certain immediate actions must be taken to bring the system under control.

4.3 Key challenges for owners and managers of cooling tower systems

The main challenge is to take immediate steps to minimise the risks associated with cooling tower systems on land for which owners and managers have responsibility. Several other elements, summarised below, are critical to the success of a risk management approach.

4.3.1 Commitment

In larger organisations, commitment means recognition by management that a cooling tower system is an asset requiring careful management.

4.3.2 Information gathering and forward planning

Any organisation with a cooling tower system must have adequate information on which to base its decisions. This includes:

- reviews of the cooling tower system to determine any shortfalls in design or performance
- development and implementation of an action plan or upgrade plan to address any deficiencies.

4.3.3 Control and performance measures

Organisations must develop reliable management systems – especially monitoring of performance measures such as *Legionella* testing – to ensure that the system is under effective and consistent control. Management reporting of variances from regulations or organisational targets is also important. Such reviews must look at more than just engineering solutions. They must also consider the people who may be exposed and ways to minimise their exposure.

4.3.4 Alternatives to cooling towers

The only way to eliminate the risk from Legionnaires' disease associated with a cooling tower is to remove the cooling tower. Viable alternatives to a cooling tower should be reviewed.

4.3.5 Communication

Larger organisations need to carefully consider the contractual relationships between the landowner and those involved in managing and maintaining a building. It is critical that communication between the parties about safety-related matters is clear and rapid.

The final key challenge is to raise employee awareness about the cooling tower system and the programs in place to minimise the risks. This must include the development of communication plans detailing who will be informed if *Legionella* is detected in the cooling tower system.

4.4 *Public Health and Wellbeing Act 2008*

The *Public Health and Wellbeing Act 2008* requires the owner of land on which there is a cooling tower system to:

- register each cooling tower system with the department. Registration periods are 1, 2 or 3 years, and there is a fee associated with registration. For more information on registration, see the website[2]
- prepare and implement an RMP for every cooling tower system on the site, which addresses the following critical risk factors
  - **stagnant water**, including lack of water recirculation in the cooling tower system, and the presence of dead-end pipework and other fittings in the system
  - **nutrient growth**, including the presence of biofilm, algae and protozoa in the cooling tower system; water temperature within a range that will support rapid growth of microorganisms in the system; and exposure of the water in the system to direct sunlight
  - **poor water quality** in the cooling tower system, including the presence of solids, *Legionella* and high levels of microorganisms
  - **deficiencies in the cooling tower**, including deficiencies in the physical design, condition and maintenance of the system
  - **location of, and public access to, the cooling tower or cooling tower system**, including the potential for environmental contamination of the system and exposure of people to the aerosols of the system
- have the RMP independently audited every year to confirm that it addresses the risk factors described in the Public Health and Wellbeing Regulations 2009, and the critical risks in relevant Australian standards. The audit must also confirm that there is documented evidence that the plan is being satisfactorily implemented
- review the RMP at least once every year.

2 www.health.vic.gov.au/legionella

Under the Act, the registration holder must advise the department within 30 days of the:

- addition of a cooling tower to the system or removal of a cooling tower from the system
- removal or permanent decommissioning of the system (see Appendix 3)
- relocation of the system on the lot of land on which it stands.

The maximum penalty for failing to register a cooling tower system is 120 penalty units for an individual and 600 penalty units for a body corporate. The maximum penalty for failing to prepare an RMP is 60 penalty units for an individual and 300 penalty units for a body corporate. Penalty units are updated annually; in 2014–15, the value of a penalty unit was $147.61.

4.5 Public Health and Wellbeing Regulations 2009

The Public Health and Wellbeing Regulations 2009 require the person who owns, manages or controls a cooling tower system to ensure the following with regard to system maintenance:

- The system is maintained and tested as described in part 7 of the Regulations, unless it is shut down or is otherwise not in use.
- The water in the system is continuously treated with one or more biocides to effectively control the growth of microorganisms, including *Legionella*. It must also be treated with a biodispersant, and other chemicals to minimise fouling, formation of scale and corrosion.
- A chlorine-compatible biodispersant is added to the recirculating water of the system, and the system is disinfected, cleaned and re-disinfected
  - immediately before initial start-up following commissioning or any shut-down period of more than 1 month
  - at least every 6 months.
- The system is inspected at least monthly to ensure that it is operating without defects.
- The water in the system is tested by a laboratory for heterotrophic colony count (HCC) at least monthly and for *Legionella* every 3 months.
- Maintenance and testing records are kept for 12 months, and can be produced for an authorised officer[3] from the department on request.

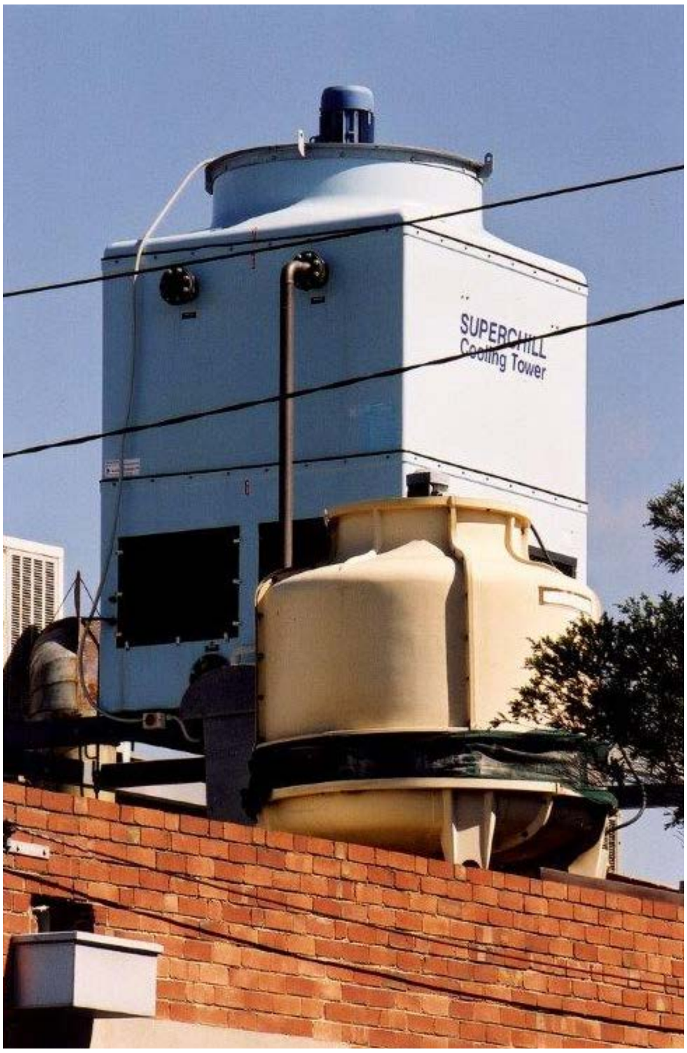
The regulations require that action is taken in response to an HCC result of more than 200,000 colony forming units per millilitre (CFU/mL) or to the detection of *Legionella* in a sample taken from the cooling tower system. The actions are summarised in Appendix 4, Figures A1–A3. It is an offence to not comply with these requirements.

3 The department's authorised officers have been specifically appointed for the purposes of the *Public Health and Wellbeing Act 2008*. Authorised officers must be suitably qualified and trained to perform their roles in enforcing the requirements of the Act and the Public Health and Wellbeing Regulations 2009 in relation to cooling tower systems. Authorised officers carry an identity card that contains their photograph and signature, and is signed by a delegate of the Secretary to the Department of Health and Human Services.

4.6 Plumbing Regulations 2008

The Plumbing Regulations 2008, among other things, set out requirements for the installation of cooling tower systems and licensing requirements for plumbers working on cooling tower systems.

The Plumbing Code of Australia is adopted by, and forms part of, the Plumbing Regulations 2008. Part E1 of the code specifies the objectives and performance requirements relating to the installation of heating, ventilation and air-conditioning systems. Australian/NewZealand Standard AS/NZS 3666.1 (*Air-handling and water systems of buildings – Microbial control – Design, installation and commissioning*), is a 'deemed to satisfy' document listed in Part E1 of the Plumbing Code of Australia and contains a section on 'Design, installation and commissioning of cooling water systems'.



Cooling towers on a rooftop: The tower in the foreground is of fibreglass construction and is often described as a bottle tower. The larger tower at rear is made of metal. Both are induced draught counter flow towers.

5 Risk management

Risk management is an integral part of good management practice. It is an iterative or continuous improvement process, consisting of steps undertaken in sequence, to enable continual improvement.

5.1 Advantages

The main advantages of risk management are that it:

- is a consistent, auditable record of the reasons and rationale for decisions taken
- is a logical way to review the operation and assess which critical areas require further investigation
- allows monitoring of critical risk factors
- is a way to achieve sustained compliance with legislative requirements.

5.2 Development of risk management plans

Many organisations with more complicated systems will decide to engage third parties, such as consultant engineers and water treatment specialists, to perform a risk assessment, and develop the RMP and a risk-based maintenance program. Additional assistance can also be sought to manage operation of the cooling tower system. The risk assessment for a highly complex system can best be performed in consultation with people such as:

- system designers
- cooling tower suppliers
- mechanical services maintenance contractors
- water treatment providers
- mechanical engineers
- occupational hygienists
- building and system owners.

In the absence of on-site expertise, it is essential that specialists in the treatment of cooling tower systems are engaged to provide and monitor appropriate water treatment.

The key competencies for individuals involved in the development of an RMP include an understanding of:

- system design and components
- water chemistry and water treatment principles, including corrosion control
- risk management principles.

As with all outsourcing of services, it is important to confirm that contractors hold adequate professional and public liability insurance.

5.3 Integration with quality assurance programs

Many organisations follow formal quality assurance programs such as the ISO 9000 series (Quality management systems), the ISO 14000 series (Environmental management systems) and AS 4804 (Occupational health and safety management systems). Where appropriate, development of an RMP should ideally be integrated into these programs. Businesses considering this approach should note that it may make the auditing of the RMP more complex than if it were a separate document.

This guide follows a typical risk management approach:

- establishing the context (strategic, organisational, risk management, risk evaluation criteria)
- identifying risks
- analysing risks
- evaluating risks
- treating risks
- monitoring and review
- communication and consultation.

5.3.1 SafetyMAP

SafetyMAP[4] is an audit tool designed to assist organisations of all sizes and functions to improve their management of health and safety. The audit criteria within SafetyMAP enable an organisation to:

- measure the performance of health and safety programs
- implement a cycle of continuous improvement
- benchmark its health and safety performance
- gain recognition for the standards achieved by its health and safety management system.

In the ‘Self assessment user guide’ for the initial level of SafetyMAP, cooling tower systems should be included in the risk assessment, since they are a potential hazard. Cooling tower systems must be assessed and should have documented control measures.

4 www.worksafe.vic.gov.au/safety-and-prevention/health-and-safety-topics/safetymap-safety-management-achievement-program

6 Identifying and analysing *Legionella* risks

During the normal operation of a cooling tower, aerosols are formed and then carried into the environment through the tower exhaust. If *Legionella* bacteria are present in the water of the cooling tower system, breathing these aerosols can result in infection.

6.1 Types of cooling towers

Cooling tower systems are normally associated with air-conditioning systems, refrigeration systems and industrial processes. The basic function of the system is to remove heat (see Figure 4). Cooling tower systems temporarily store water, which is usually recirculated, in a basin. The water is sprayed or dripped into a large chamber. Air is forced through this chamber by a thermostatically controlled fan.

Discharges from cooling towers are normally warm and humid; sometimes steam can be observed as condensation.

Figure 4: Mechanism of heat exchange in a cooling tower

The typical layout of air-conditioning systems that use cooling towers is shown in Figure 5. These cooling towers contain fill material inside the tower. Usually made of plastic, this material allows the falling water to spread over a greater area, which increases the surface area of the water to be cooled and allows more effective cooling.

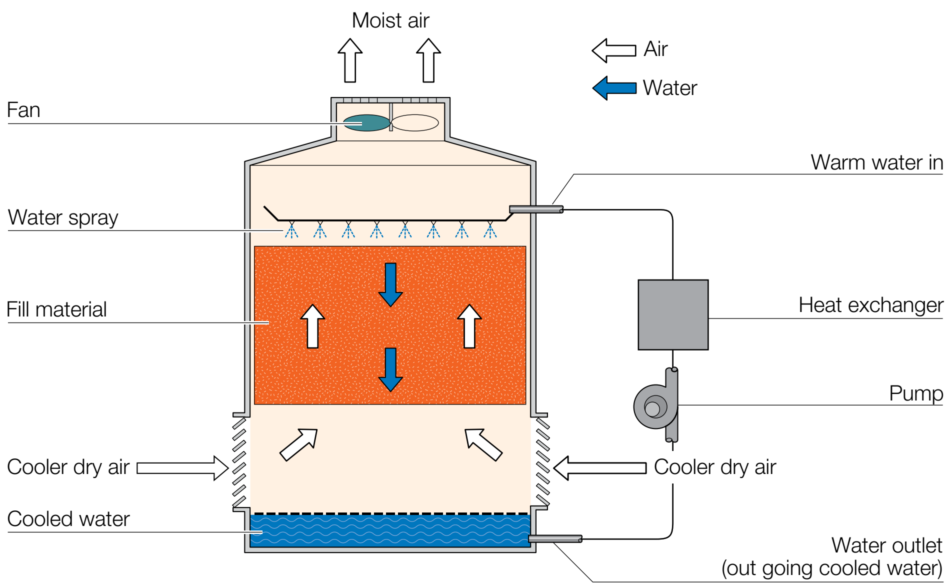
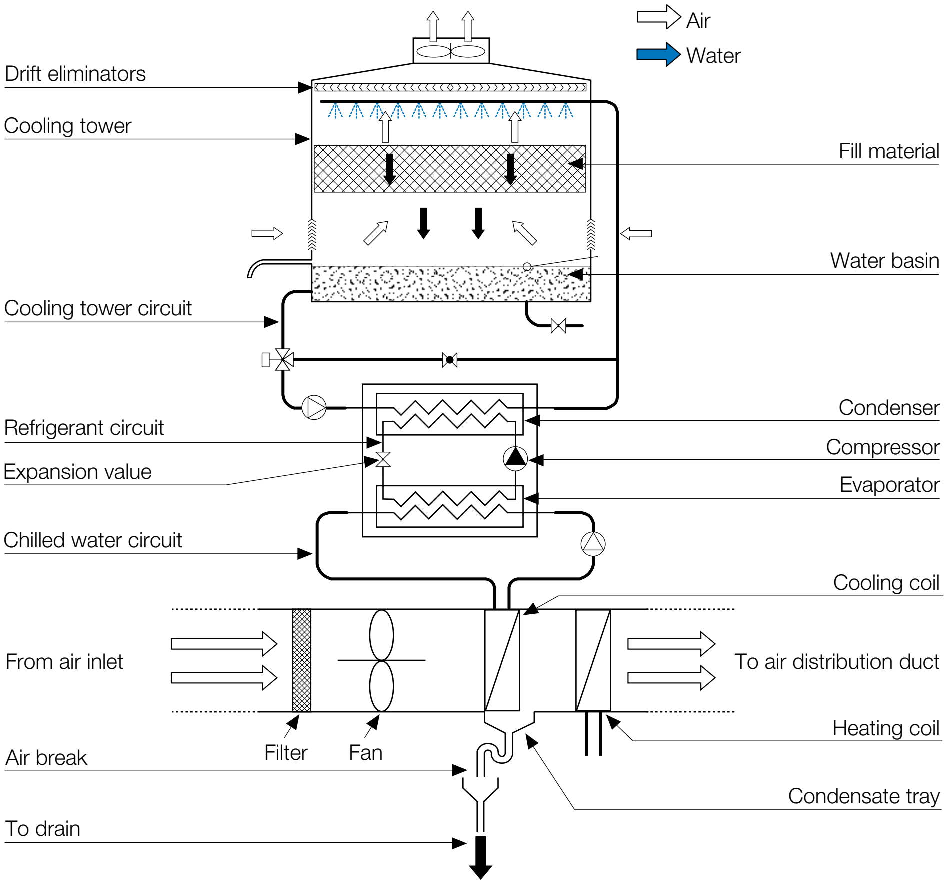


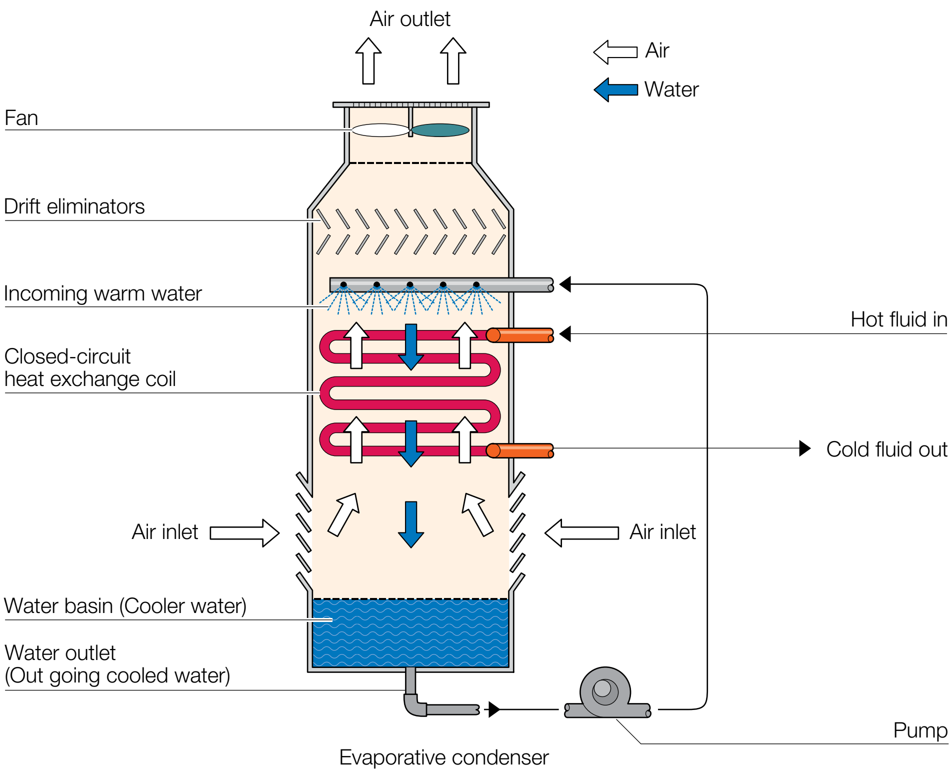
Figure 5: Typical layout of an air-conditioning system



Industrial processes often have a device called an evaporative condenser to eject heat from the process. These units work in a similar manner to cooling towers. The cooled water is distributed over a series of pipes that contain circulating refrigerants or other fluids. Unlike cooling towers, evaporative condensers do not contain any fill material. These systems also present risks for Legionnaires' disease and fall within the definition of 'cooling tower' used in the *Public Health and Wellbeing Act 2008* and the Public Health and Wellbeing Regulations 2009.

The design of a typical evaporative condenser is shown in Figure 6.

Figure 6: Typical layout of an evaporative condenser



Evaporative Cooler: These units have not been linked to cases of Legionnaires' disease

Cooling towers are often confused with evaporative coolers. An evaporative cooler uses the same general principle of recycling water. The main difference is that cooling towers use air to cool the water, whereas evaporative coolers use water to cool the air. The definition of a cooling tower in the Public Health and Wellbeing Regulations 2009 clearly states that evaporative air coolers and evaporative air-conditioners are not cooling towers.

There has been no evidence linking evaporative coolers or evaporative air-conditioners to cases of Legionnaires' disease.

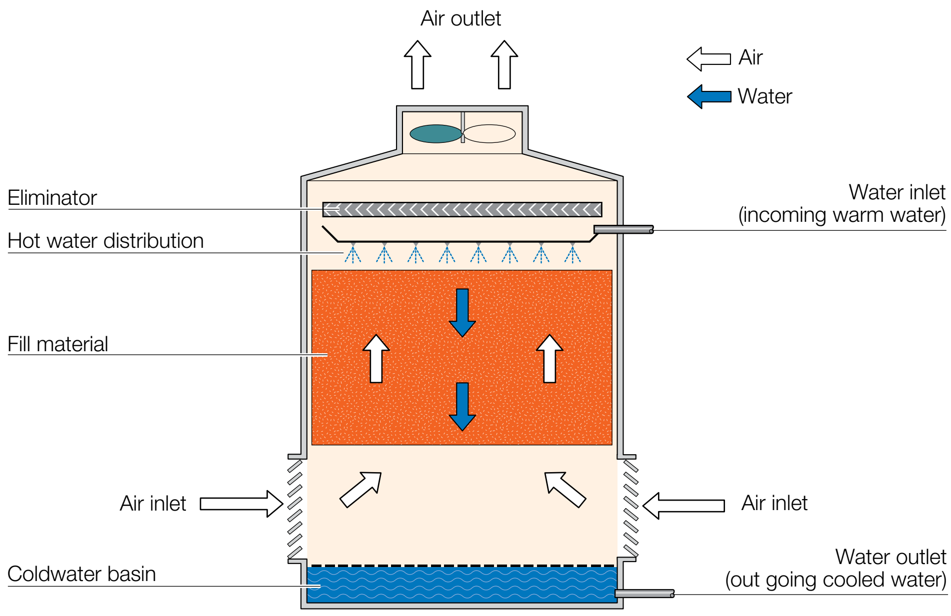
Cooling towers may be found on rooftops; in plant rooms, basements and mezzanines; and at ground level. There are four types of cooling tower, which are described in the following sections.

