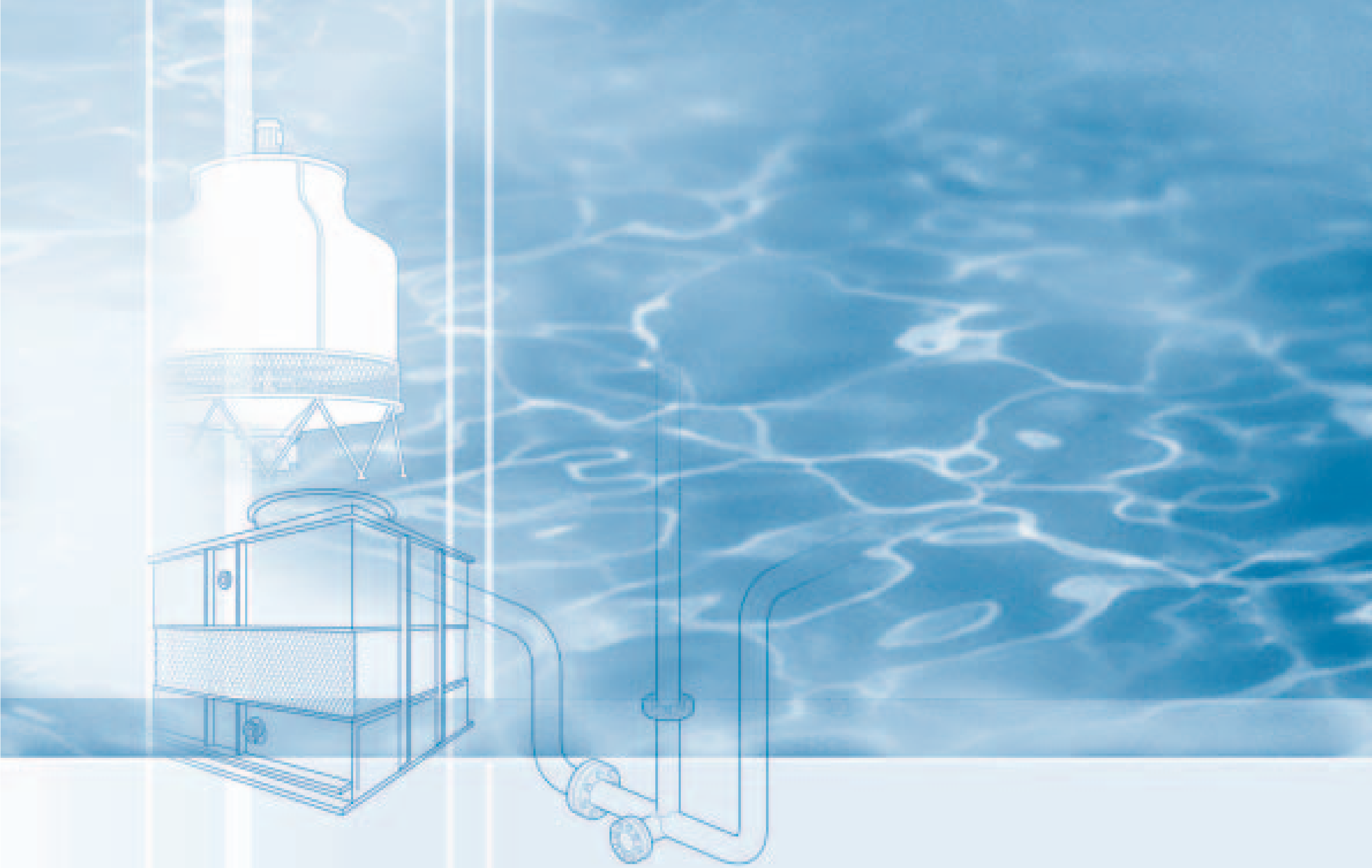

A Guide to Developing Risk Management Plans for Cooling Tower Systems

State Government Victoria
Department of Human Services

Public Health Division

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- Australian Institute of Building Surveyors
- Australian Institute of Environmental Health
- Australian Institute of Refrigeration, Air-conditioning and Heating
- Building Control Commission
- Municipal Association of Victoria
- National Water Treatment Group
- Plastics and Chemicals Industries Association
- Plumbing Industry Commission
- Property Council of Australia
- Victorian Employers' Chamber of Commerce and Industry
- Victorian WorkCover Authority.

Similarly, the Department acknowledges the work performed by the Legionella Working Party. The Working Party was established in December 1999 to advise the Minister for Health on options for managing health risks associated with cooling towers. The Working Party made a series of recommendations in June 2000 that were followed by the Victorian Government response in July 2000.

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Purpose of this Guide

This Guide is designed to assist industry develop risk management plans 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 follows a risk management approach, describing the actions necessary to meet these challenges.

Legionella Risk Management Strategy

The Victorian Government has 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. Landowners and managers of cooling tower systems have new legal responsibilities.

Responsibilities of Landowners

The *Building (Legionella) Act 2000* 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 Building Control Commission, developing a risk management plan and having that plan independently audited by an approved auditor.

The risk management plan must address the critical risks distilled from the relevant Australian Standard. This guide demonstrates the relationship between the risks associated with your cooling tower system and the development of an appropriate maintenance program for that system.

Responsibilities of Owners and Managers of Cooling Tower Systems

The Health *(Legionella)* Regulations 2001 describe the minimum requirements for maintenance of a cooling tower system. Testing for total bacterial counts is required monthly and in the event of adverse results, certain immediate actions must be taken to bring the system under control.

Key Challenges for Cooling Tower System Owners and Managers

The main challenge is to take immediate steps to minimise the risks associated with cooling tower systems on land for which they have responsibility. There are several other elements which are critical to the success of a risk management approach:

- **Commitment**
  In larger organisations, this means management recognition that a cooling tower system is an asset requiring careful management.

- **Information Gathering and Forward Planning**
  It is critical that any organisation with a cooling tower system has adequate information on which to base its decisions. This must include reviews of the cooling tower system to determine any shortfalls in design or performance and the development and implementation of an action/upgrade plan to address any deficiencies.

- **Control and Performance Measures**
  Organisations must develop reliable management systems to ensure that the system is under effective and consistent control, especially monitoring of performance measures such as *Legionella* testing. Management reporting of