6.2.1 Induced draught counter-flow

Induced draught counter-flow towers are very common. They can be identified by the fan at the top of the tower. The fan pulls air up through the tower in the opposite direction to which the water is falling. The air usually enters the tower through inlet louvres on the sides of the tower. Water is usually delivered by means of fixed or rotating spray arms. Drift eliminators are usually placed above the sprays to prevent loss of water through drift.

Figure 7 shows a schematic of these types of cooling towers.

Figure 7: Induced draught counter-flow cooling tower



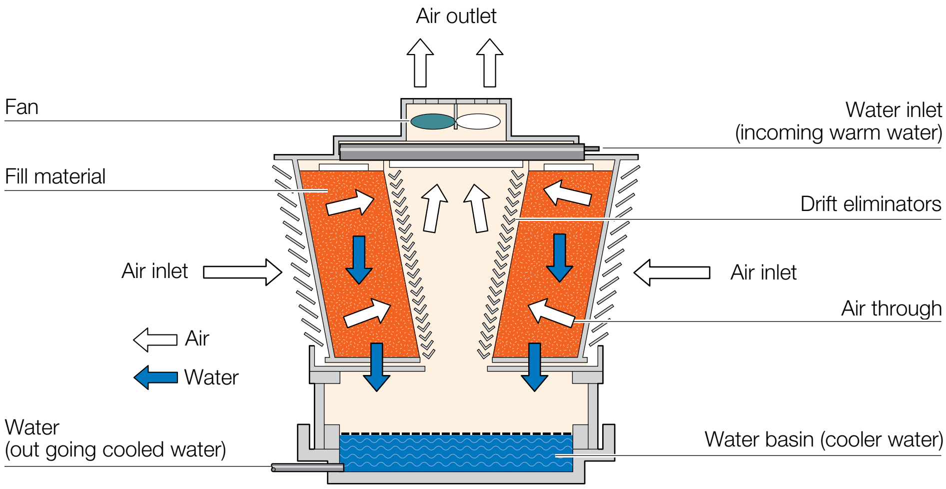
Induced draught counter flow cooling tower

6.2.2 Induced draught cross-flow

In an induced draught cross-flow cooling tower, the fan is also mounted on the top. However, the fan draws (induces) the air across the water falling from the top of the tower to the basin.

Figure 8 shows a schematic of these types of cooling towers.

Figure 8: Induced draught cross-flow cooling tower



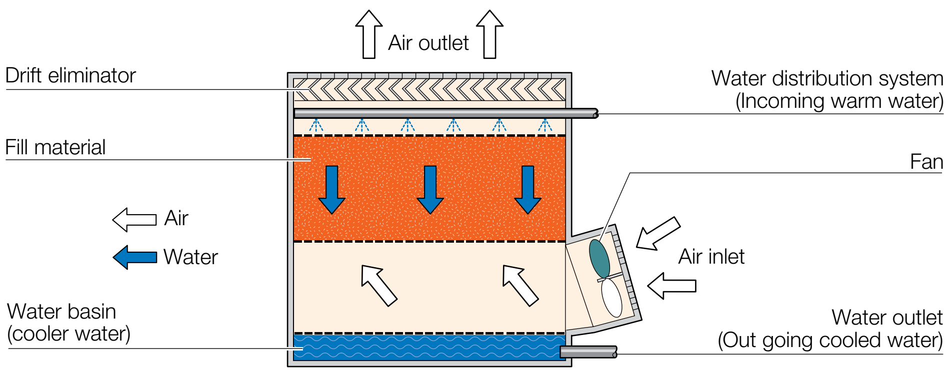
Induced draught cross-flow cooling tower

6.2.3 Forced draught counter-flow

In a forced draught counter-flow cooling tower, the fan is located at the air inlet just above the basin. Air is forced vertically through the tower fill in the opposite direction to the water flow. The air is forced out through the top of the tower.

Figure 9 shows a schematic of these types of cooling towers.

Figure 9: Forced draught counter-flow cooling tower



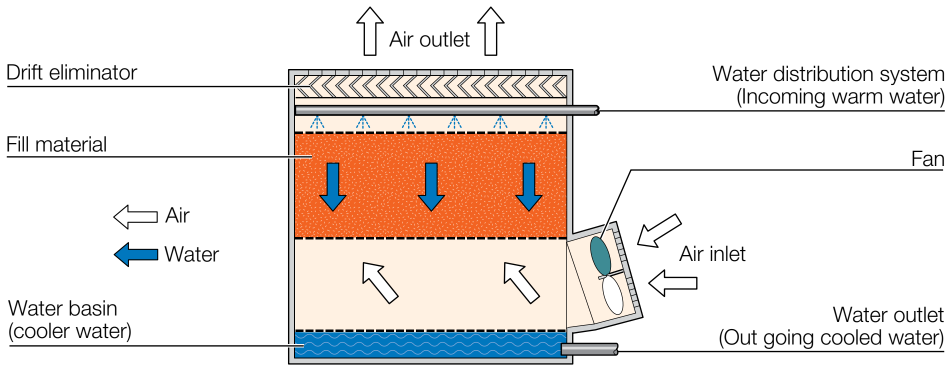
Forced draught counter flowcooling tower

6.2.4 Forced draught cross-flow

In a forced draught cross-flow cooling tower, the fan is mounted on one side and pushes the air in a cross-flow manner past the falling water.

Figure 10 shows a schematic of these types of cooling towers.

Figure 10: Forced draught cross-flow cooling tower



Forced draught counter flowcooling tower

6.2 Why outbreaks happen

Cases of Legionnaires' disease associated with a cooling tower system usually occur when a number of conditions are met. First, *Legionella* enters the cooling tower system, presumably from the water supply. The bacteria then multiply as a result of one or more of the following scenarios:

- failure to treat the water to an adequate standard, which can be due to
  - a lack or breakdown of a regular treatment schedule or system equipment
  - human error
- environmental contamination of the cooling tower water – for example, by airborne dust from nearby construction works
- poor design or location of the cooling tower system
- inadequate or non-existent maintenance (including plans for replacement of ageing cooling tower systems).

The final step in the outbreak pathway is exposure of susceptible people to the *Legionella*-contaminated droplets generated by the cooling tower system. This is often associated with favourable weather conditions, such as warm and windless days that typically occur in autumn in Victoria.

6.3 Critical risks for cooling towers

The development of an RMP that considers all these factors can be very complex, so we have identified the following five most critical risks associated with outbreaks of Legionnaires' disease from cooling tower systems:

- stagnant water
- nutrient growth
- poor water quality
- deficiencies in the cooling tower system
- location of, and public access to, cooling tower systems.

The *Public Health and Wellbeing Act 2008* and the Public Health and Wellbeing Regulations 2009 require each of these critical risks to be addressed in the RMP. Failure to do so will result in the independent accredited auditor being forced to fail the RMP and advise the department of the issue. Similarly, if the RMP does address the critical risks but is not implemented, or the RMP has not been reviewed in the 12 months before the audit, the auditor will also have no choice but to fail the RMP and advise the department. Addressing these risks will significantly reduce the likelihood of the cooling tower system contributing to an outbreak of Legionnaires' disease.

6.3.1 Stagnant water

The Regulations describe the risks associated with stagnant water as the lack of water recirculation in the system, and the presence of dead-end pipework and other fittings in a cooling tower system. Dead-end pipework is sometimes known as 'dead legs'.

Stagnant water is a risk because:

- a lack of circulation will allow solids in the water system to settle out as sludge –this sludge is implicated in the growth of *Legionella* (as discussed in Section 6.4.2) and also causes corrosion
- any biocide added to the system will not reach all parts of the system in sufficient concentration to kill the bacteria. A reservoir of *Legionella* can develop in the biofilm (which is a combination of bacteria, algae, protozoa – including amoebae – and other microorganisms). This *Legionella* can then reinfect the entire system when the biocide levels drop.

Stagnant water often occurs:

- if a cooling tower system is not used for periods of more than a month
- where the system has disused or superfluous pipes (dead legs) full of water
- where the system has pipes full of water with little or no flow or turbulence.

The way that a cooling tower system is used is significant. The start-up time for a cooling tower is a critical period and must be handled well to prevent problems occurring. Well-maintained cooling tower systems that are in use for most of the year are generally of lower risk than those that remain idle for more than a month. This is because the biofilm is readily disturbed when operations stop and start.

If the system's circulation is shut down for a month or more, the water may become stagnant. The risk of problems when the system is next turned on increases significantly because *Legionella* may have grown in the stagnant conditions, if the biocide has not reached all parts of the system.

The lack of a recirculating pump controlled by a timer to circulate water through the system at times when the tower is not in use can be a key contributor to stagnant water.

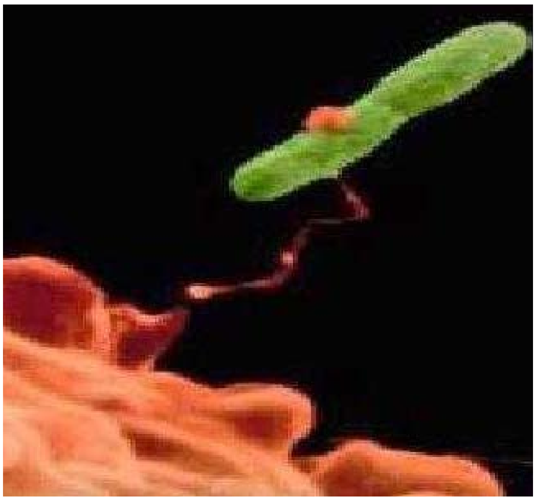
Similarly, if a tower system has dead legs, even with a high-quality maintenance program it may not be possible to consistently meet the desired standards. This is often because a biocide may not reach all extremities of the system, allowing *Legionella* to grow and potentially regularly reinfect the system.

6.3.2 Nutrient growth

According to the Regulations, nutrient growth risks include:

- the presence of algae, biofilm and protozoa
- water temperature within a range that will support rapid growth of microorganisms
- the exposure of the water to direct sunlight.

The amount of nutrients in the water needs to be controlled because it has a significant effect on the ability of bacteria to grow rapidly. The more nutrients are in the water, the more 'food' there is for bacteria.



Hiding out: *Legionella* bacterium being engulfed by an amoeba

Environmental contamination can cause nutrients to enter a cooling tower system. Dust generated on-site or off-site may enter the cooling tower system and provide a steady source of nutrients for bacteria and other organsims. Building demolition or construction, major roads, dirt roads and car parks may all generate dust. Other sources of nutrients include leaf litter from overhanging trees, bird droppings falling into the cooling tower and kitchen exhausts.

Algae, biofilm, protozoa and corrosion all have the ability to conceal and protect *Legionella* from biocides in the water, increasing the risk posed by the cooling tower system.

Algae can grow rapidly if the cooling tower water is exposed to sunlight. This most commonly happens when the tower basin or other wetted areas, such as the top wet deck of some types of cooling towers, are exposed to sunlight. Other types of cooling towers often have no sunlight protection for the tower basin. Inspection openings may be missing and therefore expose the fill to sunlight. Any algal growth will provide a food source for bacteria, including *Legionella*.

The control of biofilm is fundamental to minimising risks from *Legionella* in a cooling tower system. Biofilm can form on any of the wetted surfaces of the cooling tower system. *Legionella* bacteria are relatively easily killed by moderate concentrations of many biocides, provided that the bacteria are free-floating in the water and exposed to the biocide. However, *Legionella* has adapted to survive under adverse conditions, and has the ability to live and multiply within protozoans. These engulf the *Legionella* bacteria, which continue to grow and multiply inside the larger organism. Protozoa can resist much higher concentrations of biocides than *Legionella*, and the *Legionella* can survive inside the protozoa, particularly when the larger organism has become part of the biofilm typically found on the inside of pipes and other wetted surfaces. The biofilm may peel away from the pipe surface for a range of reasons, including physical disturbance. This can result in release of *Legionella* bacteria into the recirculating water and their discharge out of the tower within water aerosols before they can be killed by biocide.

Biodispersants, which are low-foaming detergents, are used to break down biofilm. Systems in which biodispersants are not present are at significantly higher risk of nutrient growth and biofilm formation.

Corrosion is also a risk factor, because any corrosion in the system may release iron, which is a growth factor for *Legionella*. Internal surfaces of a cooling tower system may become heavily corroded unless anticorrosion chemicals are used and corrosion levels are monitored carefully.

The temperature of the recirculating water can effect nutrient growth. It is impossible to eliminate bacteria from a cooling tower system, and water temperature will be a factor in bacterial growth rates.

6.3.3 Poor water quality

Poor water quality covers seven risk factors:[5]

- presence of *Legionella*
- *Legionella* concentration
- presence of other heterotrophic bacteria
- water quality and properties
  - cleanliness
  - presence of corrosion products
  - presence of scale and fouling
  - conductivity/total dissolved salts
  - control limits out of range
  - suspended solids (e.g. from nearby construction work)
  - control of water treatment chemicals
  - control of bleed
- presence of protozoa and algae
- characteristics of make-up water
- microbial control program.

Poor water quality is a risk because it has a direct effect on the likelihood of *Legionella* multiplying in a cooling tower system. Among other things, water quality is affected by:

- external contamination of the water with dust or soil
- accumulation of solids in the system
- the choice and levels of biocides and anticorrosives
- the presence of high levels of bacteria, including *Legionella*
- the presence of nutrients supporting microbiological growth.

Systems that do not have a comprehensive water treatment program or are not monitored for bacterial levels are significantly more likely to have poor water quality.

5 AS/NZS 3666.3:2011 (Air-handling and water systems of buildings – Microbial control – Performance-based maintenance of cooling water systems)

6.3.4 Deficiencies in the cooling tower system

Deficiencies in a cooling tower system cover five risk factors:[6]

- system size
- system design (surface area available for biofilm development compared with water volume)
- physical condition of the system
- open systems
- aerosol generation
- drift elimination.

A cooling tower system that is poorly designed or maintained is a risk because:

- high water temperature allows rapid bacterial growth
- aerosols that may be contaminated with *Legionella* can more easily leave the tower
- unsafe conditions – such as non-existent, unstable or rusted climbing ladders – pose a risk to people who need to access the tower to clean and maintain it; a safe working environment will promote better cleaning and reduce the risk of *Legionella* growth.

The physical design, maintenance and operating performance of the tower and related system can have a significant impact on the potential risk of *Legionella* transmission. If the system is undersized and water temperature is too high, the potential for rapid bacterial growth is greater. System size is important because towers with low water volume will have a high water turnover, and the biocide is less likely to be effective. The choice and concentration of biocide need to be matched to the water volume.

The risk of aerosol distribution is much greater without design modifications such as fitting of an effective drift eliminator.

6.3.5 Location of, and public access to, cooling towers

The location of, and public access to, cooling towers cover two risk factors:7

- system location
- aerosol dispersion.

A poorly located tower can be subject to environmental contamination – for example, from building sites; this can increase the level of nutrients and thus the number of bacteria, including *Legionella*. In addition, if a cooling tower system is located in an area where large numbers of people have access, this can be a problem if the system becomes contaminated with *Legionella* because all of these people will be potentially exposed; if the people exposed to the tower are from a susceptible group, the risk will be higher.

6 AS/NZS 3666.3:2011 (Air-handling and water systems of buildings – Microbial control – Performance-based maintenance of cooling water systems)

7 AS/NZS 3666.3:2011 (Air-handling and water systems of buildings – Microbial control – Performance-based maintenance of cooling water systems)

The extent to which people are exposed to aerosols is an important factor when assessing the risks associated with a cooling tower system. Steps involved in this assessment are as follows:

- Consider whether the tower is located in or near an acute health or aged residential care facility. This is important because the residents of these types of facilities are highly susceptible and most at risk of serious health consequences from an outbreak of Legionnaires' disease.
- Estimate the number of people who are in close proximity to the tower during a day. The number of people who may be exposed to the tower aerosols will affect the size of an outbreak and is therefore a significant consideration in a risk assessment. Look closely around the immediate area of the cooling towers; they are sometimes located close to heavily trafficked areas, such as footpaths or roads. Some workplaces allow smokers to leave the building to smoke. Monitor the area around each cooling tower to ensure that it is not an area where smokers congregate. This is a high-risk situation because of the evidence that smoking is a risk factor for Legionnaires' disease.

7 Evaluating the critical risks

Section 6 identified and analysed the critical risks. In this section, we evaluate these risks.

7.1 Risk classification criteria

The critical risks described in the Section 6 can, if worked through carefully, allow an accurate judgement to be made about the quality of a cooling tower system. A further process is needed to turn that judgement into an estimate of the overall risk.

To simplify an otherwise complex task requiring significant knowledge of risk management, some critical questions are suggested that relate directly to the critical risks. These questions should be answered for every cooling tower system, to help evaluate the overall risks. This approach is particularly suitable for small installations, where access to risk management specialists is not readily available.

The end result of this risk evaluation is a recommendation on how to classify the cooling tower system. In Section 8, this recommendation is used to help owners and managers treat these risks and develop an operational program.

Cooling tower with basin exposed to sunlight: This cooling tower does not have sunlight protection to the side and basin of the tower

7.1.1 Stagnant water

Is the cooling tower system (or part of the system) idle for more than a month?

The way that the tower system is used is important. Lack of water circulation is likely to result in solids in the system settling out as sludge. This may encourage the formation of biofilm. Lack of circulation will also almost certainly mean that any biocides or other chemicals being added will not reach all parts of the system. Well-maintained systems that are in use for most of the year are generally of lower risk than systems that are intermittently used. Cooling tower systems used in conjunction with air-conditioning systems are commonly shut down over winter, creating potential dead legs.

Where the system (or part of the system) is idle for more than a month, is a recirculating pump with a timer fitted to automatically circulate the water at regular intervals, to prevent it becoming stagnant?

Fitting a recirculation pump to move the water around all parts of the system is an effective risk reduction strategy in these situations.

Are dead legs present?

Dead legs in a cooling tower system are pipes that are full of water, but have little or no flow through them. A potential dead leg is any pipe that branches off from another main pipe and has a length longer than the internal diameter of the main pipe. Other components of a cooling tower system, such as off-line chillers or stand-by pumps, may also potentially become dead legs.

Dead legs have been linked to consistent problems with maintaining water quality and with the presence of *Legionella*, because of the difficulty in killing *Legionella* in such areas. Biocide added to one part of the system is unlikely to reach all parts of the system to control bacterial growth. Also, a lack of flow through the system will allow solids in the water to settle out in the pipe as sludge.

7.1.2 Nutrient growth

Are there factors in and around the site that may lead to environmental contamination and an increase in the level of nutrients in the cooling tower system?

Environmental contamination provides nutrients that can encourage more rapid bacterial growth. The introduction of high levels of solids will also reduce the effect of biocides. The site should be inspected to identify potential nutrient sources.

Nutrients may be introduced through dust from building demolition or construction sites, heavy traffic, unsealed roads or carparks, trees or other vegetation, and birds or other animals. Once identified, this can be taken into consideration in developing the RMP.

Is there a corrosion control program?

Without adequate corrosion control, iron may be released as a product of corrosion, encouraging *Legionella* to grow.

A good corrosion control program will include both the continuous addition of anticorrosion chemicals and close monitoring of the impact of the recirculating water on the metal surfaces of the tower system. This is generally done by regular inspection (at least quarterly) of test plates, called corrosion coupons, which are made of identical metals to those used in the system. Under some circumstances, chemical testing to measure the concentration of copper and iron in solution is used as a supplement to the use of corrosion coupons. It is also important to regularly (annually) inspect components such as condensers for corrosion.

Are any of the wetted surfaces exposed to sunlight?

A physical check of the cooling tower should confirm whether any of the wetted surfaces, including the water in the basin, wet deck (if present) and fill, are exposed to sunlight.