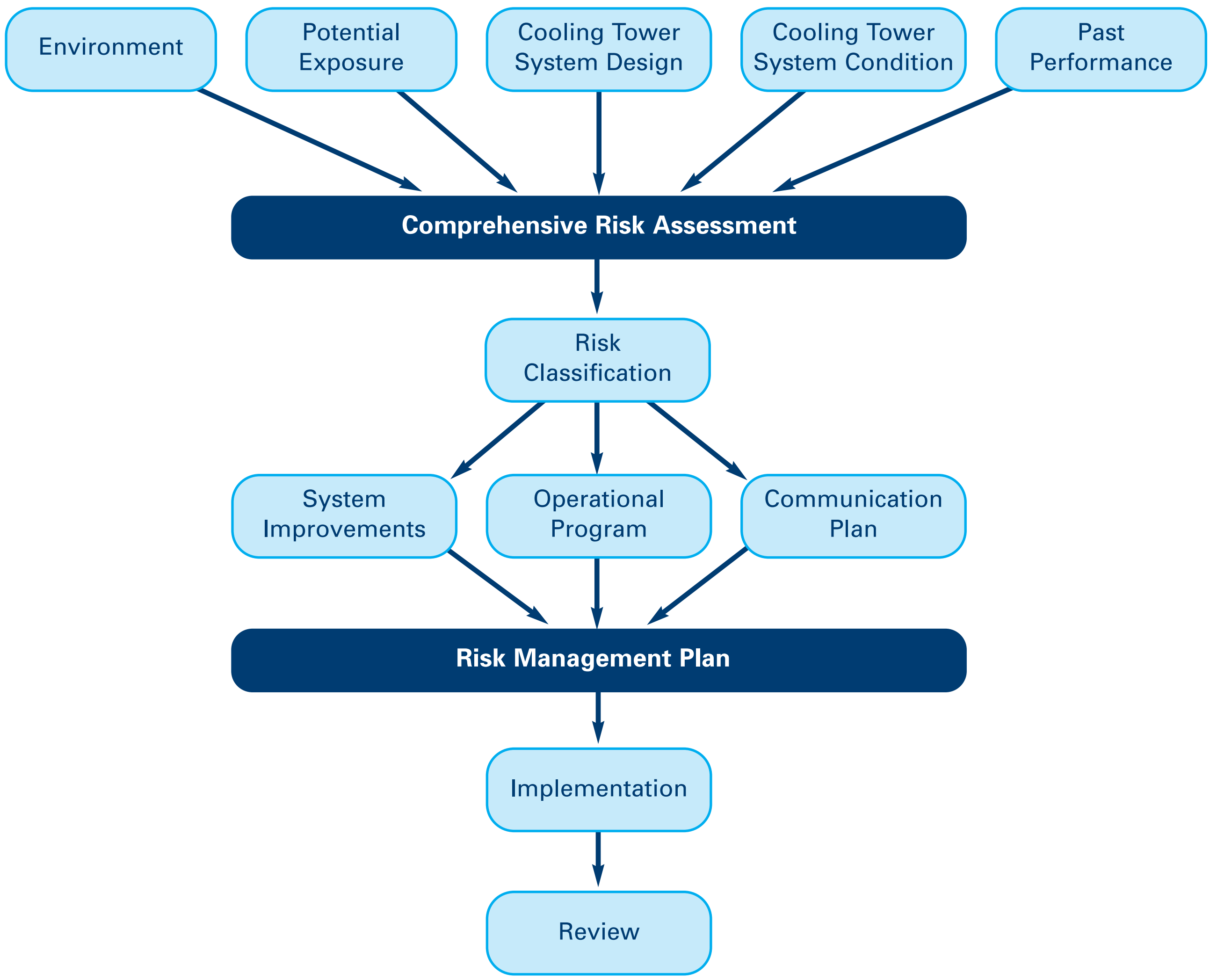
variances from regulations or organisational targets is also important. Such reviews must look at more than just engineering solutions. They must also consider the people who may be exposed and ways to minimise their exposure.

- **Alternatives to Cooling Towers**
  The only way to eliminate the risk from Legionnaires' disease associated with a cooling tower is to remove it. A review of viable alternatives should be conducted.

- **Communication**
  Larger organisations need to carefully consider the contractual relationships between the landowner and those involved in management and maintenance of a building. It is critical that there is clear and rapid communication between the parties about safety related matters.

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.

Figure 1 Risk Management Process for Cooling Tower Systems



1 Introduction

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

1.1 *Legionella* and Legionnaires' Disease

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 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* bacteria.
- Conditions suitable for multiplication of the organisms: suitable temperature (20°C to 50°C) and a source of nutrients such as sludge, scale, rust, algae and other organic matter.
- A means of creating and spreading breathable droplets, such as the aerosol generated by a cooling tower, shower or spa.
- Exposure of susceptible people to these aerosols.

1.2 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 (such as cancer, lung disease, diabetes and transplant recipients) may be at increased risk of Legionnaires' disease.

1.3 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 proves fatal. A small percentage may suffer some permanent disablement.

Between 1979 and 1999, 82 people died from Legionnaires' disease in Victoria. During the same period, 422 people were diagnosed with the disease and recovered. It is likely that a considerably larger number contracted the disease, but were not correctly diagnosed.

1.4 Potential for Legal Liability and Prosecution

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 Building, Health and Occupational Health and Safety Acts. There is also strong likelihood of legal action for damages suffered by individuals or companies as a result of the outbreak.

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

1.5 Do You Really Need a Cooling Tower System?

This Guide is focused on the very real risk that a cooling tower system may produce *Legionella* contaminated aerosols and cause an outbreak of Legionnaires' disease.