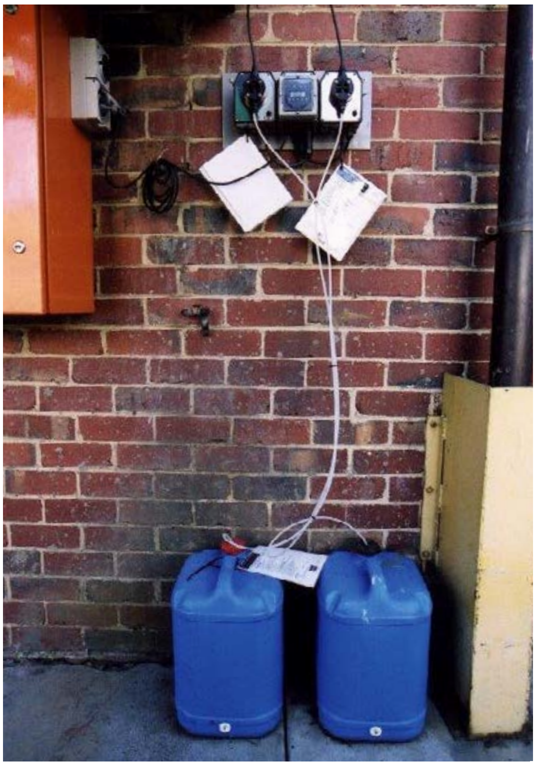
Is a biodispersant used?

Biodspersants should be applied to continually break down biofilm as it forms. Biodispersants need to be compatible with the other chemicals that are used.

7.1.3 Poor water quality

Has an automated biocide dosing device been fitted?

Siphon devices intended to deliver biocide into the cooling tower water are not recommended because they regularly block up – as a result, biocide may not be delivered to the cooling tower water. Manual dosing is also not recommended because it is totally reliant on operator reliability and quality. The department recommends use of a modern automated biocide dosing device to deliver a preset amount of biocide (and other chemicals) into the recirculating water at regular intervals, ensuring that the water is continuously treated. Various types of automated devices are available; the department recommends a type that monitors chemical parameters and adds varying amounts of biocide, depending on the water quality. Modern dosing systems can also detect some problems with the system and alert system managers through audible or visual alarms, which can be incorporated into building management systems and personal electronic devices.



Automated biocide dosing: This device has a timer which controls a pump to inject a pre-set volume of biocide into the water

As with any method of biocide dosing, the total water volume of the system must be calculated to ensure that the correct amount of biocide is used to obtain the concentration required to kill *Legionella* (as recommended by the manufacturer). This concentration will vary, depending on the biocide. Automated biocide dosing devices with poorly calculated dosing will not be effective.

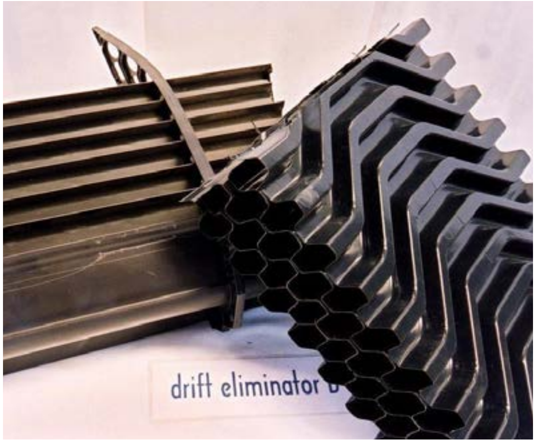
Is a comprehensive water treatment program in place?

A comprehensive water treatment program usually includes the use of:

- two or more biocides in combination, to reduce the likelihood of *Legionella* becoming resistant to a particular biocide – they must be used in the appropriate concentrations, and at least one must be proven to be effective in controlling *Legionella*
- a biodispersant compatible with the chemicals in use (including chlorine)
- chemicals or other agents to effectively minimise scale formation, corrosion and fouling
- performance indicators relevant to the water treatment process involved, monitored very frequently, which collectively inspire confidence that the chemistry of the cooling tower system water is under effective control – the measures may address parameters such as the concentration of biocides, levels of solids, conductivity, pH and water clarity
- effective biocide dosing to maximise the impact of the biocides.

7.1.4 Deficiencies in the cooling tower system

Is a modern, high-efficiency drift eliminator fitted to all cooling towers in the system?



Drift eliminator: This shows a typical modern drift eliminator

Cooling towers that are not fitted with an effective drift eliminator present a higher risk of an outbreak of Legionnaires' disease in the event that the water treatment regime fails. If the water treatment fails or is ineffective, aerosols leaving the cooling tower can contain *Legionella*. A drift eliminator fitted and installed to comply with Australian Standard AS/NZS 3666.1 (*Air-handling and water systems of buildings – Microbial control – Design, installation and commissioning*) can significantly reduce the amount of aerosols leaving the tower. For these reasons, it is strongly recommended that any cooling tower system that is not fitted with a drift eliminator is replaced or upgraded.

AS/NZS 3666.1 establishes a performance standard for drift eliminators. The performance of a drift eliminator is very difficult to verify in practice, so the manufacturer should be consulted to ensure that the drift eliminator is of modern, high-efficiency design. If the drift eliminator does meet the requirements of AS/NZS 3666.1, its condition and position should be checked to ensure that it has not been bypassed.

Has the system design been reviewed?

A review of the system design may highlight issues that affect the overall risk associated with the system. For example, automated valves that shut off part of the system for lengthy periods may create stagnant water.

Detailed operational manuals will greatly assist this process. If these are not available, the review should ensure that there is a detailed understanding of how the system works and of water flows. Mechanical services contractors may be required to assist with a review of more complex systems. Where a detailed understanding of the system design already exists, additional work may not be required.

The review should also establish whether the system complies with AS/NZS 3666.1. It is likely that only relatively new towers will comply in all respects. The key features of AS/NZS 3666.1 include:

- easy and safe access for maintenance
- automatically controlled water treatment systems
- materials used in construction
- tower fill
- ease of cleaning, including drainage of basins
- drift eliminators
- splash prevention
- location
- bleed-off
- sunlight protection.

‘As constructed’ plans may assist with this review.

As a minimum, an assessment should be made to check that:

- there is easy and safe access to the towers to allow cleaning and maintenance; without such access, it may not be possible to adequately clean or maintain the system
- the tower fill and drift eliminator are installed correctly and are in good condition
- wetted surfaces are protected from sunlight
- the towers discharge exhaust away from occupied areas, pedestrian thoroughfares, air intakes, building openings and trafficable areas
- the towers avoid contamination by the exhaust discharges of air-handling systems such as kitchen exhausts or other cooling tower systems.

Modern fill: Fill made of materials such as polypropylene is now available for retrofitting to most types of cooling towers.

Has the operation and performance of the system been reviewed?

A review of the operation of the system can detect practices or procedures that increase the risk of *Legionella* growing in the system. Such as review should confirm how the system is used, including any manual or automated operation controlling water flow or water temperature.

7.1.5 Location and access

Is the tower system located in, or near, an acute health or aged residential care facility?

In acute health or aged residential care facilities, highly susceptible individuals could potentially be exposed to the tower aerosols. Typically, occupants of such facilities are at greater risk of infection than other members of the community. Cooling tower systems located in these facilities are always classified as the highest risk, regardless of the condition of the tower or operational program. A cooling tower system located near such a facility is also regarded as high risk.

Where an RMP is being developed for a cooling tower system located near an acute health or aged residential care facility, it is good practice to discuss the development of the plan with the facility’s management.

How many people are in close proximity to the tower during a day?

People who are in close proximity to the tower may be exposed in the event that the system becomes contaminated and allows *Legionella* to escape in aerosols. However, there is no exact or defined distance beyond which a tower is regarded as safe. Clearly, anyone working, visiting or living on or near the site of the tower is at a higher risk than someone who does not pass anywhere near the tower. The department recommends that people within a radius of 500 m should be considered as being potentially exposed to droplets from a cooling tower.

We use the terms ‘very high’, ‘high’, ‘moderate’ and ‘low’ to describe the numbers of people that could potentially be exposed to a tower system. Table 1 gives examples of sites that fit these descriptions.

Table 1: Sites associated with exposure of different numbers of people to a cooling tower system

Number of people who may be exposed to a cooling tower system	Examples of sites
Very high	All buildings within large business districts (e.g. Melbourne Central Business District, Southbank, Geelong Business District) Major places of assembly or entertainment Large suburban and regional shopping complexes Office towers Large strip shopping precincts
High	Workplaces, including factories, with significant staff numbers High-density residential areas Apartment buildings in city fringe areas
Moderate	Small strip shopping precincts Smaller workplaces Low-density residential areas
Low	Rural sites (e.g. dairy milking sheds) Location well away from public gathering places or thoroughfares, with few workers

Of those people exposed to the aerosols from a tower, not all will be susceptible to Legionnaires' disease, but it is difficult to estimate the proportion who are at risk. For this reason, unless special circumstances mean that significant numbers of people at risk come into close proximity with the tower, the overall number of people can be used as a guide to the level of risk.

Special local circumstances may need to be taken into consideration in the risk assessment. For example, if the cooling tower is located next to a senior citizens club, a higher risk classification should be used. Where the number of potentially exposed people fluctuates – for example, with higher numbers once or twice a year at a special event – the highest number should be used to categorise the risk of the system.

7.2 Evaluating the risk associated with a cooling tower system

The first step in evaluating the risk associated with a particular cooling tower system is to understand and describe the existing situation. Table 2 lists the questions that should be considered for each critical risk.

Table 2: Questions to be considered for each critical risk

Critical risk	Question
Stagnant water	Is the cooling tower system (or part of the system) idle for more than a month? Where the system (or part of the system) is idle for more than a month, is a recirculating pump with a timer fitted to automatically circulate the water at regular intervals, to prevent it becoming stagnant? Are dead legs present?
Nutrient growth	Are there factors in and around the site that may lead to environmental contamination and an increase in the level of nutrients in the cooling tower system? Is there a corrosion control program? Are any of the wetted surfaces exposed to sunlight? Is a biodispersant used?
Poor water quality	Has an automated biocide dosing device been fitted? Is a comprehensive water treatment program in place?
Deficiencies in the cooling tower system	Is a modern, high-efficiency drift eliminator fitted to all cooling towers in the system? Has the system design been reviewed? Has the operation and performance of the system been reviewed?
Location and access	Is the tower system located in, or near, an acute health or aged residential care facility? How many people are in close proximity to the tower during a day?

7.2.1 Risk classification table

Responses to these questions will enable the overall risk associated with a cooling tower system to be established using the cooling tower risk classification table (Table 3).

We have evaluated possible responses to the questions. For the various combinations of responses, we have evaluated the combined risk and developed a logical grouping of cooling tower systems with similar overall risks. There are four risk categories: A, B, C and D. A is the highest risk, and D is the lowest risk.

These risk categories are used in Section 8 to help owners and managers select an appropriate maintenance or operational program.

7.2.2 Using the risk classification table

Table 3 lists each of the critical risks (in the left-hand column) and, for each risk, the possible combinations of responses to the questions in Table 2.

If a cooling tower system matches any of the combinations of responses in a particular row (for example, the row associated with the stagnant water critical risk), the risk classification (A, B, C or D) is at the base of the column in which the combined response is located.

The overall risk associated with a particular system is the highest classification obtained for **any** of the critical risks.

For example:

- If a system does match a response to any critical risk in column A, the overall risk classification is category A.
- If a system does not match a response to any critical risk in column A but does match a scenario in column B, the overall risk classification is category B.
- If a system does not match a response to any critical risk in column A or column B but does match a scenario in column C, the overall risk classification is category C.
- If a system does not match a response to any critical risk in column A, column B or column C but does match a response to any critical risk in column D, the overall risk classification is category D.

This process of categorising the cooling tower system should be:

- completed before developing a maintenance or operational plan
- repeated for every cooling tower system on the site
- repeated whenever the cooling tower system or environmental conditions are changed (for example, by completion of a works program).

Section 8 discusses how to treat each of the critical risks, and strategies for reducing the overall risk classification.

Table 3: Cooling tower system risk classification

Critical risk	Higher risk			Lower risk
Stagnant water	System is idle more than one month **and** Recirculating pump with timer not fitted	System is idle more than one month **and** Recirculating pump with timer fitted **and** 'Dead legs' exist	**Any ONE of the following:** System is idle more than one month **or** 'Dead legs' exist	System operates continuously **and** No 'dead legs
Nutrient growth	**Any THREE of the following:** Environmental contamination **and** No corrosion control program **and** Wetted surfaces not protected from sunlight **and** No biodispersant used	**Any TWO of the following:** Environmental contamination **or** No corrosion control program **or** Wetted surfaces not protected from sunlight **or** No biodispersant used	**Any ONE of the following:** Environmental contamination **or** No corrosion control program **or** Wetted surfaces not protected from sunlight **or** No biodispersant used	No significant environmental contamination **and** Corrosion control program exists **and** Wetted surfaces protected from sunlight **and** Biodispersant used
Poor water quality	No automated biocide dosing device installed **and** No comprehensive water treatment program in place	No automated biocide dosing device installed **and** Comprehensive water treatment program in place	Automated biocide dosing device installed **and** No comprehensive water treatment program in place	Automated biocide dosing device installed **and** Comprehensive water treatment program in place
Deficiencies in the cooling tower system	Modern, high efficiency drift eliminator not fitted **and** No review of system design **and** No review of system operation and performance	Modern, high efficiency drift eliminator not fitted	Modern, high efficiency drift eliminator not fitted **and at least ONE of the following:** No review of system design **or** No review of system operation and performance	Modern, high efficiency drift eliminator not fitted **and** System design reviewed **and** System operation and performance reviewed
Location and access	System is located in an acute health or aged residential care facility **or** Very high numbers of people are potentially exposed	System is located near an acute health or aged residential care facility **or** High numbers of people are potentially exposed	System is not located near an acute health or aged residential care facility **and** Moderate numbers of people are potentially exposed	System is not located near an acute health or aged residential care facility **and** Low numbers of people are potentially exposed
Risk classification	If your system matches **any** of the above responses, the Risk Classification for the system is **A**	If your system matches **any** of the above responses and does not match **any** of the responses in Risk Classification A, the Risk Classification for the system is **B**	If your system matches **any** of the above responses and does not match **any** of the responses in Risk Classification A or B, the Risk Classification for the system is **C**	If your system matches **any** of the above responses and does not match **any** of the responses in Risk Classification A, B or C, the Risk Classification for the system is **D**
	Higher risk			Lower risk

8 Treating the critical risks

All cooling tower system owners should aim to lower the overall risk associated with their system, if possible – for example, so that the overall risk classification is reduced from A to B. In most cases, the only way this can be done is via capital investment, such as fitting drift eliminators, automated dosing devices and recirculating pump timers. Without capital investment, the maintenance or operational program for the system will need to increase considerably.

As discussed in Section 7, a number of critical questions need to be considered in relation to the existing condition of the cooling tower system.

This section explains how to use the risk classification process from Section 7 to identify an operational program for the cooling tower system.

It highlights the importance of ensuring that the operational program is consistently implemented.

8.1 Is a cooling tower system really needed?

A basic principle of risk management is to first see if it is possible to eliminate the risk altogether. Whenever a cooling tower system exists on a site, it is possible to reduce and manage the risks, but not eliminate them.

At an early stage of a review of the risks associated with a cooling tower system, it should be established whether the original purpose for the cooling tower system still exists. For example, for industrial processes, is the cooling tower system still crucial to the process or has it become redundant?

Viable alternatives to the cooling tower system should also be considered. Owners of land and businesses with smaller cooling tower systems should consider a move to air-cooled systems, which are not associated with Legionnaires' disease because there is no reservoir of recirculating water. Air-cooled systems also eliminate the ongoing costs of water treatment and testing.

If no viable alternative currently exists to the cooling tower system, it is time to begin the risk management process.

8.2 Strategies to address the critical risks

Possible responses to the critical risks are described below. Some relate to improvements to the cooling tower system itself, whereas others concern maintenance or operational aspects of the system.

8.2.1 Risk control strategies for stagnant water

Cooling tower system improvements

Improvements to the cooling tower system to minimise the risks associated with stagnant water include the following.

Installing a timer connected to a recirculating pump, set to operate to circulate biocide and other chemicals when the system is idle

If the tower system, or part of the system, is idle for more than a month, a simple strategy to minimise the risk of stagnant water is to install a timer to the recirculating pump. This ensures that water circulates through the system. It will also allow the biocide to treat the water and reduce the likelihood of bacterial growth. This is relatively easy to achieve and is suited to tower systems that are not used for long periods.

Checking whether there are dead legs, and removing or activating them

The first step is to locate any potential dead legs. As a rule of thumb, a dead leg is a pipe that branches off the main pipe and is longer than the internal diameter of the main pipe.

A visual examination for potential dead legs is a vital part of the risk assessment because of their importance in *Legionella* control. The entire pipe network needs to be followed and inspected to identify potential dead legs.

On small sites with simple systems, a visual inspection may be sufficient. On larger sites or sites with more complex systems, the process of checking for dead legs should include reviewing information from 'as constructed' plans of the tower system, considering anecdotal information from staff and contractors, and visually inspecting the system. Some consultants offer services that involve measuring heat losses through the pipe system as a proxy for determining low-flow areas.

Where potential dead legs are identified, it may be possible to confirm their status by draining them. This may require liaison with a mechanical services contractor to avoid damage to the system. Where a pipe can be drained, the presence of sludge in the water confirms that there has been little or no circulation through the pipe, and action must be taken to deal with it. If there is no sludge and the water is clear, the pipe is probably not a dead leg, but a conservative approach will minimise risks. Those involved in draining the potential dead leg should use personal protective equipment to prevent inhalation of aerosols.

Once dead legs have been identified, the risk needs to be addressed – for example, by removing the dead legs. Removing dead legs can be a relatively straightforward task on small sites. On large and complex sites, it may be appropriate to develop a program for the progressive removal of the pipes over a period of years, depending on the current performance of the tower system and the overall risk assessment.

In some cases, removal is not feasible, and conversion of the pipe into active or live use may be an alternative. This process is called 'activation'. However, the preference is to remove the pipe, wherever possible.

Dead legs may be activated by:

- installing a pipe connected to a pump, drawing water from the dead leg and injecting it into another part of the system – this achieves circulation in the pipe and reduces deposition of sludge in the pipes, allowing biocides to reach all parts of the system
- draining or flushing the pipe at regular intervals (say, twice per month) to remove the stagnant water.

Where dead legs are located and cannot be removed or activated for a period, this information should be provided to the water treatment provider. It can then be considered in the development of an appropriate operational program. A higher level of maintenance and testing is used to compensate for the higher risk that the dead legs represent.

8.2.2 Risk control strategies for nutrient growth

Cooling tower system operation

Key strategies to minimise the risks associated with nutrient growth include the following.

Identifying sources of environmental contamination and attempting to reduce the amount

All possible sources of environmental contamination should be identified – for example, dust from demolition or construction sites, dirt car parks or roads, heavily used roads or birds nesting. Where possible, the level of contamination should be reduced. For example, during periods of construction or demolition, water might be used to reduce the amount of dust generated. If this is not possible, other strategies will be needed to reduce the impact of the contamination.

Using a biodispersant

A biodispersant will help break down the biofilm on the wetted surfaces in the tower system.

Controlling corrosion

Control of corrosion is best achieved by a well-considered water treatment program, including use of anticorrosive additives and close monitoring of the impact of the water on the metal surfaces of the tower system.

Corrosion control is critical to some business operations. In these cases, independent specialist advice should be sought on the appropriate control and monitoring techniques.

Instituting a more frequent cleaning program

The Public Health and Wellbeing Regulations 2009 require cooling tower systems to be disinfected, cleaned and re-disinfected at least every 6 months. This needs to include the cleaning of all wetted surfaces in the system. More frequent cleaning will help to control nutrient growth.

Cooling tower system improvements

Improvements to the cooling tower system to minimise the risks associated with nutrient growth include the following.

Protecting the cooling tower basin from sunlight

It is important to protect the cooling tower basin (and the top deck of larger cooling towers) from sunlight. In many cooling towers, the sides are open, allowing sunlight to reach the cooling tower basin and encouraging algae to grow. The risk may be reduced by installing or refitting (where they have been removed) sides to the tower structure. The material used to protect the sides must be durable and easily cleaned. Material such as ultraviolet-stabilised polypropylene is commonly used and is appropriate for this purpose. Other materials that can be used include reinforced fibreglass.

Reducing the water temperature of the system, where possible

The temperature of the water in the system has a direct impact on the rate of bacterial growth. It may be possible, after discussion with equipment suppliers and mechanical service contractors, to lower the temperature by adjusting the thermostats, with little or no detriment to the operating efficiency of the overall cooling tower system.

8.2.3 Risk control strategies for poor water quality

Cooling tower system operation

Key strategies to minimise the risks associated with poor water quality include the following.

Undertaking a comprehensive water treatment program

The Public Health and Wellbeing Regulations 2009 require that the cooling tower system be continuously treated with:

- one or more biocides to effectively control the growth of microorganisms, including *Legionella*
- chemicals or other agents to minimise scale formation, corrosion and fouling
- a biodispersant.

The water treatment program must therefore involve the use of a biodispersant, anticorrosives and one or more biocides.

The choice of biocides is important. They must be proven to be effective under local conditions in killing *Legionella* and other bacteria. Material data sheets should be reviewed to ensure that such evidence is available, and to indicate any occupational health or environmental issues that are associated with the product. The biocide must be administered in such a way that the recommended concentration is maintained at all times. This requires an accurate calculation of the total water volume and the volume of the biocide required to reach the recommended concentration, taking into account water loss due to evaporation and bleed-off.

The Regulations permit the use of chemical or physical agents as biocides, provided that they are capable of killing microorganisms, including *Legionella*.

Chemical biocides are the most commonly used in cooling tower systems and are of two types: oxidising and non-oxidising.

Oxidising biocides include commonly used chemicals such as chlorine and bromine. These chemicals kill bacteria relatively quickly, and concentrations in water can be monitored relatively easily. Modern automated dosing units continually test to ensure that the required parameters are met. Oxidising biocides tend to be associated with corrosion, so corrosion needs to be monitored and corrosion control measures put in place.

Non-oxidising biocides include isothiazolone, which is relatively commonly used for water treatment in cooling towers. These chemicals kill bacteria more slowly, and concentrations cannot easily be monitored in the field; a laboratory test is required to determine the concentration.

Best practice usually involves the use of multiple biocides (both non-oxidising and oxidising simultaneously) that are rotated periodically to avoid problems with the bacteria developing tolerance to a particular biocide. Modern automated dosing units are able to dispense a number of different chemicals into a system.

Very few systems use nonchemical biocidal devices, such as devices that generate ultraviolet light, ozone or electromagnetic fields. Solid biocides also exist, including mineral crystals. The department recommends use of nonchemical biocides only as a secondary biocide in conjunction with conventional chemical biocides.

Regularly monitoring the chemical parameters as a measure of water quality

Establishment and frequent monitoring of performance indicators to determine whether a cooling tower system is under control is an important aspect of risk management. Once a performance indicator has been identified, a target range should be established beyond which corrective action is required.

Chemical parameters such as the concentration of biocides,[8] pH, conductivity (to measure the build-up of solids) and water temperature are good performance indicators. Table 4 lists the more commonly used indicators and the indicative ranges for each. More precise levels than the indicative ranges shown in the table may be required for particular systems. These can be determined in conjunction with the water treatment provider.

As a minimum, performance indicators should be monitored at least monthly. Monitoring more regularly can reduce the risk of the water chemistry and the system moving out of control without warning to operators, well before a scheduled bacterial test might indicate a problem.

pH meter: An example of an automated pH meter linked to a system which treats the water to maintain a predetermined pH

Automation is available for many of these monitoring tasks. Devices to monitor chemical parameters continuously can be linked to building automation systems or to more conventional alarms, with preset levels for each parameter to alert operators of problems requiring action. In higher-risk locations, the use of high levels of automation is strongly recommended to minimise the risks.

Table 4: Indicative water quality values

Indicator	Indicative target range[a]
Bacteria	
Legionella	Not detected (<10 CFU/mL)[b]
HCC	Less than 200,000 CFU/mL[c]
Solids	
Total dissolved solids	Less than 1,000 mg/L
Conductivity	Less than 1,500 µS/cm
Suspended solids	Less than 150 mg/L
Calcium hardness	Less than 180 mg/L

8 Currently, technology exists to monitor only bromine or chlorine levels on a continuous basis.

Indicator	Indicative target range[a]
pH	
pH (for bromine-based compounds)	7–8.5
pH (for chlorine-based compounds)	7–7.6
Total alkalinity	80–300 mg/L
Other additives	
Biodispersant	Follow the manufacturers' specifications
Corrosion inhibitor	Follow the manufacturers' specifications

CFU = colony forming unit; HCC = heterotrophic colony count

a Water conservation should also be considered. For more information, refer to Australian Institute of Refrigeration, Air Conditioning and Heating 2009, *Best practice guidelines: water conservation in cooling towers,* <www.airah.org.au/imis15_prod/content_files/bestpracticeguides/bpg_cooling_towers.pdf>.

b The Public Health and Wellbeing Regulations 2009 prescribe a series of actions that must be taken following the detection of *Legionella* in a cooling tower system sample.

c The Public Health and Wellbeing Regulations 2009 prescribe a series of actions that must be taken when a cooling tower system sample has an HCC of more than 200,000 CFU/mL.

Testing frequently for heterotrophic colony count levels

Testing of bacterial levels in the recirculating water of the cooling tower system must be a part of every cooling tower system's RMP.

HCC is used as an indicator of water quality in cooling tower systems. The test measures the total bacterial load in the sample of water, in colony forming units per millilitre (CFU/mL).

A high HCC (which is regarded as any count of more than 200,000 CFU/mL) indicates that the system is moving out of control and may support *Legionella* growth, unless corrective action is taken. However, there is no direct correlation between HCC and *Legionella* concentration. It is possible to have a very low HCC and still detect *Legionella* and, conversely, a high HCC level but not detect *Legionella*.

Samples of recirculating water to be tested for HCC should be:

- taken as described in AS 2031 (*Water quality – Sampling for microbiological analysis*), which specifies selection of a suitable sampling container and preservation of the sample for later testing
- collected as described in AS/NZS 3666.3 (*Air-handling and water systems of buildings – Microbial control – Performance-based maintenance of cooling water systems*). The sample should be stored at 2–10 °C before analysis, and analysis should begin within 24 hours of the sample being taken
- analysed in accordance with the relevant method in AS 4276.3 (*Water microbiology – Heterotrophic colony count methods*).

The Public Health and Wellbeing Regulations 2009 require monthly HCC testing. If the HCC is above 200,000 CFU/mL, the Regulations require that action is taken as described in Section 4.5. This includes resampling.

Although testing must occur at least monthly, the frequency should be proportionate to the risk posed by the system – that is, higher-risk systems may need to be tested more frequently.

As part of a risk assessment, it is important to look at past HCC results. HCC levels over time can be graphed. If the action level of 200,000 CFU/mL is marked on the graph, it is readily seen when HCC levels approach it.

Testing for Legionella

Legionella testing is the ultimate performance test of a cooling tower system. The Public Health and Wellbeing Regulations 2009 require testing for *Legionella* at least once every 3 months. Action must be taken within 24 hours following detection of *Legionella* in any water sample taken from a cooling tower system. The method of laboratory testing for *Legionella* is such that an acceptable result is generally reported as 'less than 10 CFU/mL'.

Although testing for *Legionella* is required at least every 3 months, the department strongly recommends that the frequency of testing be based on the risk assessment for the system and proportionate to the risks posed by the system. Testing frequencies for *Legionella* are discussed in Section 8. The use and frequency of *Legionella* testing should be based on the risk of potential growth of *Legionella*, combined with the potential for exposure of people to aerosols from the system. The results of testing should be seen as an indicator of system performance. However, because of the inherent difficulties associated with *Legionella* testing (for example, *Legionella* lives in the biofilm but may not be picked up in the sample), the absence of *Legionella* in an isolated test cannot be seen as definitive proof that the system is operating well at another time.

Another important consideration is the impact of a positive *Legionella* result. This is discussed further in Section 10.

Testing for *Legionella* requires samples to be:

- taken in containers as described in AS 2031
- collected as described in AS/NZS 3666.3
- stored and transported as described in AS/NZS 3896 (*Waters – Examination for Legionella spp. including Legionella pneumophila*). This standard requires that the samples be transported to the testing laboratory as soon as possible and then analysed in accordance with AS/NZS 3896. The testing is much more sophisticated than for HCC, and results can take up to 10 days.

When selecting a testing laboratory to perform these tests, it is important to ensure that the organisation follows the relevant Australian Standards in their testing processes. The Regulations require that the laboratory is accredited by the National Association of Testing Authorities.

Using appropriate bleed-off rates suited to the system in use

To overcome build-up of solids, a small percentage of the total water volume should be discharged to waste at regular intervals. This operation is known as bleed-off. The water is drained from the system to the sewer and replaced with fresh water. Automated devices are available to assist in this process – for example, a flow-controlled device that drains a preset volume of water at regular intervals. Modern automated dosing systems also automatically control bleed-off. Conductivity, which is related to the levels of solids in the water, is measured by the units and used to initiate bleed-off at appropriate times, also taking into consideration the biocide dosing interval.

Cooling tower system improvements

Improvements to the cooling tower system to minimise the risks from poor water quality include the following.

Installing automated dosing devices

The method of adding chemicals such as biocides, anticorrosives and biodispersants to the water can significantly affect the overall risk. Manual dosing (which relies totally on the operator), and drip-feed or siphon devices are not recommended by the department.

pH meter: An example of an automated pH meter linked to a system which treats the water to maintain a predetermined pH

An automated dosing device is more reliable, because a preset volume of biocide (and other chemicals such as biodispersants and anticorrosives) can be injected into the recirculating water at regular intervals. Many of these systems have alarms fitted to warn of problems such as pump failure. Automatic dosing has become the industry standard in Victoria and is highly recommended by the department.

Several types of automated devices are available for chemical dosing:

- timer-controlled dosing pumps
- feedback-controlled dosing devices that use oxidation–reduction potential probes
- feedback-controlled dosing devices, including those that directly measure chlorine and bromine concentrations.

Timer-controlled dosing pumps rely on a pump and timer that are connected to a drum containing the chemical to be dosed. This requires manual setting, based on an operator's calculation of the volume and time interval required to achieve the target concentration. Alarms are available to warn of pump failure. One pump is required for each chemical to be dosed.

Feedback control is only available for administering oxidising chemicals such as chlorine and bromine. It can be used to keep these biocide concentrations in the target range at all times. The equipment can be connected to building automation systems and alarms to advise of problems or to track the dosing performance.

Feedback-controlled dosing using oxidation–reduction potential probes measures a parameter that has a relationship to the concentration of the oxidising chemicals in the water. Devices are also now available that directly measure either chlorine or bromine concentration.

In large installations comprising multiple cooling towers connected in series (cells), some cells may be shut down in rotation for lengthy periods. The automated dosing device is sometimes only connected to one cell, and it may be necessary to have multiple dosing points in such situations.

It is also important to have a bunded area to contain any spillage or leaks from chemical drums, to prevent discharge to stormwater systems or a safety hazard to workers.

Solid biocide materials that dissolve to release biocides into the circulating water may be regarded as an automated dosing device for the purposes of risk classification.

Selecting an appropriate point for chemical dosing

Selecting an appropriate point for the dosing of chemicals can have a dramatic impact on water quality (as measured by bacterial testing). As a general rule, dosing needs to occur well away from the point where the water quality is monitored by bacterial testing, to ensure that the testing occurs at a point that is representative of the water in the system. If the water is tested immediately after the chemicals have been applied, levels of bacteria in the water immediately around the dosing point may be low, but not truly representative of the bacterial load further down the system, where biocide concentrations are much lower.

Generally, unless there are clear local reasons for dosing at a different point, the department recommends that dosing of chemicals occurs immediately, or soon after, the cooled water leaves the cooling tower. This means that a lower volume of chemicals would be lost from splashing in the cooling tower.

Providing a dedicated water sampling point

The selection of a bacterial sampling point is important. It should be well away from the dosing point. Ideally, if dosing occurs soon after the cooled water leaves the tower, testing should occur just before the warmed water enters the tower. This is obviously only possible where a sampling tap has been fitted. A sampling tap should not have excessively long pipe lengths and should be as close to the main pipe as possible. The tap should be run for at least 30 seconds before sampling. A sampling tap can create a potential dead leg, so the tap should be flushed at least once a month.

Where a sampling tap is not available, sampling is usually only possible from the tower basin, or from water as it falls from the fill into the basin.

In either case, the sampling point should be clearly marked on the tower, along with the department-assigned cooling tower system (CTS) number. Its location should be described in the RMP.

Installing side-stream water filtration in dirty environments

An appropriately installed side-stream filter can be a very effective component in a cooling tower system that is subject to environmental contamination. However, if the filter is not properly maintained with regular backwashing, it can become a site for microbial growth and contaminate the water in the system. These filters use either sand, cartridges or a centrifugal design to filter the water.

Sand filter

8.2.4 Risk control strategies for deficiencies in the cooling tower system

Cooling tower system improvements

Key strategies to minimise the risks associated with deficiencies in the cooling tower system include the following.

Undertaking a comprehensive review of the system design to confirm that it complies with AS/NZ 3666

A comprehensive review of the system design should be the first step in a capital works program. The review can be performed by contacting the original supplier, or by full or partial comparison with AS/NZS 3666.

It is very difficult to confirm that drift eliminators comply with the standards after the cooling tower has been installed.

Undertaking a comprehensive review of the current operation and performance of the system

A review of the current operation and performance of the system could include a check of the water temperature in the basin as the water leaves the tower. Ideally, this is compared with the operating design specifications to ensure that the system is not working at an excessively high temperature or above its original design capacity. If the design specifications are not available, all equipment should be checked to ensure that it is operating effectively.

Developing operating and maintenance manuals

AS/NZS 3666.2 states that operating and maintenance manuals shall be provided for a cooling tower system. The standard describes these manuals as including:

- physical details, including drawings, of the plant, equipment, systems and pre-treatment carried out
- recommendations on maintenance, including water treatment maintenance and management
- recommended cleaning methods and dismantling instructions
- start-up, operating and shut-down procedures
- particulars of the maintenance management program.

For older systems, much of this information may not be available, but some information may be collectable during the risk assessment process. It is critical to understand the basic design of the system, including the water flow. This may require discussion with maintenance or mechanical services contractors, who may be able to explain the basic functioning of the system as part of a risk assessment. Any information such as schematic or concept drawings should be included in an operational manual for these older systems.

New systems should not be commissioned until such information is available. The recommended shut-down and start-up procedures, in particular, should be documented to minimise risks.

Assessing useful system life

Like other mechanical assets, cooling tower systems have a limited useful life. Beyond a certain point, further maintenance becomes uneconomical, and complete replacement of the tower must be considered. An assessment should be made of the useful life of the tower system and how well the system is meeting business needs. This information, combined with risk considerations, will allow owners of cooling tower systems to make decisions about when the system should be replaced or upgraded.

There may be alternatives to the cooling tower system because of new technology – for example, for small air-conditioning-related or refrigeration-related cooling towers. Air-cooled systems generally have higher capital costs and higher energy consumption, occupy more floor area and create higher noise levels, but they do eliminate the risk of *Legionella* and the cost of maintaining a water system. They could particularly be considered where the required heat rejection is below 750 kW. However, equipment size and hours of operation per year also need to be considered. Any cost–benefit analysis associated with the possible replacement of a cooling tower with an air-cooled system should consider the potential costs associated with an outbreak of Legionnaires' disease as well as energy consumption.

Air cooled system: Three air cooled systems forming part of an air conditioning system

Installing an effective drift eliminator to comply with AS/NZ 3666.1

Cooling towers not fitted with effective, modern drift eliminators present a greater risk of an outbreak of Legionnaires' disease in the event of failure of the water treatment regime. A drift eliminator constructed and fitted to comply with AS/NZS 3666.1 can significantly reduce the amount of aerosols leaving a tower. However, no simple field test can confirm that a drift eliminator is working effectively, so an assessment needs to be made of its condition. For example, the supplier can be asked to confirm that the drift eliminator met the standard at the time of installation. Drift eliminators are generally constructed of modern materials such as propylene. Where possible, the drift eliminator should be checked to ensure that it is still in good condition and has not become dislodged from its installation position.

Reviewing and monitoring tower safety

Tower safety (for example, ladders, rails and platforms) is critical to those who work on the tower. The integrity and physical condition of all components must be reviewed and regularly monitored to prevent breakage or other failure, as this may lead to a serious accident. Note that the department has a policy of notifying WorkSafe where there are concerns about tower safety.

Using suitable materials for external components

Wood is not regarded as a suitable material for use in cooling towers becasue it deteriorates rapidly in a warm and moist environment. However, in some large industrial cooling towers, it may be the only suitable material. If it is used, it will require careful and regular maintenance.

Using suitable materials for internal components

Many older tower systems use inappropriate materials inside the cooling tower – for example, wood for drift eliminators or fill. These should be replaced with durable modern materials such as ultraviolet-stabilised polypropylene.

8.2.5 Risk control strategies for location and access

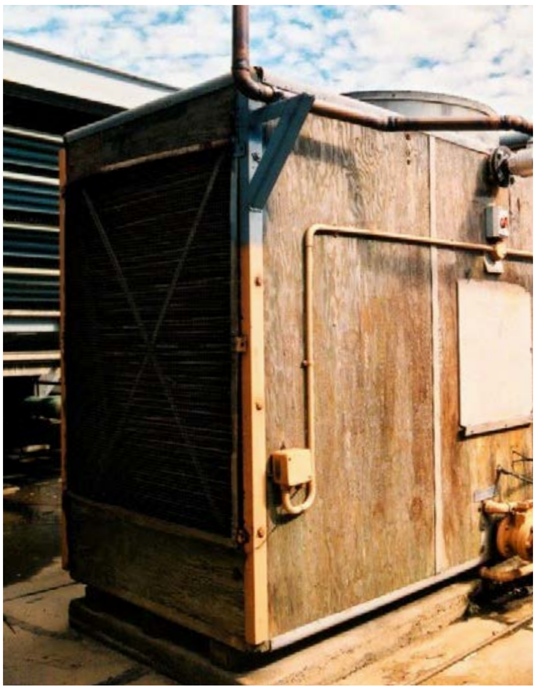
Cooling tower system operation

Key strategies to reduce the risks associated with location and access include the following.

Restricting access to the tower and its surrounds to staff and contractors with a direct need to access the area

Restricting access to essential staff and contractors reduces the number of people who may be exposed to aerosols. This is best achieved through clarity about individual roles. Identifying those people who require access to the area and establishing a security system is one method of restricting access.

Tower ladder: Tower safety is important. Proper decking and ladders must be provided



Wooden tower: An aged tower constructed largely of wood

Using high standards of maintenance for towers located in high-risk locations

The highest standards of maintenance (including frequency of inspection and service) and bacterial testing are needed in high-risk locations – that is, where the tower system is located in, or near, an acute health or aged residential care facility, or where large numbers of people would be exposed to aerosols from the system.

Undertaking more frequent cleaning for tower systems exposed to significant environmental contamination

For towers that are exposed to environmental contamination, such as soil or dust from demolition or construction sites, the cleaning frequency may need to be increased to address the risk that the level of solids in the system will increase and encourage bacterial growth.

Cooling tower system improvements

Improvements to the cooling tower system to reduce the risks associated with location and access include the following.

Displaying warning signs to advise staff or contractors that the area has restricted access

All staff and contractors should be discouraged from gathering near the area. A sign should be placed advising of 'Authorised access only.'

Preventing the area around cooling tower system being used as a gathering place for staff or others

On some sites, smokers use the area around the cooling tower as a place to congregate outside the building. Since smokers are at higher risk of contracting Legionnaires' disease if exposed to *Legionella*, such a practice should be discouraged.

Changing risks: The re-development of an adjacent building to residential use has increased the numbers of people who live close to the cooling tower

Best practice is to clearly mark or label each cooling tower as a 'Cooling tower'. It is strongly recommended that all cooling tower systems are marked with the department's CTS number and a tower reference number, for ease of identification by contractors – for example, 'Cooling tower 1 – CTS 1234'.

Restricting access to the tower

Access to the tower can be restricted by methods such as locking access points (where access cannot otherwise be restricted) and erecting fencing with locked gate access.

Relocating the tower to a more remote site or a less contaminated environment

Relocation of the tower is relevant for large sites where a cooling tower system is located close to either high numbers of people or highly vulnerable groups, such as those present in a hospital, nursing home or aged persons' facility. Such a decision would need to consider not just the engineering issues involved, but the potential impact on highly vulnerable people.

Ensuring a safe and stable area for maintenance workers to access the tower system

People who have to access the cooling tower system for maintenance or inspection must be able to do so safely. This includes having safe access to the area near the cooling tower, including ladders, ramps or platforms. The access area around the platform needs to be sufficiently large to facilitate all of the major works that need to be done on the cooling tower system, including access to, and removal of, key components for cleaning.

Installing a side-stream filter

Where a tower is exposed to significant environmental contamination, the use of side-stream filtration (see Section 8.2.3) can reduce the level of solids and improve water quality.

Environmental contamination: An unmade car park in the area adjacent to a cooling tower may increase the levels of solids in the water and must be addressed in the RMP

8.3 Operational programs

Once a risk assessment has been completed, the risks posed by the cooling tower system can be classified (see Section 7.2). The next task is to develop an operational or maintenance program that is proportionate to the risks.