A basic principle of risk management is to first see if it is possible to eliminate the risk altogether. For as long as 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, establish if the original purpose for the cooling tower system still remains. In the case of industrial processes for example, is the cooling tower system still crucial to the process or has it become redundant?

Also ask whether there are viable alternatives to the cooling tower system. Owners of land and businesses with smaller cooling tower systems with a heat rejection requirement of under 750 kW should consider a move to air cooled systems and so eliminate the public health risk associated with the system. Air cooled systems are not associated with Legionnaires' disease, because there is no reservoir of recirculating water. Not only can the risk of Legionnaires' disease be eliminated, but also the ongoing costs of water treatment and testing.

If once these possibilities have been explored, no viable alternative currently exists to your cooling tower system, it is time to begin the risk management process.

1.6 *Legionella* Risk Management Strategy

The Victorian Government has developed a comprehensive strategy to reduce the incidence of Legionnaires' disease by strengthening the regulatory framework and improving maintenance standards for cooling tower systems. Implementing the strategy is the responsibility of the Department of Human Services, Building Control Commission (BCC) and the Plumbing Industry Commission (PIC).

The key aspects of the strategy are to:

- Improve maintenance levels of cooling tower systems.
- Establish a comprehensive register of cooling tower systems, by amending the *Building Act 1993*.
- Require the owners of any land on which there is a cooling tower system to prepare and implement a risk management plan for the effective maintenance of that system.
- Require an annual audit of each risk management plan.
- Provide for inspections of cooling tower systems on the basis of risk assessment or information received through audits.
- Provide an enhanced technical advisory and outbreak investigation service through the Department of Human Services.
- Ensure that new cooling tower systems are constructed and installed to meet the relevant Australian Standards.

Amendments to the *Building Act 1993* and new building and plumbing regulations will require all owners of land where cooling towers are located to:

- Register the cooling tower system with the Building Control Commission. In the case of systems installed before the *Building (Legionella) Act 2000* was introduced, registration must be made within six months of that date. After that date, registration must occur before commissioning the systems. Registration is an annual process for which a fee is payable.

- Prepare and implement a Risk Management Plan (RMP) for each cooling tower system on the land.
- Have the RMP independently audited on an annual basis to confirm that it addresses the risk factors described in the Building (*Legionella* Risk Management) Regulations 2001, and that there is documented evidence that the plan is being satisfactorily implemented.
- Ensure that new cooling towers are constructed and installed meet the relevant Australian Standards (AS/NZS 3666).

The registration levy will fund:

- An education and awareness raising campaign targeting owners of land, industry representatives and cooling tower maintenance companies.
- Developmental and ongoing costs associated with the register.
- Random inspections of maintenance records and equipment checks by authorised health officers of the Department of Human Services.
- An enhanced technical advisory and outbreak investigation service within the Department of Human Services.
- Education and research activities relating to the control of *Legionella*.

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

Outbreaks of Legionnaires' disease in Victoria in 2000 resulted in ill health for individuals concerned and impacted on their families. There have also been significant economic losses reported by the businesses implicated in those outbreaks.

We have prepared this Guide and a template of an RMP to help businesses through this significant change to 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 contained in the Guide will assist you to comply with the new laws, but individual business needs and environmental conditions may require different or more stringent maintenance regimes, based on your individual risk assessment.

Disclaimer

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

1.6.1 Key Contacts

For further information on this strategy, please contact:

Agency	Internet address	Telephone
Department of Human Services Public Health Division (Environmental Health Unit)	www.legionella.vic.gov.au	1800 248 898
Building Control Commission	www.buildcc.com.au	9285 6400
Plumbing Industry Commission	www.pic.vic.gov.au	9889 2211

2 How this Guide Works

This Guide has been designed to assist land owners, cooling tower system owners and managers provide a safe environment for their staff, contractors, customers and the public, and comply with their responsibilities under Victorian law.

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

The guide will also help users develop cooling tower system maintenance programs and cooling tower system improvements within the Risk Management Plan (RMP) framework.