Section 6 identified risks associated with cooling tower systems. Several relate to the treatment of water and the standard of maintenance (including cleaning) of the cooling tower system.

The way that an operational program is implemented will have a dramatic impact on the overall risk associated with a cooling tower system. A well-considered and well-written operational program that is not well implemented can still lead to significant problems. For example, something as simple as the supply of biocide being cut because the container is empty can lead to rapid growth of *Legionella*. Section 8.4.2 describes considerations for selecting and monitoring a maintenance contractor.

The first element to consider in risk treatment relating to operational programs is the standard and frequency of maintenance and cleaning programs to address the following critical risks:

- stagnant water
- nutrient growth
- poor water quality.

A well-structured operational program will include:

- competent personnel who are trained for their tasks
- inspection
- servicing
- HCC testing
- *Legionella* testing
- cleaning
- performance measures
- record keeping.

8.3.1 Training of personnel

Personnel with appropriate skills and experience are required to operate and maintain a cooling tower. They should have a skill level appropriate to the task they are required to perform.

Skills can be obtained by practical instruction and/or formal training.

Competencies required to fulfil the tasks described in the following sections include:

- knowledge of occupational health and safety
- handling of chemicals used in the process
- use of cleaning tools
- understanding of the components of a cooling tower system, including pumps
- use of water quality testing apparatus
- sample collection, storage and transport.

8.3.2 Inspection

Inspection means simple monitoring of key components, such as:

- an observation of water clarity
- a check that the chemical dosing devices are operating – for example, by monitoring the levels of chemicals within the tanks to confirm that they have decreased since the last inspection.

A more complete list of items to be inspected is included in Appendix 5. A nontechnical person with minimal training can do the inspections. Inspections should be frequent. Where problems are noted, they need to be reported to the responsible person, who can then authorise remedial works.

8.3.3 Servicing

Servicing must be performed by personnel with a much higher degree of knowledge than is required for an inspection. Typically, a service would include:

- a check of the water quality, including parameters such as pH, conductivity and biocide levels
- refilling of chemical dosing tanks
- removal of empty tanks
- a check of all dosing and control equipment, including timers, pumps and tubing; this should involve a calibration check on the pumps and resetting, if necessary, against desired parameters
- inspection of the wetted components and general integrity of the system
- corrosion checks.

Action should immediately be taken to remedy any problems.

8.3.4 HCC testing

HCC testing is described in Section 8.2.3.

8.3.5 *Legionella* testing

Testing for *Legionella* is described in Section 8.2.3.

8.3.6 Cleaning

A cooling tower system should only be cleaned by a competent person who is trained for that task.

8.3.7 Performance indicators

Another critical element of the operational program is the use of performance indicators, such as those listed in Section 8.2.3. If operational programs are outsourced, performance indicators should ideally be clarified before the program is defined in a contract.

8.3.8 Record keeping

A written record must be kept of all work associated with the system. Regulation 60 of the Public Health and Wellbeing Regulations 2009 requires that records are kept of all maintenance and corrective activities, such as repairs, and of all microbiological test results, for the preceding 12 months. Appendix 6 gives some guidance on the types of information that should be kept, as a minimum.

These records are usually kept on-site; however, in some circumstances, they may be stored off-site – for example, a property manager may hold the records on behalf of a building owner.

Regulation 60(2) requires reports of all maintenance and corrective actions for the preceding 12 months to be produced for inspection when requested by an authorised officer. However records are stored for the cooling tower system, it is important that staff know where they are kept and how to access them quickly.

8.4 Selecting an appropriate operational program

To help with decisions on an appropriate operational program (that is, the standard of maintenance), we have developed a series of standard operational programs, together with a means of selecting the appropriate one for any system. These programs represent the department's view on what is reasonable practice to maintain a cooling tower system.

A risk classification for the cooling tower can be determined from Table 3. Table 5 shows the recommended operational program based on that risk classification. For example, for a system that is classified as risk category A, the recommended operational program is program A, and so on.

Table 6 describes the details of the recommended operational programs. Each program meets the ongoing maintenance requirements of the Public Health and Wellbeing Regulations 2009.

Table 5: Selection of an operational program

Risk classification	Recommended operational program
A	A
B	B
C	C
D	D

Table 6: Recommended operational programs

<table>
<tr><th>Program A</th><th>Program B</th><th>Program C</th><th>Program D</th></tr>
<tr><td>Weekly inspection</td><td>Monthly inspection
(2 weeks after service)</td><td>Monthly inspection
(2 weeks after service)</td><td rowspan="2">Monthly service</td></tr>
<tr><td>Fortnightly service</td><td>Monthly service</td><td>Monthly service</td></tr>
<tr><td>HCC and Legionella tested at a minimum of once each month</td><td>HCC and Legionella tested monthly</td><td>HCC tested monthly
Legionella tested every 2 months</td><td>HCC tested monthly
Legionella tested every 3 months</td></tr>
<tr><td colspan="4">Six-monthly cleaning, or more frequently where environmental contamination (e.g. dust, soil, building works) is a problem</td></tr>
</table>

HCC = heterotrophic colony count

Consideration should be given to increasing the frequency of bacterial testing and monitoring of chemical parameters whenever major changes are made to the system. For example, even if upgrades have been made to the system by installing increased automation, it is important to monitor the system closely to confirm that it is under control before reverting to a lower testing frequency. As well, seasonal variations may increase the risk of *Legionella* growth; as a result, it may be appropriate to increase the service or testing frequencies during seasons of higher risk.

8.4.1 Model operational program

Appendix 4 is a model operational program that can be completed after the risk assessment has been undertaken. It will form part of the RMP.

Appendix 6 is a model service report that is provided as a guide to the detail that is required at each service.

Appendix 7 contains the key elements of a model service contract, which can be completed and tailored to suit specific needs.

8.4.2 Maintenance contractors

The risk of problems with a cooling tower system can be reduced by using appropriately skilled people or organisations to maintain it. In most cases, owners of cooling tower systems will seek outside assistance to maintain the system. Typically, such services are supplied by specialised water treatment companies. It is good practice to be clear about the standard of maintenance required and for this to be specified in writing.

The qualifications and experience of companies should be carefully considered before they are engaged for these types of services. The outsourcing of a service such as cooling tower system maintenance does not mean that a company has eliminated its legal responsibility – the owner of the land and the owner of the cooling tower system still have the legal responsibilities described in Section 4 of this guide.

Contract management and supervision are critical to the success of an outsourcing arrangement. Regular reports, feedback between the parties and performance monitoring are essential components of contract management.

Some key questions to consider when employing a water treatment provider include the following:

- Is the organisation a member of relevant industry bodies – for example, the Australian Institute of Refrigeration, Air Conditioning and Heating, or the Plastics and Chemicals Industries Association?
- What is the formal training level of the personnel (for example, water science, chemistry, mechanical engineering)?
- What are the competencies, skills and experience of the personnel who would be involved with your site?
- Is the company experienced with your particular type of system?
- Can they produce references from other companies that can be substantiated by you?
- Can they demonstrate to you how they calculate the required dosage rates for the biocides that they propose to use and that the biocide is proven to be effective under local conditions in killing *Legionella*?
- What, if any, formal quality assurance systems are used by the company? Are they regularly externally audited?

When evaluating tenders or proposals from companies interested in providing these types of services, the lowest price is not always the best service provider for a particular system.

Many contractors have developed their own service reports. The details provided in their reports should meet or exceed the details in Appendix 6.

Maintenance contractors should be monitored closely to ensure that the service is being delivered consistently and in the required manner. Regular reporting arrangements and meetings at which the performance indicators are discussed should be a standard practice.

As with any contract, it is important to be clear about the arrangements in the event that the service contract terminates for some reason. It is critical to maintain continuity of maintenance of the cooling tower system.

The type of contract entered into should be considered carefully. For example, it may appear cheaper to request a fixed-price all-inclusive contract because the cost can be spread equally across the year. As well, the contractor has an incentive to manage the cooling tower system to a high standard to reduce the likelihood of costly 'call backs' to deal with problems, such as adverse microbiological results. However, these types of contracts can introduce other problems – for example, if the agreed price does not adequately cover the actual cost of the required service, contractors may cut corners, affecting the standard of maintenance and increasing the potential risks associated with the system.

9 Monitoring and review

The RMP is required to be reviewed and updated annually, or whenever there are major changes to the operations. It should also be reviewed whenever the risks have changed.

The RMP may need modifying because of:

- changes to the cooling tower system or its use
- changes to the use of the building in which the cooling tower system is installed
- the availability of new information or technology about risks or control measures
- the results of checks indicating that measures to control the system are no longer effective
- a case of Legionnaires' disease that is possibly associated with the system
- unusual factors such as demolition or construction of buildings on or near the site, or road works or other construction activities that generate dust[9]
- special events that will bring large numbers of people onto or near the site[10]
- a change in the number, or level of vulnerability, of people who may be exposed to aerosols from the cooling tower system – for example, construction of an apartment building near an existing cooling tower would introduce significant numbers of new residents into a risk assessment.

If *Legionella* is isolated in a cooling tower system, the water treatment program, tower operation and maintenance program of the system must be reviewed within 24 hours of receiving notification of the result.[11] Good record keeping – as required by Victorian law – will assist such a review by allowing trends to be monitored. If a site or organisation has multiple cooling tower systems and *Legionella* has been detected in one system, strong consideration should be given to reviewing the maintenance program and risks associated with **all** of the systems. This may identify any common problems. In higher-risk or more complex sites, or where large workforces are involved, the department recommends that an independent consultant is engaged to review the maintenance progam.

A single person with sufficient authority to initiate action and commit funds must have responsibility and accountability for the operation of the cooling tower system. The overall management of the cooling tower system will benefit if that person has been trained in the management of risks associated with cooling tower systems.

Regular reporting to senior management is an important aspect of risk management, particularly in larger organisations. It is important that those with the power and authority to allocate funding for capital or ongoing improvements have access to sufficient information on which to base their decision making.

9 In such circumstances, options for addressing the increased risk of contamination of the water are to increase the cleaning frequency, increase the rate at which biocide is added, install a side-stream filter, or a combination of these.

10 Special events may warrant increased maintenance to address the increased risk associated with large numbers of people coming to or near a site.

11 Public Health and Wellbeing Regulations 2009

10 Communication

Owners and managers need to be clear on what to do, who to notify and how to undertake this notification in the case of an adverse event.

10.1 Adverse events

An adverse event in this context includes:

- an HCC of more than 200,000 CFU/mL
- detection of *Legionella* at any concentration
- being advised of a case of Legionnaires' disease that is possibly associated with the cooling tower system.

The department strongly recommends that every organisation with a cooling tower system develops and maintains an action plan to deal with adverse events. A communication plan needs to contain responses to events of varying seriousness.

10.1.1 High HCC

HCC test results (see Section 8.2.3) indicate to those responsible for the system the extent of control over the system – in particular, the water chemistry. There is no direct correlation between HCC and *Legionella* concentration. For example, it is possible to have a very low HCC and still detect *Legionella*. Equally, it is possible to have a very high HCC but not detect *Legionella*. However, a high HCC (more than 200,000 CFU/mL) is an indicator that the system is moving out of control and may support *Legionella* growth unless action is taken to bring the system back under control. The Public Health and Wellbeing Regulations 2009 specify the action that must be taken for HCC levels above 200,000 CFU/mL (see Section 4.5).

Since HCC is not directly related to Legionnaires' disease, it is not regarded by the department as having the same public health significance as the detection of the disease-causing *Legionella* bacteria.

10.1.2 Detection of *Legionella*

Detecting *Legionella* in the recirculating water of a cooling tower system has public health implications. Consequently, the Public Health and Wellbeing Regulations 2009 require a response within 24 hours, including disinfection of the system, and resampling and testing for *Legionella* 2–7 days later.

10.1.3 Legionnaires' disease

Being advised by the department that a case of Legionnaires' disease is possibly associated with the site must trigger a range of responses, including following the advice of the department in relation to treatment of the cooling tower system on-site.

10.2 Developing a communication plan

A communication plan should consider the responses to each of the adverse events listed above, and describe in detail who will be informed, how they will be informed and what the message will be.

The department strongly recommends that communication plans be developed in an open and participative manner that involves key stakeholders and particularly staff. This can best be done using existing structures such as an occupational health and safety committee.

10.2.1 General issues

In deciding who will be advised of an adverse event, the following issues should be considered.

Due diligence

Due diligence is a legal principle that, to minimise the potential for another party to take legal action against you for failing to properly exercise a duty of care to that person, you should be able to demonstrate that you took all reasonable precautions to stop an adverse event occurring and to minimise the potential impact of damage relating to that event.

In relation to cooling tower systems, this can be demonstrated by a clearly documented process that has reviewed the risks associated with the cooling tower system and developed an action plan that was implemented efficiently.

However, where a cooling tower system has been tested and *Legionella* has been detected, the potential for the system to cause Legionnaires' disease also needs to be considered.

Minimising the adverse impact on the business

Experience with major outbreaks of Legionnaires' disease has shown that linking cases of the disease with particular premises can have a major impact on the business concerned. Immediate and appropriate action is essential, combined with adequate disclosure at appropriate times. Early diagnosis and treatment of people exposed to *Legionella* could enable them to minimise the impact of the disease and could limit the impact on the business.

This approach has to be carefully balanced with the need to avoid causing undue anxiety for those involved.

Minimising the adverse health impacts on exposed people

The potential for serious health effects from Legionnaires' disease needs to be considered when deciding who to notify in the event that *Legionella* is detected. Considerations include whether the tower system is located in, or close to, an acute health or aged residential care facility, or whether other susceptible groups have been exposed to aerosols from the system. This could influence the decision on who and how to notify at an early stage. Notification will allow those potentially exposed to monitor their health and seek medical advice if they show symptoms.

The role of workplace health surveillance

Workplace surveillance to identify staff absent because of ill health (particularly with flu-like symptoms) immediately after *Legionella* has been detected in a cooling tower system can form part of a communication plan. Once identified, the worker concerned may be contacted and in some cases advised to bring the matter to the attention of their medical practitioner. Workplace surveillance may be recommended by the department under some circumstances, such as the possible linking of the site with a case of Legionnaires' disease.

10.2.2 Post-sampling treatment

Many organisations that have had a positive *Legionella* test in a cooling tower system have been reluctant to notify their stakeholders of the result. This is generally because they are unsure of the potential reaction. The workforce or others may be alarmed and want to know what action has been, and will be, taken.

Owners and managers may wish to consider adopting a standard preventive disinfection procedure in which the water of the system is disinfected immediately after the sample is taken.[12] This is a conservative practice, but addresses problems associated with the 10-day time lag between testing and receiving the test results. In the event of a positive test result, staff and others can be advised that the Public Health and Wellbeing Regulations have been followed by disinfection of the system, a review of cooling tower–related programs, correction of any faults and retesting 2–7 days later. In this way, the information about a positive result for *Legionella* can be accompanied by details of the preventive action already taken to disinfect the system, as well as action being taken after the positive test.

10.2.3 Who to inform if *Legionella* is detected

Employers have a legal obligation under the *Occupational Health and Safety Act 2004* to fully inform the elected health and safety representatives at the workplace about all health and safety aspects of the working environment. Detection of *Legionella* in a cooling tower system should be notified to elected health and safety representatives.

The information must also be communicated to those with responsibility for the cooling tower system, including the water treatment provider.

Other people who should also be considered for notification are:

- the chief executive
- staff who may be affected by the cooling tower
- other occupiers of the building
- customers
- service contractors
- neighbours of the site who may have been exposed to aerosols from the system
- medical and occupational health officers of the business
- relevant unions
- site owners
- the employee assistance program (where it exists) to brief counsellors on the issues so they can deal with enquiries from concerned staff who may need counselling
- media liaison staff for the business
- the public spokesperson for the business
- the department's *Legionella* Team[13]
- the local council environmental health officer.

The policy on how and what will be communicated about the problem and the action to be taken needs to be considered. The flow of information in such a situation is summarised in Figure 11. It is not uncommon for industry to have complex management relationships in place on a site.

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12 A cooling tower system is disinfected by dosing the water of the system with:

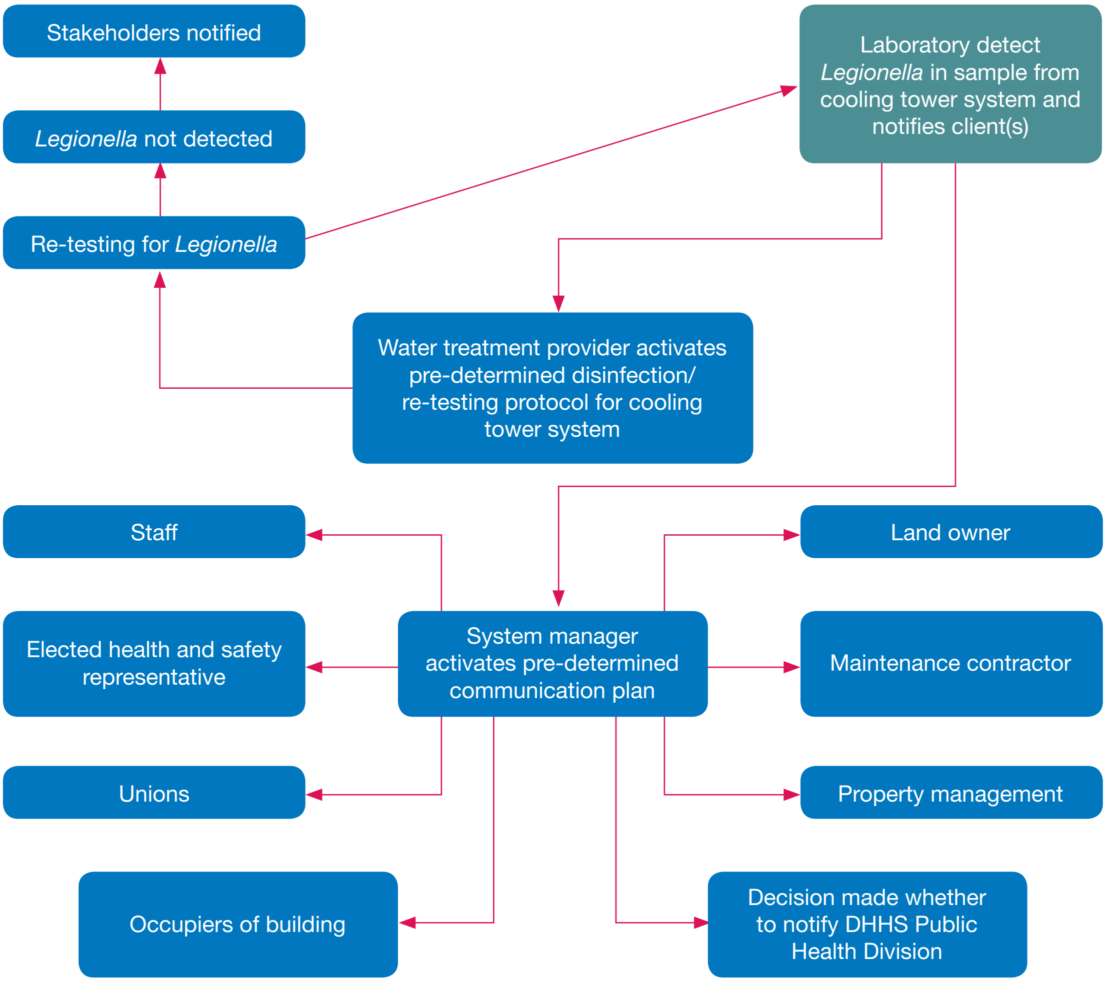
a) a chlorine-based compound, equivalent to at least 10 mg/L of free chlorine for at least an hour, while maintaining the pH of the water between 7.0 and 7.6, or

b) a bromine-based compound, equivalent to at least 20 mg/L of free bromine for at least an hour, while maintaining the pH of the water between 7.0 and 8.5.

13 This is a mandatory action under the circumstances described in Section 10.3.

For example, in a Melbourne CBD office tower, the site may be owned by one company that has outsourced property management. The property manager usually then outsources property maintenance. The property maintenance company outsources mechanical services maintenance, and the mechanical services contractor outsources water treatment for the cooling tower system. Communication in such a complex web of corporate structures is crucial, and should be defined in a communication plan and in contracts between the parties.

Figure 11: Recommended *Legionella* detection communication plan



Action plans will vary from site to site. Appendix 8 provides a model procedure for cooling tower systems in which *Legionella* is detected. Such an education program should ideally occur before an adverse event. It should include basic information about where the cooling tower systems are located, what is done to manage the risks of Legionnaires' disease and what procedures are in place to deal with the detection of *Legionella*.

10.2.4 Who to inform if high HCC is detected

Some organisations are opting to use a totally transparent approach and inform all stakeholders of all bacterial test results. The department considers *as a minimum* that a high HCC result (more than 200,000 CFU/mL) should be communicated to:

- those who are responsible for the cooling tower system
- the occupational health and safety committee – this could be done via a report to the next scheduled meeting of the committee, describing the result and the action that has been taken to address the issue, including water treatment and retesting.

10.3 Notifying the Department of Health and Human Services

The Public Health and Wellbeing Regulations 2009 require that, if *Legionella* is detected in three consecutive water samples taken from the same system, the responsible person (who owns, manages or controls the cooling tower system) must notify the department of the detection of the bacteria immediately by telephone, followed by a written notification within 3 days of the third detection of the organism.

If consecutive adverse results are obtained – such as high HCC levels or the detection of *Legionella* – it is suggested that the RMP be independently reviewed to attempt to identify any weaknesses in the system that can be improved to reduce the overall level of risk.

11 Auditing

The *Public Health and Wellbeing Act 2008* requires that the RMP be independently audited by an approved auditor. This is the 'statutory audit'. It should not be confused with a review of an RMP, which may be conducted at any time by a competent person.

11.1 Why is an audit needed?

The purpose of the audit is to confirm that the RMP addresses the critical risks prescribed in the Public Health and Wellbeing Regulations 2009:

- stagnant water
- nutrient growth
- poor water quality
- deficiencies in the cooling tower system
- location and access.

The auditor will be required to satisfy themselves that the RMP meets the requirements of the *Public Health and Wellbeing Act 2008* and the Public Health and Wellbeing Regulations 2009. The auditor must be satisfied that the risk factors have been considered and addressed as required, based on the risk analysis.

The auditor will also need to view the maintenance logbooks and any other documents referred to in the RMP to satisfy themselves that the RMP is being implemented. For example, where the RMP identifies a work program to install a drift eliminator by a particular date, the auditor will need to see proof that it has been installed, such as a statement from the supplier.

11.2 When and how often is the audit required?

An annual audit of the RMP is required.

11.3 Where can an approved auditor be found?

The *Public Health and Wellbeing Act 2008* specifies that only people approved by the department can be engaged to audit cooling tower system RMPs. All approved auditors are listed on the department's website.[14]

11.4 Does the auditor need to visit the site?

The audit is essentially a paper audit. It may be undertaken by forwarding copies of all relevant documents to the auditor for an off-site audit. This may be particularly suitable in more remote areas where the travel time and costs of attendance on-site would be significant. However, it is important to note that the original documents must be available for inspection at all times.

11.5 What if the auditor does not approve the RMP?

If the auditor believes that the requirements of the legislation have not been met, they must notify the department's *Legionella* Team, who will investigate the report.

14 www.health.vic.gov.au/legionella

11.6 What records need to be maintained for the audit?

In addition to the RMP, the auditor will need to inspect maintenance records.

The Public Health and Wellbeing Regulations 2009 require the responsible person to keep for the preceding 12 months:

- all maintenance activities undertaken in relation to the system; this includes records of any services, cleans, inspections and repairs to the system
- all microbiological test results of samples taken from the system
- any approval issued by the Secretary of the Department of Health and Human Services to use a different method of maintenance and testing.

Appendix 1 Template for cooling tower system risk management plan

Components and format of a risk management plan

Generally, a risk management plan (RMP) should have a number of basic components, including:

- site and contact details
- assessment of each of the critical risks
- summary of the overall risk classification
- details of the system (collected during the risk assessment process)
- attachments or references to other documents, such as operational plans and shut-down procedures.

There is no prescribed format for an RMP. This template is provided as a guide, but other formats may be used.

About the template

The template is designed to be completed:

- by operators of cooling tower system, or landowners who have cooling tower systems on their land
- after reading this guide
- after completing a thorough risk assessment, as outlined in this guide.

This process will meet the requirements of the *Public Health and Wellbeing Act 2008* for development of an RMP.

An RMP must be developed for every cooling tower system on the site. It must be made available to an authorised officer of the Department of Health and Human Services on request.

Implementation of the operational program outlined in the RMP would also meet the requirements of the Public Health and Wellbeing Regulations 2009.

An electronic version of the template (in Word) is also available,15 and can be modified for development of an RMP.

Disclaimer

This document is intended only as a general guide to the development of risk management plans for cooling tower systems. No warranty as to the completeness of the information is given. The Department of Health and Human Services and its employees disclaim all liability and responsibility for any direct or indirect loss or damage that may be suffered through reliance on any information contained in, or omitted from, this document. No person should act solely on the basis of the information contained in the document without obtaining appropriate professional advice about obligations in specific circumstances.

15 www.health.vic.gov.au/legionella/index

Site and key contact details[16]

Record	Details
Site location *(property address)*	
Number of cooling towers in system	
Cooling tower system number[17]	
Registration period[18]	
Tower location reference *(if one exists)*	
Site owner's name and contact details *(Include company name, and contact person's business and after-hours telephone numbers)*	
Cooling tower system owner's name and contact details *(Include company name, and contact person's business and after-hours telephone numbers)*	
Person responsible for day-to-day operation of the cooling tower system *(Include company name, and contact person's business and after-hours telephone numbers)*[19]	
Water treatment provider's name and contact details *(Include company name, and contact person's business and after-hours telephone numbers)*	
Water sampling or laboratory contractor name and contact details *(Include company name, and contact person's business and after-hours telephone numbers)*	
Department of Health and Human Services *Legionella* Team	1800 248 898

16 The *Public Health and Wellbeing Act 2008* requires the department to be notified in writing within 30 days of any change in ownership, address or any other contact details by the owner of the land (or their agent) on which the cooling tower system is located.

17 This is marked on the Certificate of Registration supplied by the department.

18 The department registers cooling tower systems for 1, 2 or 3 years. The registration period is included on the certificate of registration.

19 This person has the authority to approve the disinfection of the system on request of the department. It is not the water treatment service provider.

Critical risks

Stagnant water

Risk control strategy for stagnant water	Assessment of the cooling tower system	Operational or tower system improvement response[20]
Install a timer connected to a recirculating pump set to operate at least once a day to circulate the water	Is the system (or part of the system) idle for more than a month? ❑ Yes ❑ No	
	Where the system (or part of the system) is idle for more than a month, is a recirculating pump with a timer fitted to automatically circulate the water at regular intervals, to prevent it becoming stagnant? ❑ Yes ❑ No[21]	
Remove or activate any 'dead legs'	Are there dead legs in the system? ❑ Yes ❑ No	
Other[22]		

Risk classification for stagnant water[23]	❑ A	❑ B	❑ C	❑ D

20 Indicate the operational program or improvements you will put in place as a result of this assessment.

21 If you do not have a recirculating pump and timer installed, you can address the risk by installing such a pump. You should state the date that the pump will be installed. If you do not propose to install such a pump, you should describe how you will address the risk in the response column.

22 Use this row to describe other risks and response strategies that relate to these risks.

23 Refer to Table 3 in Section 7.2.2 of this guide to find the scenario that matches your system, to evaluate the risk from your system associated with stagnant water.

Nutrient growth

Risk control strategy for nutrient growth	Assessment of the cooling tower system	Operational or tower system improvement response[24]
Identify sources of environmental contamination and, where possible, reduce the amount of contamination	Are there factors in and around the site that may lead to environmental contamination and an increase in the level of nutrients in the water of the cooling tower system? ❑ Yes ❑ No	
	If 'Yes', can you reduce the levels of contamination? ❑ Yes[25] ❑ No[26]	
Control corrosion	Do you have a corrosion control program? ❑ Yes ❑ No[27]	
Increase the frequency of cleaning	How frequently is the tower cleaned?[28]	
Protect the basin and 'top deck' of the tower from sunlight	Are any of the wetted surfaces exposed to sunlight? ❑ Yes[29] ❑ No	
Reduce the water temperature, where possible	Can the water temperature of the tower be reduced? ❑ Yes[30] ❑ No[31]	
Other[32]		

Risk classification for nutrient growth[33]	❑ A	❑ B	❑ C	❑ D

24 Indicate the operational program or improvements you will put in place as a result of this assessment.
25 Describe the strategies in the response column.
26 Describe how you will address the risk in the response column.
27 The Public Health and Wellbeing Regulations 2009 require treatment of the cooling tower system water with chemicals or other agents to minimise corrosion.
28 The Public Health and Wellbeing Regulations 2009 require disinfection, cleaning and re-disinfection before initial start-up or any shut-down period of more than 1 month, and at intervals not exceeding 6 months.
29 Describe how you will address the risk in the response column.
30 Describe how and when you will reduce the temperature in the response column.
31 Describe how you will address the risk in the response column.
32 Use this row to describe other risks and response strategies that relate to these risks.
33 Refer to Table 3 in Section 7.2.2 of this guide to find the scenario that matches your system, to evaluate the risk from your system associated with nutrient growth.

Poor water quality

Risk control strategy for poor water quality	Assessment of the cooling tower system	Operational or tower system improvement response[34]
Ensure comprehensive water treatment program	Do you use two or more biocides in some form of rotation? ❑ Yes ❑ No[35]	
	Is the system continuously treated with a biodispersant? ❑ Yes ❑ No[36]	
	Do you use a biodispersant that is compatible with the other chemicals in use (including chlorine) during the disinfection, cleaning and re-disinfection process? ❑ Yes ❑ No[37]	
	Do you treat the water with anticorrosion chemicals? ❑ Yes ❑ No[38]	
	Have you developed performance indicators that are frequently measured to confirm that the water chemistry is under control? ❑ Yes[39] ❑ No[40]	
Test for HCC	How frequently do you test for HCC?	
Test for *Legionella*	How frequently do you test for *Legionella*?[41]	
Manage HCC	What HCC do you allow before you take remedial action? ❑ 200,000 CFU/mL ❑ Less than 200,000 CFU/mL[42]	
Respond to high HCC results	How do you respond to a high HCC test result? ❑ We follow Figure A1[43] ❑ We follow Figure A2[44] ❑ We follow our own response plan[45]	

34 Indicate the operational program or improvements you will put in place as a result of this assessment.
35 Use of two biocides is recommended, to minimise the risks of bacteria becoming resistant to the biocide.
36 The Public Health and Wellbeing Regulations 2009 require that the system is continuously treated with a biodispersant.
37 The Public Health and Wellbeing Regulations 2009 require the use of a chlorine-compatible biodispersant as part of the disinfection, cleaning and re-disinfection process, which is required (as a minimum) before initial startup or any shut-down period of more than 1 month, and at intervals not exceeding 6 months.
38 The Public Health and Wellbeing Regulations 2009 require treatment of the cooling tower system water with chemicals or other agents to minimise corrosion.
39 Describe these in the response column.
40 Monitoring of performance indicators can increase your confidence that the system is under control and can provide early warning when it is not. Describe how you will address the risk in the response column.
41 The Department of Health and Human Services recommends that every cooling tower system be tested regularly for *Legionella*, as per Section 8.4 of this guide. The Public Health and Wellbeing Regulations 2009 require a minimum of quarterly testing for *Legionella*.
42 If you use a lower number than 200,000 CFU/mL, provide the number in the response column.

Risk control strategy for poor water quality	Assessment of the cooling tower system	Operational or tower system improvement response[34]
Respond to the detection of *Legionella*	How do you respond to *Legionella* being detected in a sample?[46] ❑ We follow Figure A3[47] ❑ We follow another plan that still meets the requirements of the Regulations[48]	
Respond to the detection of *Legionella* on two or more occasions within a 12-month period	How do you respond to *Legionella* being detected in a sample on two or more occasions during a 12-month period[49]? ❑ The RMP is reviewed, in addition to the required actions (refer to Figure A3) ❑ Other (provide details)	
Label the cooling tower system	Is the cooling tower and cooling tower system labelled with the CTS number? ❑ Yes[50] ❑ No[51]	
Ensure appropriate bleed-off rates to prevent a build-up of solids	Is an automated bleed-off device installed?[52] ❑ Yes ❑ No[53]	
Install automated biocide dosing device	Do you have an automated biocide dosing device? ❑ Yes ❑ No[54]	
Install automated dosing devices for all chemicals and agents	Do you have automated dosing devices for all chemicals and agents? ❑ Yes ❑ No[55]	
Select an appropriate point for chemical dosing	Does the chemical dosing occur well away from the sampling point for bacterial tests? ❑ Yes ❑ No[56]	
Provide a dedicated water sampling point	Are water samples always taken from the same point? ❑ Yes ❑ No	
	If 'Yes', is that point clearly labelled with the CTS number?[57] ❑ Yes ❑ No	
	Has a sampling tap been fitted? ❑ Yes ❑ No	

46 The Public Health and Wellbeing Regulations 2009 require that action is taken following the detection of *Legionella*.
47 This refers to Figure A3 in Appendix 4, which summarises aspects of the requirements of the Public Health and Wellbeing Regulations 2009.
48 Detail the process that you will follow in the response column.
49 Section 92(2) of the Public Health and Wellbeing Act 2008 requires the owner of the land to take all reasonable steps to ensure that the RMP is reviewed, and if necessary updated, if *Legionella* is detected in the cooling tower system on two or more occasions in any period of 12 months.
50 Describe where the label appears on the system in the response column. The department recommends that you use a system where a tower is labelled with the CTS number (e.g. '1234') followed by a slash and then a number or other identifying mark to describe the tower (e.g. '1234/1' would designate Tower 1 of system 1234).
51 Describe in the response column how you will deal with the risk of confusion about which tower or system is being referred to in service reports or laboratory test results (among other things).
52 Best practice is the use of conductivity-controlled meters fitted with lock-out devices to prevent excessive loss of chemicals during the bleed-off process.
53 Describe how you will address the risk of poor water quality in the response column.
54 Best practice is the use of electronic, programmable, automated dosing units. Describe how you will address the risks of biocide failure in the response column.
55 Best practice is the use of electronic, programmable, automated dosing units. Describe how you will address the risks of inadequate chemical dosing in the response column.
56 You should modify your sampling program to ensure that you are getting representative results.
57 This number is printed on your Certificate of Registration.

Risk control strategy for poor water quality	Assessment of the cooling tower system	Operational or tower system improvement response[34]
Install a side-stream filter if environment is dirty	Is the environment around the tower dirty? ❑ Yes ❑ No	
	If 'Yes', do you have a side-stream filter? ❑ Yes ❑ No[58]	
Other[59]		

CFU = colony forming unit; CTS = cooling tower system; HCC = heterotrophic colony count

Risk classification for poor water quality[60]	❑ A	❑ B	❑ C	❑ D

58 Describe how you will address the risk in the response column.

59 Use this row to describe other risks and response strategies that relate to these risks.

60 Refer to Table 3 in Section 7.2.2 of this guide to find the scenario that matches your system, to evaluate the risk from your system associated with poor water quality.

Deficiencies in the cooling tower system

Risk control strategy for deficiencies in the cooling tower system	Assessment of the cooling tower system	Operational or tower system improvement response[61]
Review the system design against AS/NZS 3666	Has a review been conducted? ❑ Yes ❑ No[62]	
	Can any improvements be made to the system design to reduce risks? ❑ Yes[63] ❑ No[64]	
Review current performance of system	Has a review been conducted? ❑ Yes[65] ❑ No[66]	
Develop operating and maintenance manuals	Have operating and maintenance manuals been developed? ❑ Yes ❑ No[67]	
Review the useful life of the system and plan to replace it at an appropriate time	When was the tower built?	
	Do you have a program to replace it? ❑ Yes[68] ❑ No[69]	
Install a modern, high-efficiency drift eliminator	Is a modern, high-efficiency drift eliminator fitted to every tower in the system? ❑ Yes ❑ No[70]	
	Are the drift eliminators in good condition? ❑ Yes ❑ No[71]	
	Have the drift eliminators been certified by the manufacturer as meeting AS/NZS 3666? ❑ Yes ❑ No[72]	
Use suitable materials for external components	Have you reviewed the condition of the tower structure? ❑ Yes[73] ❑ No[74]	

61 Indicate the operational program or improvements you will put in place as a result of this assessment.
62 Describe how you will address the risk in the response column.
63 Describe the improvements in the response column.
64 Describe how you will address the risk in the response column.
65 Describe the improvements in the response column.
66 Without a review, it is impossible to complete a proper risk assessment. Describe how you will address the risks without the review in the response column.
67 Describe how you will address the risks in the response column.
68 Describe when you plan to replace the system in the response column.
69 Describe how you will address the risks in the response column.
70 Describe how you will address the risk of excessive drift leaving the towers in the response column (e.g. by installing a drift eliminator that complies with AS/NZS 3666).
71 Describe how you will address the risk of excessive drift leaving the towers in the response column (e.g. by installing a drift eliminator that complies with AS/NZS 3666).
72 Describe how you will address the risk of excessive drift leaving the towers in the response column (e.g. by installing a drift eliminator that complies with AS/NZS 3666).
73 Describe the improvements in the response column.
74 Describe how you will address the risk in the response column.

Risk control strategy for deficiencies in the cooling tower system	Assessment of the cooling tower system	Operational or tower system improvement response[61]
Use suitable materials for internal components	Have you reviewed the materials and condition of the internal components of the tower system? ❑ Yes[75] ❑ No[76]	
Other[77]		

Risk classification for deficiencies in the cooling tower system[78]	❑ A	❑ B	❑ C	❑ D

75 Describe the improvements in the response column.

76 Describe how you will address the risk in the response column.

77 Use this row to describe other risks and response strategies that relate to these risks.

78 Refer to Table 3 in Section 7.2.2 of this guide to find the scenario that matches your system, to evaluate the risk from your system associated with deficiencies in the cooling tower system.

Location and access

Risk control strategy for location and access	Assessment of the cooling tower system	Operational or tower system improvement response[79]
Understand the extent of potential exposure to the cooling tower	Is the cooling tower system located in an acute health or aged residential care facility? ❑ Yes[80] ❑ No	
	If 'No', is the cooling tower system located within 500 m of an acute health or aged residential care facility? ❑ Yes[81] ❑ No	
Minimise access to tower and surrounds	How many people have access to the tower and its surrounds?[82] ❑ Very high numbers[83] ❑ High numbers[84] ❑ Moderate numbers[85] ❑ Low numbers[86]	
	Are warning signs[87] displayed around the tower? ❑ Yes ❑ No[88]	
	Is the area around the cooling tower system used as a gathering place for staff and visitors, particularly smokers? ❑ Yes[89] ❑ No	
	Is access to the tower restricted? ❑ Yes ❑ No[90]	
Relocate the tower to a more remote site or less contaminated environment (where possible)	Have you reviewed whether it is possible to relocate the tower to a safer location? ❑ Yes[91] ❑ No[92]	

79 Indicate the operational program you will put in place as a result of this assessment.
80 Classify as risk category A and respond with the highest standards of maintenance and surveillance.
81 Classify as risk category B (at the minimum) and respond with high standards of maintenance and surveillance.
82 Consider the surroundings within 500 m of the cooling tower
83 Refer to Figure 10 of this guide.
84 Refer to Figure 10 of this guide.
85 Refer to Figure 10 of this guide.
86 Refer to Figure 10 of this guide.
87 For example, 'Authorised persons only'.
88 Describe in the response column how you will address the risks without such signs.
89 Describe in the response column how you will address the risk of smokers being in close proximity to the cooling tower.
90 Describe in the response column how you will address the risks until access to the tower has been restricted.
91 Describe outcomes of the review in the response column.
92 Describe in the response column how you will address the risk of location and access without such a review.

Risk control strategy for location and access	Assessment of the cooling tower system	Operational or tower system improvement response[79]
Ensure that there is a safe and stable area for maintenance workers to access the cooling tower system	Have you reviewed the working environment for maintenance workers?[93] ❑ Yes[94] ❑ No[95]	
Other[96]		

Risk classification for location and access[97]	❑ A	❑ B	❑ C	❑ D

Risk assessment summary

Critical risk	Risk classification[98]			
Stagnant water	❑ A	❑ B	❑ C	❑ D
Nutrient growth	❑ A	❑ B	❑ C	❑ D
Poor water quality	❑ A	❑ B	❑ C	❑ D
Deficiencies in the cooling tower system	❑ A	❑ B	❑ C	❑ D
Location and access	❑ A	❑ B	❑ C	❑ D
Are there any other considerations that may affect the overall risk assessment of the cooling tower system?				
Overall cooling tower system risk classification category	❑ A	❑ B	❑ C	❑ D

93 This is a key area in terms of meeting your responsibilities under the Occupational Health and Safety Act.
94 Describe in the response column the outcomes of the review (e.g. any actions to be taken).
95 Describe in the response column how you will address the risks without such a review.
96 Use this row to describe other risks and response strategies that relate to these risks.
97 Refer to Table 3 in Section 7.2.2 of this guide to find the scenario that matches your system, to evaluate the risk from your system associated with location and access.
98 Tick the appropriate box based on your responses to the questions in Table 3 in Section 7.2.2 of this guide.