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 as well as a risk-based maintenance program. Additional assistance can then be sought to manage the cooling tower system operation. 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 provider
- Mechanical engineers
- Occupational hygienists
- Building and system owner.

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 includes 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 adequate professional and public liability insurance for the task at hand is held by the contractors.

This Guide follows a risk management approach to help you make critical decisions about both cooling tower system improvements and maintenance and testing quality and frequency.

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

Publication Formats

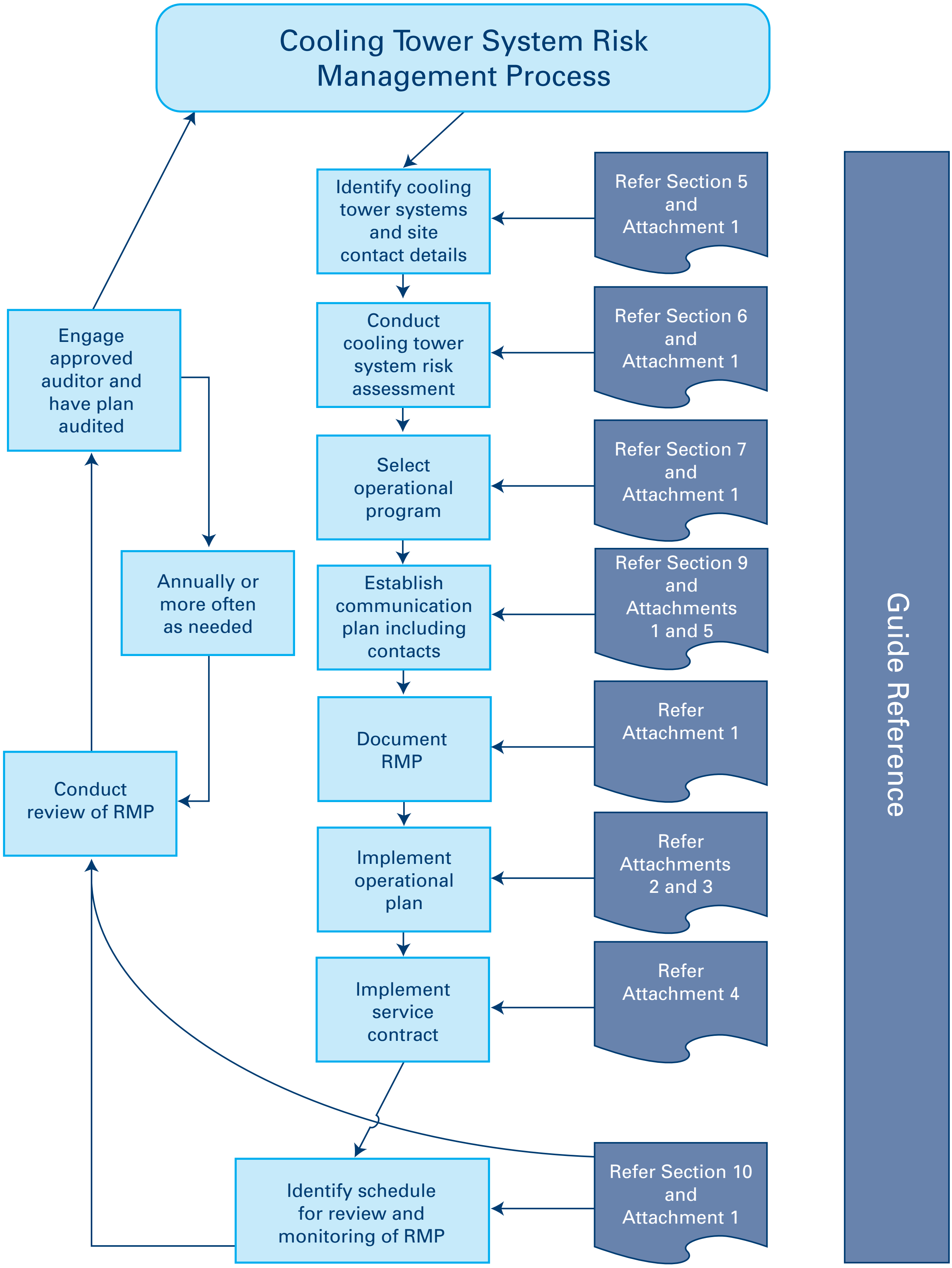
The Attachments and all Tables in the Guide are available on the Internet at www.legionella.vic.gov.au in Microsoft Word 2000 format.