Attachments[99]

Operational program

Recommended operational programs based on risk classification

Program A	Program B	Program C	Program D
Weekly inspection	Monthly inspection (2 weeks after service)	Monthly inspection (2 weeks after service)	Monthly service
Fortnightly service	Monthly service	Monthly service	
HCC and *Legionella* tested at a minimum of once each month	HCC and *Legionella* tested monthly	HCC tested monthly *Legionella* tested every 2 months	HCC tested monthly *Legionella* tested every 3 months
Six monthly cleaning, or more frequently where environmental contamination (e.g. dust, soil, building works) is a problem			

HCC = heterotrophic colony count

Element	Response	
Describe your maintenance program	❑ Department of Health and Human Services program A	
	❑ Department of Health and Human Services program B	
	❑ Department of Health and Human Services program C	
	❑ Department of Health and Human Services program D	
	❑ Self-developed	
	❑ Developed by consultant	
If self-developed or developed by consultant, complete remainder of table		
Service frequency	❑ Weekly	
	❑ Fortnightly	
	❑ Monthly	
HCC testing frequency	❑ Monthly	❑ Every ………… week(s)
Legionella testing frequency	❑ Every 3 months	❑ Every ………… weeks/months
Tower cleaning frequency	❑ Every 6 months	❑ Every ………… months
Inspection frequency	❑ Every ………… weeks/months	

99 Other information that can be appended to the RMP includes site plan, photographs, schematics of water flows, cooling tower makes and models, and basic system parameters (e.g. system volume, system heat rejection capacity, system operating temperature).

Monitoring and review

Element	Response
Date that the RMP is due for review	
Name and title of person responsible for the review	
Date that the RMP was reviewed	
Are all site and key contact details accurate? Has the Department of Health and Human Services been notified of any changes?	❑ Yes ❑ No
Is the cooling tower system currently registered with the Department of Health and Human Services?	❑ Yes ❑ No
Does the RMP require amendment?	❑ Yes ❑ No
Was the review conducted as a result of a triggering event?[100]	
If the RMP requires amendment, dates that the amendments were due and completed	Due
	Completed

100 Under section 92(2) of the Public Health and Wellbeing Act 2008, the owner of the land must take all reasonable steps to ensure that the RMP is reviewed and, if necessary, updated, if:

- *Legionella* is detected in the cooling tower system on two or more occasions in any period of 12 months; or
- the owner of the land is given written advice by the Secretary of the Department of Health and Human Services that a case of Legionnaires' disease is associated with the cooling tower system; or
- the owner of the land receives a report from the Secretary, any person engaged by the owner of the land or the owner of the cooling tower system that control measures used for the cooling tower system are inadequate or require improvement; or
- there is a significant change in
- any of the environmental conditions under which the cooling tower system operates; or
- the operation of the cooling tower system; or
- the owner of the land receives an audit certificate that states that the RMP does not address the prescribed risks.

Communication

Element	Details			
List parties (names and contact details) who will be informed in the event of a positive *Legionella* test	**Category**	**Name and title**	**Telephone**	**Comment**
	Staff			
	Occupational health staff or contractors			
	Unions			
	Building owner			
	Other building occupiers			
	Medical officer			
	Staff counsellors			
	Department of Health and Human Services *Legionella* Team		1800 248 898 or email legionella@health.vic.gov.au	
	Media liaison officer			
	Company spokesperson			
	Chief executive			
	Other (specify)			

Endorsement of risk management plan

Name and position of person responsible for risk management plan	
Signature	Date

Appendix 2 Responsibilities of stakeholders

Stakeholder	Responsibility
Landowner	• Register all cooling tower systems on the land • Take all practicable steps to ensure that an RMP is developed for all cooling tower systems • Take all practicable steps to ensure that the RMPis reviewed annually • Take all practicable steps to ensure that the RMP is audited annually for all cooling tower systems • Ensure that reasonable steps are being taken to minimise the risks
System owner	• Allocate sufficient resources to manage the risks of *Legionella* • Ensure that the Public Health and Wellbeing Regulations 2009 are complied with
System manager	• Ensure that the Public Health and Wellbeing Regulations 2009 are complied with • Manage contracts that relate to the system • Ensure that any reports from contractors requiring action are actioned promptly • Report to senior management any requirements for capital expenditure • Ensure that reasonable steps are taken to minimise the risks
Property manager	• Manage contracts that relate to the system • Ensure that any reports from contractors requiring action are actioned promptly • Report to the client any requirements for capital expenditure, and any significant public health or safety issues
Property maintenance contractor	• Manage contracts that relate to the system • Ensure that any reports from contractors requiring action are actioned promptly • Report to the client any requirements for capital expenditure, and any significant public health or safety issues
Mechanical services maintenance contractor	• Manage contracts that relate to the system • Ensure that any reports from contractors requiring action are actioned promptly • Report to the client any requirements for capital expenditure, and any significant public health or safety issues
Water treatment provider	• Comply with the Public Health and Wellbeing Regulations 2009 • Provide advice to clients on water treatment issues • Treat water to minimise risks of *Legionella* growth
RMP consultant	• Perform a comprehensive risk assessment that identifies risks to the client and recommends corrective actions to minimise these risks • Ensure that the draft RMP meets legal requirements for client acceptance
Cooling tower supplier	• Confirm that tower meets AS/NZS 3666
Cooling tower system designer	• Ensure that the system meets AS/NZS 3666, and reduces risks of ‘dead legs’ and *Legionella* growth in general

RMP = risk management plan

Appendix 3 Decommissioning a cooling tower system

Where an existing cooling tower system is no longer required, the following actions should be taken:

- Drain the cooling tower system to the sewer, in accordance with any advice from the local water authority.
- Remove chemical dosing tanks.
- Disconnect the power supply to the system.
- Disconnect the water supply to the system.
- Remove the tower and preferably the other components of the system. Where this is not practical, place a sign on the tower indicating that the system must not be reactivated.

The Department of Health and Human Services must be notified within 30 days that a cooling tower system has been decommissioned. This can be done using a form that is available on the department's website (www.health.vic.gov.au/legionella).

Appendix 4 Model operational program

Scope of work

The maintenance program includes:

- treatment of the cooling tower system for control of corrosion, scale formation and fouling, and to minimise microbiological growth (ensuring that it remains at safe levels)
- testing of the water for heterotrophic colony count (HCC) (also called total bacteria or total plate count)
- testing of the water for *Legionella*
- monitoring of the cooling tower system structure itself to ensure that the cooling tower equipment is operating effectively, and that the cooling tower system is safe and free from hazards.

Chemical program

The chemical program must incorporate use of:

- a corrosion and scale inhibitor
- at least one biocide (preferably two, used in rotation)
- a biodispersant to help remove any biofilm in the system.

Bacterial testing

Bacterial testing is required as follows.

Heterotrophic colony count

- Sampling for HCC in accordance with AS/NZS 3666.3 for sample collection, and AS 2031 for selection of containers and preservation of water samples for microbiological testing.
- Analysis of water samples for HCC in accordance with AS 4276.3 by a laboratory accredited by the National Association of Testing Authorities.
- Analysis commenced within 24 hours of the sample being taken.[101]

Legionella

- Sampling for *Legionella* in accordance with AS/NZS 3666.3 for sample collection, and AS 2031 for selection of containers and preservation of water samples for microbiological testing.
- Transport of the samples to the laboratory as soon as possible.
- Testing for *Legionella* by a laboratory in accordance with AS/NZS 3896 (*Waters – Examination for Legionella spp. including Legionella pneumophila*) by a laboratory accredited by the National Association of Testing Authorities.

101 In some remote areas, it is not always possible to achieve this objective, but analysis must still take place in the shortest practicable time. Contact should be made with the testing laboratory to determine the best transport option.

Reporting

Reporting of all results must include:

- for any results that exceed the limits set by legislation or this contract (whichever is more stringent), immediate notification by fax or email,[102] and a follow-up telephone call to confirm receipt
- emailing of a copy of all results[103]
- availability to discuss results, either by telephone or on-site, as appropriate.

Poor results

The Public Health and Wellbeing Regulations 2009[104] specify the following with regard to HCC:

1. Within 24 hours of receiving a report from a laboratory that any sample of water taken from the cooling tower system has a heterotrophic colony count exceeding 200,000 colony forming units per millilitre, the responsible person must ensure that the following procedure is implemented:
   a. the water of the system must be manually treated with additional quantities of biocide or with an alternative biocide; and
   b. the water treatment program, tower operation and maintenance program of the system must be reviewed; and
   c. any faults must be corrected; and
   d. any changes necessary to prevent a re-occurrence of those faults must be implemented.
5. Between 2 and 7 days after the water has been treated under subregulation (1), the responsible person must ensure that a further sample of the recirculating water of the system is taken and is delivered to a laboratory for testing and reporting on for heterotrophic colony count.
6. Within 24 hours of receiving a report from a laboratory that a sample taken in accordance with subregulation (2) has a heterotrophic colony count exceeding 200,000 colony forming units per millilitre, the responsible person must ensure that the water of the cooling tower system is disinfected.
7. Between 2 and 7 days after the water has been disinfected under subregulation (3), the responsible person must ensure that a further sample of the recirculating water of the cooling tower system is taken and is delivered to a laboratory for testing and reporting on for heterotrophic colony count.
8. If, after following the procedure in subregulations (1), (2), (3) and (4), the heterotrophic colony count still exceeds 200,000 colony forming units per millilitre, the responsible person must:
   a. ensure that the steps in subregulations (3) and (4) are repeated until the heterotrophic colony count does not exceed 200,000 colony forming units per millilitre in 2 consecutive water samples taken approximately one week apart; or
   b. close the cooling tower system until the problem has been remedied.

These Regulations are summarised in Figure A1.

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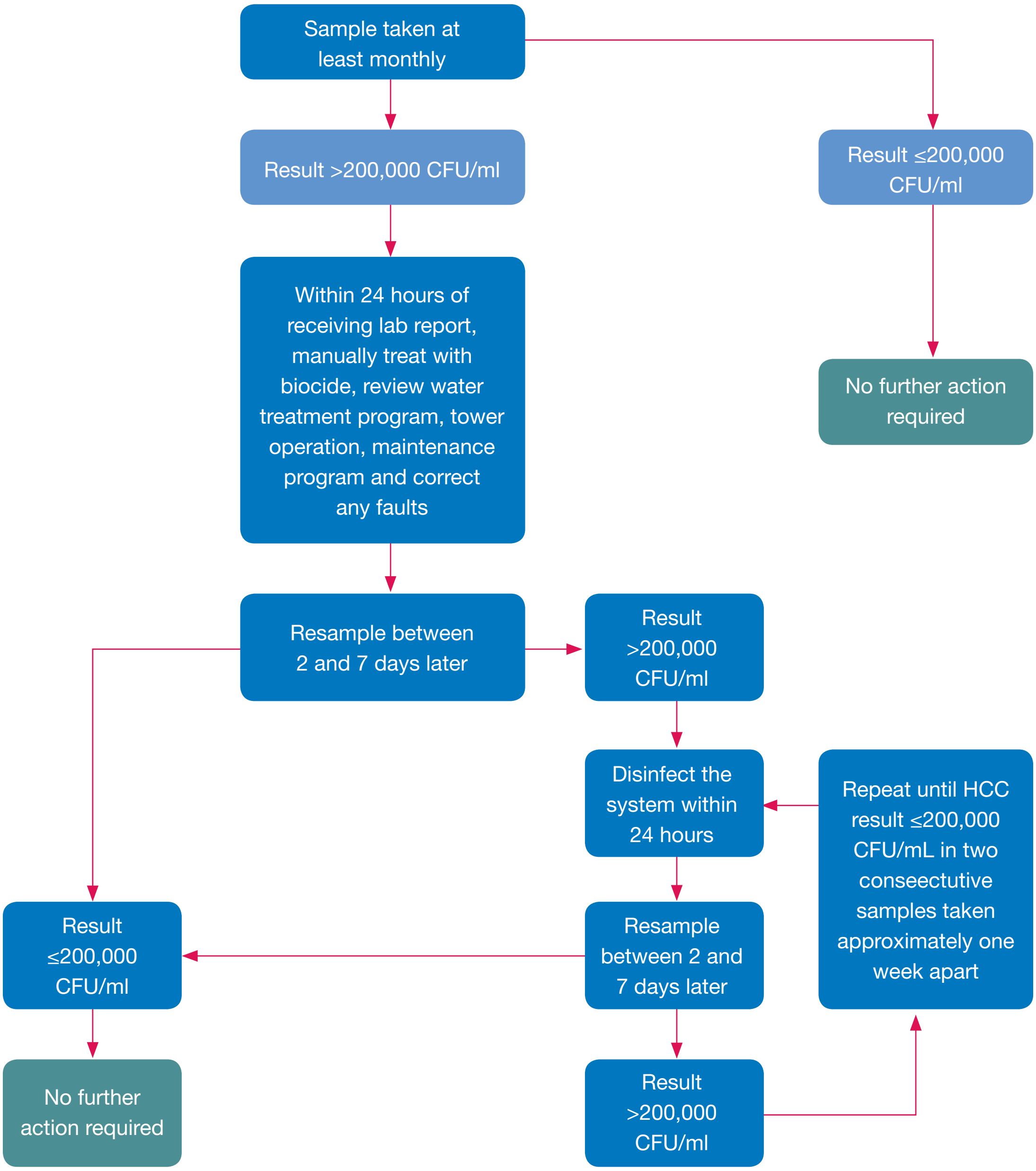
102 Where the sampling and maintenance have been outsourced to one company that then subcontracts to another company for microbiological analysis, it is important that you obtain a copy of the testing laboratory's results rather than a report from the maintenance contractor.

103 Where available

104 Regulation 57

Figure A1: Standard HCC sampling and response

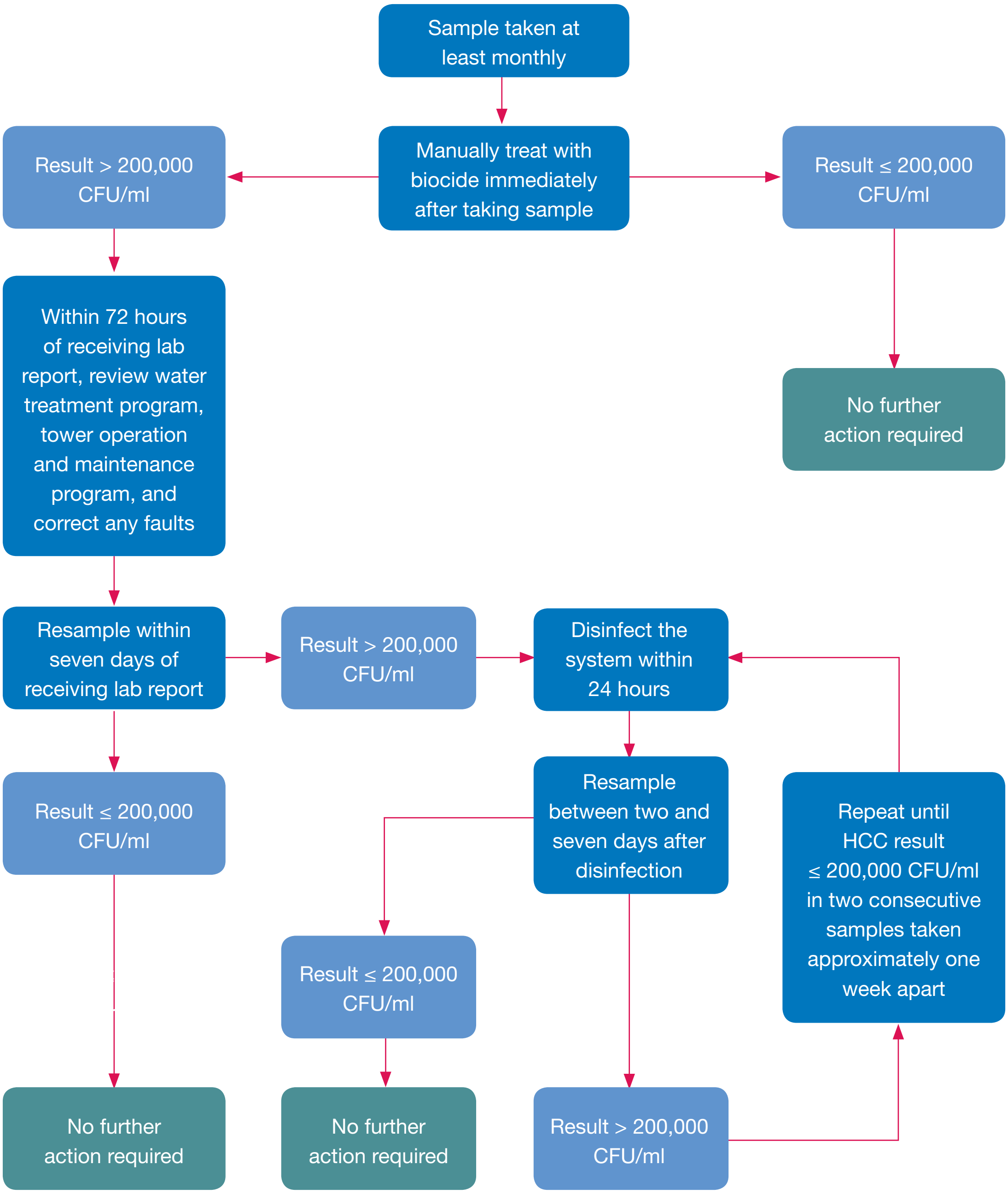


The Regulations further state:

1. The responsible person is not required to comply with subregulations (1) to (5) if:
   a. during the period between the sample being taken for the purpose of regulation 56(2) and the receipt of a report from a laboratory indicating that the cooling tower system has a heterotrophic colony count exceeding 200,000 colony forming units per millilitre, the system was manually treated with additional quantities of biocide or an alternative biocide; and
   b. within 72 hours of receiving the report that any sample of water taken from the cooling tower system has a heterotrophic colony count exceeding 200,000 colony forming units per millilitre, the responsible person–
      - reviews the water treatment program, tower, operation and maintenance program; and
      - corrects any faults and makes changes necessary to prevent a re-occurrence of those faults; and
   c. within 7 days of receiving the report in subregulation (6)(b), the responsible person ensures that a further sample of the recirculating water of the system is taken and is delivered to a laboratory for testing and reporting on for heterotrophic colony count;
   d. within 24 hours of receiving a report that a sample taken in accordance with subregulation (6)(c) has a heterotrophic colony count exceeding 200,000 colony forming units per millilitre, the responsible person –
      - ensures the water in the cooling tower system is disinfected; and
      - between 2 and 7 days after the water has been disinfected in accordance with paragraph (i), ensures that a further sample of the recirculating water of the system is taken and is delivered to a laboratory for testing and reporting on for heterotrophic colony count;
   e. after following the procedure in subregulation (6)(d) the heterotrophic colony count continues to exceed 200,000 colony forming units per millilitre, the responsible person –
      - ensures the steps in subregualtion (6)(d) are repeated until the heterotrophic colony count does not exceed 200,000 colony forming units per millilitre in 2 consecutive water samples taken approximately one week apart; or
      - closes the cooling tower system until the problem has been remedied.

These Regulations are summarised in Figure A2.

Figure A2: Alternative HCC sampling and response



The Public Health and Wellbeing Regulations 2009[105] specify the following with regard to *Legionella*:

1. Within 24 hours of receiving a report that *Legionella* has been detected in a water sample taken from a cooling tower system, the responsible person must ensure that the following procedure is implemented :
   a. the cooling tower system must be disinfected; and
   b. the water treatment program, tower operation and maintenance programs of the system must be reviewed; and
   c. any faults must be corrected and any changes necessary to prevent a re-occurrence of those faults must be implemented.
4. Between 2 and 7 days after the disinfection required by subregulation (1)(a) has been completed, the responsible person must ensure that a further sample of the recirculating water of the system is taken and is delivered to a laboratory for testing and reporting on for *Legionella*.
5. Within 24 hours of receiving a report that *Legionella* has been detected in a sample taken in accordance with subregulation (2), the responsible person must ensure that the water of the cooling tower system is disinfected, cleaned and re-disinfected.[106]
6. Between 2 and 7 days after the disinfection required by subregulation (3) has been completed, the responsible person must ensure that a further sample of the recirculating water of the system is taken and is delivered to a laboratory for testing and reporting on for *Legionella*.
7. If, after following the procedure in subregulations (1), (2), (3) and (4), *Legionella* is still detected, the responsible person must:
   a. ensure that the steps in subregulations (3) and (4) are repeated until *Legionella* is not detected in 2 consecutive water samples taken approximately one week apart; or
   b. close the cooling tower system until the problem has been remedied.

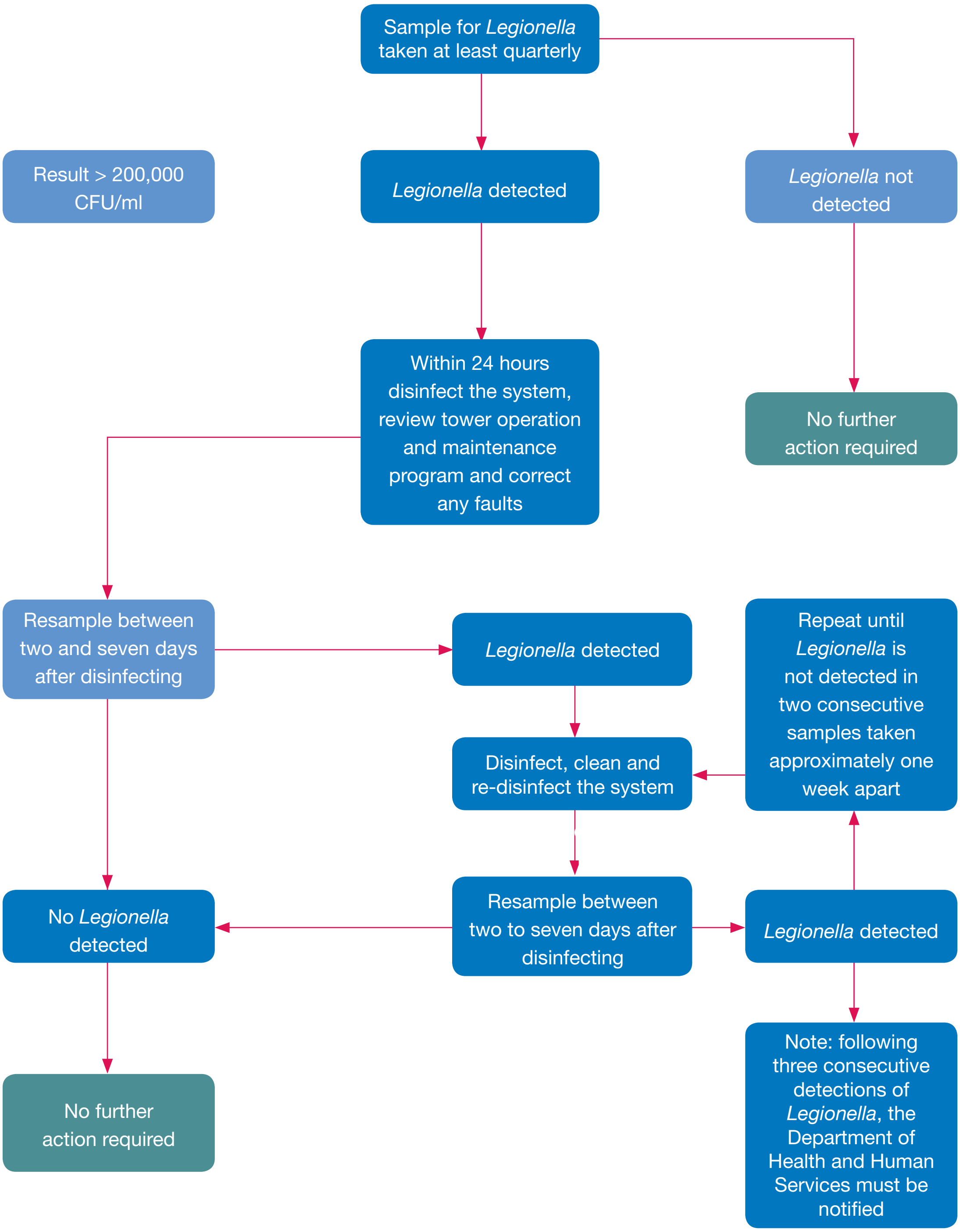
These Regulations are summarised in Figure A3.

1. If, while following the procedure in this regulation *Legionella* is detected in 3 consecutive water samples taken from the same system, the responsible person must notify the Secretary of the detection of the presence of that organism:
   a. immediately by telephone; and
   b. by notice in writing within 3 days.

105 Regulation 58

106 A chlorine-compatible biodispersant must be added to the recirculating water, and the system must then be disinfected by dosing the water with a chlorine-based biocide, equivalent to 10 mg/L of free chlorine for at least 1 hour, while maintaining a pH of between 7.0 and 7.6. A bromine-based compound may be used equivalent to at least 20 mg/L of free bromine for at least 1 hour, while maintaining the pH of the water between 7.0 and 8.5.

Figure A3: *Legionella* sampling and response



Service frequency

The service frequency shall be as specified in the operational plan.

The service shall ensure that:

- water quality is checked
- chemical dosing tanks are refilled
- empty tanks are removed from the site
- dosing and control equipment is checked, and is operating correctly; if problems are observed, remedial action will be taken to fix the problem
- the wetted components will be inspected, and the general integrity of the system (including cleanliness) will be checked; action will be taken to remedy any problems.[107]

In addition to the service frequency, the corrosion coupons (metal test plates) will be checked every 3 months for signs of corrosion. The corrosion coupons must be of the same types of metal as those used in the cooling tower system, and are to be immersed in the system water and checked as above.[108]

All samples of water to be taken for bacterial testing (HCC and/or *Legionella*) must be taken before any addition of chemicals.

Tower cleaning

Tower cleaning shall be in accordance with the operational program.[109]

The tower cleaning process should be as follows:

3. Thoroughly clean the internal shell, fill and tower sump by brushing and/or hosing all surfaces.
4. Remove all debris.
5. Thoroughly clean internally and externally all water filters, strainers, separators, water nozzles and fittings associated with the water distribution system.

Service report

A service report must be completed at the time of each visit, detailing all test results, observations and actions taken, including repairs, maintenance and testing work. The information to be provided as a minimum following each visit is shown in Appendix 6.

A copy of the service report[110] is to be provided to the responsible person, and any points of significance are to be discussed with the contract manager.

107 Insert other requirements

108 You may need to seek independent specialist advice about the risk of corrosion in your system and the best ways to control and monitor it.

109 Insert desired cleaning frequency (e.g. 6-monthly).

110 The Public Health and Wellbeing Regulations require the responsible person for the cooling tower system to keep records of all microbiological test results, as well as maintenance and corrective activities undertaken in relation to the system during the preceding 12 months. These records must be produced for inspection at the request of authorised officers from the Department of Health and Human Services. Electronic record keeping is becoming more popular, and the department considers this to meet the requirement of the Regulations, provided that these records can be produced on request.

Appendix 5 Routine inspection of a cooling tower system

A routine inspection by a competent person as described in this guide should include checks of:

- power supply
- connection and integrity of chemical dosing lines
- water clarity
- levels of dosing chemicals within tanks
- performance indicators, such as chemical parameters
- obvious visible corrosion
- obvious physical defects or damage
- pump operation.

Appendix 6 Model service report

At a minimum, the written service report should include the following components:

- Date of service or inspection.
- Identification of the cooling tower system.
- Identification of particular towers.
- Name of the person and organisation conducting the inspection or service.
- Type, make and model of the cooling tower(s).
- Water storage volumes for dosing calculations.
- Details of the inspection – for example, what was the purpose and scope?
- Details of any actions, such as:
  - any chemicals added and their volumes
  - whether the bleed-off rate was checked
  - whether the tower(s) were cleaned
  - whether the cooling tower water was tested for chemical levels, and the results for key parameters such as pH
  - whether the cooling tower water was tested for bacteria – What tests were requested? What is the name of the laboratory? What were the results?

It is advisable for the desired or target range for each parameter to be listed as part of the result, and a statement (with comments, if required) provided of whether the test result was within the range.

Appendix 7 Key elements of a model service contract

Disclaimer

This document describes only the key elements that should be considered in a contract for treatment and servicing of a cooling tower system to manage the risk of *Legionella* infection. The precise terms and conditions of the contract – including its duration and price, and the conditions under which it may be terminated – will need to be determined by the contracting parties themselves. The document is not intended to replace the need for contracting parties to obtain their own specialist commercial or legal advice.

Introduction

This specification deals with best-practice management of corrosion and microbiological control for *(insert name of company)*.

The service required will include the supply of chemicals and services for treatment of the cooling tower at *(insert address of site)*. This includes full cleaning of the tower, including disinfection.

The attached plan shows the cooling tower systems covered by the contract and the piping layout for the system.

Scope of work

The contractor shall supply all necessary chemicals and provide all necessary technical services to:

- maintain the cooling tower in accordance with the attached maintenance schedule
- ensure that our staff, contractors and the public are not affected by water treatment maintenance or the operation of the cooling tower
- meet all occupational health and safety obligations
- note and report any mechanical faults associated with the cooling tower to the contract manager.

Quarterly meetings

The contractor shall attend a meeting each quarter with the contract manager to:

- review compliance with Australian Standards AS/NZS 3666, AS 2031, AS 4276.3.1 and AS/NZS 3896, and legislation (including the Public Health and Wellbeing Regulations 2009)
- discuss the performance of the cooling tower and the contractor, including any works program that may be required.

Indicators

The contractor shall ensure that:

- the heterotrophic colony count complies with the Public Health and Wellbeing Regulations 2009 in at least 95% of tests over a 12-month period, and that *Legionella* is not detected in any samples
- corrosion is at low levels – no visible signs of corrosion should be present[111]
- chemical control is maintained in accordance with an agreement to be reached before the commencement of the contract. The ranges in the table below are provided for guidance.

111 You may need to seek engineering advice about an acceptable rate of corrosion for your business operation.

Indicative water quality target ranges	
Bacteria	
Legionella	Not detected (<10 CFU/mL)
Heterotrophic colony count	Less than 200,000 CFU/mL
Solids	
Total dissolved solids	Less than 1,000 mg/L
Conductivity	Less than 1,500 µS/cm
Suspended solids	Less than 150 mg/L
Calcium hardness	Less than 180 mg/L
pH	
pH (for bromine-based compounds)	7–8.5
pH (for chlorine-based compounds	7–7.6
Total alkalinity	80–300 mg/L
Other additives	
Biodispersant	Follow the manufacturer's specifications
Corrosion inhibitor	Follow the manufacturer's specifications

CFU = colony forming units

Where the results of testing do not meet the requirements of the Public Health and Wellbeing Regulations 2009, the contractor must immediately notify the contract manager.

Occupational health and safety

The contractor is responsible for the safety of its employees while on-site, in all matters over which the contractor has control. All equipment brought on site by the contractor or its employees must fulfil the requirements of occupational health and safety legislation.

Quality assurance

The contractor shall have a formal quality assurance system in place and provide evidence that the quality assurance system has been audited each year.

Insurance

The contractor shall have both professional indemnity and public risk insurance in place for the supply of services for the term of this contract. The contractor shall provide an annual confirmation of the continued existence of the policies.[112]

112 The level of insurance should address the worst-case scenario where the cooling tower is demonstrated to have been the source of an outbreak of Legionnaires' disease.

Appendix 8 Model procedure following *Legionella* being detected in a cooling tower system

Background

The Public Health and Wellbeing Regulations 2009 require cooling tower systems to be continuously and effectively treated with one or more biocides to effectively control the growth of microorganisms, including *Legionella*.

Cooling tower systems should also be continuously treated with chemicals and other agents to minimise scale formation, corrosion and fouling, and with a biodispersant.

{…responsible person…} is responsible for the operation of the cooling tower system within **{…company name…}**. If he/she is unavailable, **{…emergency contact…}** is to be contacted.

{…water treatment provider…} is employed to undertake the maintenance, cleaning and bacterial testing of the cooling tower system.

If *Legionella* is detected, **{…water treatment provider…}** will telephone or email **{…responsible person…}** with the initial results, and then send a written report with the results of heterotrophic colony count (HCC) and *Legionella* tests by email.

Phone numbers:

Responsible person:

Emergency contact:

Water treatment provider:

Legionella detection

If *Legionella* is detected in a sample of water taken from the cooling tower system at **{site address}**, the following actions will be taken:

1. **{…responsible person…}** will contact the water treatment provider to arrange for the disinfection[113] of the cooling tower system, and review[114] the water treatment program, tower operation and maintenance program of the system. The water treatment provider will correct any faults identified within 24 hours of the *Legionella* notification.

   {…responsible person…} will advise people in the manner described and listed in the table below, and continue to communicate with these stakeholders as the *Legionella* detection is addressed.

2. **{…responsible person…}** will arrange for **{…water treatment provider/other…}** to take a sample of water from the cooling tower system and submit it to the laboratory for *Legionella* testing between 2 and 7 days after the disinfection.

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113 Disinfection of a cooling tower system is achieved by dosing the water of the system with:
- a chlorine-based compound, equivalent to at least 10 mg/L of free chlorine for at least 1 hour, while maintaining the pH of the water between 7.0 and 7.6; or
- a bromine-based compound, equivalent to at least 20 mg/L of free bromine for at least 1 hour, while maintaining the pH of the water between 7.0 and 8.5.

114 This review must be documented. It will usually involve the water treatment company and staff with expertise in the process.

If *Legionella* is detected in a second consecutive sample of water:

3. **{…responsible person…}** will arrange for the water treatment provider to clean the cooling tower system. This means that the cooling tower system will be disinfected, cleaned and re-disinfected.
4. **{…responsible person…}** will arrange for **{…water treatment provider/other…}** to take a sample of water from the cooling tower system and submit it to the laboratory for *Legionella* testing between 2 and 7 days after the clean.

   If *Legionella* is detected after following the steps above:

5. **{…responsible person…}** will repeat steps 3 and 4 until *Legionella* is not detected in two samples taken approximately 1 week apart, or close the cooling tower system until the problem has been corrected.

   If *Legionella* is detected in three consecutive water samples:

6. **{…responsible person…}** will notify the Department of Health and Human Services *Legionella* Team by calling 1800 248 898 immediately and by emailing Legionella@health.vic.gov.au within 3 days of receiving notification of the detection.

If **{responsible person}** is unavailable, **{emergency contact**} is to undertake the role of the responsible person.

Positive *Legionella* test notification list

Category	Name and position	Telephone	Responsibility for notification
Staff			To be advised by … [115]
Elected health and safety representatives			To be advised by
Occupational health staff/ contractors			To be advised by
Unions			To be advised by
Building owner			To be advised by
Other building occupiers			To be advised by
Medical officer			To be advised by
Staff counsellors			To be advised by
Service contractors			
Neighbours of the site			
Customers			
Department of Health and Human Services, Legionell Team		1800 248 898	To be advised by
Local council	Environmental health officer		To be advised by
Media liaison officer			To be advised by
Company spokesperson			To be advised by
Chief executive			To be advised by

115 Once the decision to notify has been made, consideration must be given to the method of notification. This will work best where staff (in particular) have some understanding of the procedures for the cooling tower and the significance of test results, well in advance of notification of the adverse result.

Appendix 9 Model procedure for decontaminating a cooling tower system

Background

Decontamination may be required in cooling tower systems linked to a case or cases of Legionnaires' disease, as described in the Public Health and Wellbeing Regulations 2009.

Procedure

The following process is considered by the Department of Health and Human Services to meet the intent of the Regulations. Other processes can be used, provided that they meet the requirements of the Regulations.

1. Follow all relevant occupational health and safety procedures, including the use of personal protective equipment.
2. Cease any chemical treatment. Isolate any electrical equipment except the water treatment pump.
3. Add a low-foaming, chlorine-compatible biodispersant to the recirculating water.
4. Disinfect the system by dosing the water with either:
   - a chlorine-based compound, equivalent to at least 10 mg/L of free chlorine for at least 1 hour, while maintaining the pH of the water between 7.0 and 7.6, or
   - a bromine-based compound, equivalent to at least 20 mg/L of free bromine for at least 1 hour, while maintaining the pH of the water between 7.0 and 8.5.

   Add the disinfectant slowly, over 5–10 minutes, to a turbulent zone of the tower basin to promote its rapid dispersion. Use an anti-foaming agent if excessive foaming occurs.
5. Switch off equipment and drain cooling tower to waste in a manner approved by the local water authority. The entire cooling water system should be drained.[116] Use of a wet vacuum cleaner can make it easier to remove waste material from the basin floor.
6. Refill with clean water and switch on the recirculating pump.
7. Repeat step 4, but maintain the specified concentrations for 3 hours. Then switch off the recirculating pump. Drain the cooling tower system to waste in a manner approved by the local water authority.
8. Inspect the drift eliminators, and clean, repair or replace them, as necessary. If the eliminators are moved, ensure that they are correctly installed on replacement. Suitable precautions should be taken to minimise the release of aerosols during cleaning operations.
9. Thoroughly clean the internal shell, fill and tower sump by brushing and gently hosing all surfaces. Remove all debris. Avoid damage to the tower and accessories during this operation.
10. Thoroughly internally clean all water filters, strainers, separators, water nozzles and fittings associated with the water distribution system.
11. Reassemble all components and hose with clean water.
12. Repeat step 4, but maintain the specified concentrations for 3 hours. Then switch off the recirculating pump. Drain the cooling tower system to waste in a manner approved by the local water authority.
13. Refill with clean water and switch on the recirculating pump.

116 Where this is not practicable, a very high bleed-off rate should be used during step 4. This will help to remove suspended particulate matter from the system and partially replace cooling water with clean make-up water.

14. Repeat step 4 if the water is not visually clear. Clean the water filters and strainers, and repeat step 13. Repeat this sequence until the water quality is satisfactory.
15. Immediately reinstate comprehensive effective water treatment, including use of biocide(s) and anticorrosives, and scale control.
16. Record all actions in the maintenance logbook.

Abbreviations

CFU	colony forming units
CTS number	cooling tower system number
the department	the Victorian Department of Health and Human Services
HCC	heterotrophic colony count
RMP	risk management plan

Glossary

Acute health or aged residential care facility

A place where acute health care is provided (such as a hospital) or aged residential care facilities (such as nursing homes or hostels).

Automated dosing device

A device that automatically discharges a measured amount of chemical to the water inside a cooling tower system.

Biocide

A physical or chemical agent capable of killing microorganisms, including *Legionella* bacteria.

Biodispersant

A chemical added to the water inside a cooling tower system, to penetrate and break down any biofilm that may be present on the wetted surfaces.

Biofilm

A surface layer of microorganisms. It is usually combined with particulate matter, scale and products of corrosion.

CFU/mL

Colony forming units per millilitre. The unit of measure of bacterial levels in a sample.

Cleaned

Cleaning if a cooling tower system involves the following steps:

1. Thoroughly clean the internal shell, fill and tower sump by brushing and/or hosing all surfaces.
2. Remove all debris.
3. Thoroughly clean internally and externally all water filters, strainers, separators, water nozzles and fittings associated with the water distribution system.

Cooling tower

A device for lowering:

- the temperature of recirculated water, by bringing the water into contact with fan-forced or fan-induced atmospheric air; or
- the temperature of water, a refrigerant or other fluid in a pipe or other container, by bringing recirculated water and fan-forced or fan-induced atmospheric air into contact with the pipe or container.

An evaporative air cooler or evaporative air-conditioner is not a cooling tower.

Cooling tower fill

A structure at the top of a cooling tower that is designed to create an extensive wetted surface area through which air passes.

Cooling tower system

A system comprising:

- a cooling tower or a number of interconnected cooling towers that use the same recirculating water
- any machinery that is used to operate the tower(s)
- any associated tanks, pipes, valves, pumps or controls.

Decontamination

A process used when a cooling tower system is suspected or implicated as a source of Legionnaires' disease. The decontamination process is usually determined in consultation with the Department of Health and Human Services *Legionella* Team. It involves a series of actions to disinfect, clean and re-disinfect the cooling tower system (see Appendix 9).

Disinfection

A process intended to kill or remove pathogenic microorganisms, including *Legionella*.

In the case of a cooling tower system, disinfection consists of dosing the water of a system with either:

- a chlorine-based compound, equivalent to at least 10 mg/L of free chlorine for at least 1 hour, while maintaining the pH of the water between 7.0 and 7.6; or
- a bromine-based compound, equivalent to at least 20 mg/L of free bromine for at least 1 hour, while maintaining the pH of the water between 7.0 and 8.5.

Heterotrophic colony count (HCC)

An estimate of the number of viable units of bacteria per millilitre of water made using the pour plate, spread plate or membrane filter test. Also known as total bacteria count, total plate count or viable bacteria count test.

Operational program

A documented program detailing the water treatment and physical maintenance of the cooling tower system, including details of service frequency.

Owner of land

Owner in relation to the land or Crown land within the meaning of the *Public Health and Wellbeing Act 2008*.

Responsible person

Person who owns, manages or controls the cooling tower system.

Service frequency

The frequency with which the cooling tower system is thoroughly checked by a competent person. It includes a check of the water quality, as well as physical components.

Slug dosing

The manual addition, in a single dose, of a much higher amount of chemical biocide than is normally applied, with the intention of rapidly raising the concentration of biocide in the water to a level expected to kill most if not all organisms in the water.

Bibliography

Australian Standards:

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