The Guide will be supplied to every owner of land with a registered cooling tower system and is also available on the Internet at http://www.legionella.vic.gov.au

This Guide is also included in the *Cooling Tower System Legionella Risk Management Site Kit* that will be supplied to every site that is registered with the Building Control Commission. The Site Kit provides for essential documentation such as service reports and bacterial test results to be stored appropriately for annual audit purposes.

2 How this Guide Works

Figure 2 Cooling Tower System Risk Management Process



3 Your Legal Responsibilities

Under Victorian law, people responsible for cooling tower systems must meet a range of requirements. These are summarised below.

3.1 *Building (Legionella) Act 2000*, Building *(Legionella* Risk Management) Regulations 2001 and Building (Cooling Tower Systems Register) Regulations 2001

The Building Act and related Regulations require the owner of land on which there is a cooling tower system to:

- Register each cooling tower system with the Building Control Commission annually
  and
- Develop an RMP for every cooling tower system on the site that considers the following critical risk factors:
  - **Stagnant water**, including the lack of water recirculation in a cooling tower system and the presence of dead-end pipework and other fittings in a system.
  - **Nutrient growth**, including the presence of biofilm, algae and protozoa in a cooling tower system, water temperature within a range that will support rapid growth of microorganisms in a system and the exposure of the water of a system to direct sunlight.
  - **Poor water quality**, including the presence of solids, *Legionella* and high levels of microorganisms in a cooling tower system.
  - **Deficiencies in the cooling tower**, including deficiencies in the physical design, condition and maintenance of the system.
  - **Location of and public access to a cooling tower or cooling tower system**, including the potential for environmental contamination of the system and potential for exposure of people to the aerosols of the system.

  and
- Have the RMP independently audited every year
  and
- Review the RMP at least once every year
  and
- Keep records of all repair, maintenance and testing work that is carried out on the system for at least seven years after the records were created
  and
- Ensure that the RMP and the records referred to earlier are kept either at the building in which the system is housed or at a building on the land where the system is located.
- Advise the Building Control Commission within 30 days of:
  - Addition or removal of a cooling tower to or from the system.
  - Removal or permanent decommissioning of the system.
  - Relocation of the system on the lot of land on which it stands.

The maximum penalty for failing to register is $12,000. The maximum penalty for failing to complete a Risk Management Plan is $6,000.

3.2 Plumbing (Cooling Towers) Regulations 2001

The Plumbing (Cooling Towers) Regulations 2001 require that new cooling tower systems be constructed to 'Australian/New Zealand Standard 3666: Air handling and water systems of buildings—Microbial Control'.

3.3 *Health Act 1958*

The Health Act requires all owners and occupiers of premises not to allow a condition to exist that is, or is liable to be, dangerous to health.

In addition, owners and occupiers of property should note that authorised officers under this Act have extensive powers of entry to sites to investigate potential breaches of the Act or threats to public health.

3.4 Health (*Legionella*) Regulations 2001

The Health (*Legionella*) Regulations 2001 requires the person who owns, manages or controls a cooling tower system to ensure that:

System Maintenance

a) The system is maintained and tested as described later unless the system is shut down or is otherwise not in use and is completely drained of water.

b) The water in the system is maintained in a clean condition.

c) The water in the system is continuously treated with one or more biocides to effectively control the growth of microorganisms, including *Legionella*, as well as with other chemicals to minimise fouling and the formation of scale and corrosion.

d) A chlorine-compatible biodispersant is added to the recirculating water of the system and that the system is disinfected, cleaned and re-disinfected:

- immediately prior to initial start up following commissioning or any shut down period of greater than one month
- at least every six months.

e) The system is inspected at least monthly to ensure the system is operating without defects.

f) The water in the system is laboratory tested for Heterotrophic Colony Count (HCC) at least monthly.

g) A maintenance log book is kept up-to-date and on the premises with records of all maintenance activities and microbiological test results and produced on request to an authorised officer.

Adverse Test Results

h) Within 24 hours of receiving a report that a sample was found to have a HCC of greater than 100,000 CFU/mL, the water in the system must be manually dosed with additional quantities of biocide or with an alternative biocide. The water treatment program, tower operation and maintenance program must be reviewed and any faults corrected to prevent a re-occurrence of the faults. Between two and four days after the manual dosing a second sample must be taken and tested for HCC.

i) Within 24 hours of receiving a report that the result of the re-sampling described above was an HCC greater than 100,000 CFU/mL, the cooling tower system must be disinfected, cleaned and re-disinfected. Between two and four days after the disinfection process, a further sample must be taken and tested for HCC.

j) If after taking the previous steps the HCC result is still above 100,000 CFU/mL, then the process in i) must be repeated until the HCC result is less than 100,000 CFU/mL in two consecutive water samples taken approximately one week apart, or the cooling tower system is closed until the problem has been remedied.

k) Within 24 hours of receiving a report that *Legionella* has been detected in the water of the system, the system must be disinfected, and a review performed of the water treatment program, tower operation and maintenance program. Any faults must be corrected. Between two and four days after the disinfection a second sample must be taken and tested for *Legionella*.

l) Within 24 hours of receiving that advice that *Legionella* was detected in the second sample, the system must be disinfected, cleaned and re-disinfected. Between two and four days later another sample must be taken and tested for *Legionella*.

m) If, after following the previous steps *Legionella* is still present then the process in l) must be repeated until no *Legionella* is detected in two consecutive water samples taken approximately one week apart or the cooling tower system is closed until the problem has been remedied.

n) If, while following the procedure described in these regulations *Legionella* is detected in three consecutive water samples taken from the same system, the responsible person must notify the Department of Human Services of the detection immediately by telephone, followed by a written notification within three days of the third detection of the organism.

o) Decontaminated in the event that the system is implicated as the source of infection in a case or an outbreak of Legionnaires' disease.

The maximum penalty for not complying is $10,000.

3.5 *Occupational Health and Safety Act 1985*

The Occupational Health and Safety Act requires an employer to maintain a safe working environment. It establishes a general duty of care that employers owe their employees. Liability arises when a person is 'exposed' to a risk of injury to health or safety.

The Act also requires employers and the self-employed to ensure that, as far as practicable, the health and safety of members of the public is not affected adversely by their business activities.

The State Government has announced plans to increase the penalties to a maximum of $750,000. This is expected to be debated in Parliament in late 2001.

3.6 *Crimes Act 1958*

Draft legislation is expected to be introduced to Parliament in late 2001, amending the Crimes Act to create an offence of industrial manslaughter.

4 Risk Management

Risk management is recognised as 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.

4.1 Advantages

The main advantages of risk management are:

- A consistent, auditable record of the reasons and rationale for decisions taken.
- A logical way to review the operation and assess which critical areas require further investigation.
- Critical risk factors can be monitored.
- A way to achieve sustained compliance with legislative requirements.

4.2 Methodology

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** for site owners and those responsible for cooling tower systems.
- **Identification**, **analysis**, **evaluation** and **treatment** of **critical risks** for cooling tower systems.
- **Monitoring** and **reviewing** the RMP.
- The importance of **communication** in the event of problems with a cooling tower system.

The Guide culminates in a template RMP that will enable you to properly manage the risks associated with a cooling tower system.

Owners or operators of more complex sites should consider engaging specialist assistance to perform the risk assessment and develop a risk management plan.

4.3 Risk Management Standard

Australian and New Zealand Standard 4360: 1999 Risk Management (AS/NZ 4360) describes the main elements of a risk management process as:

- Establishing the context (strategic, organisational, risk management, risk evaluation criteria)
- Identifying risks
- Analysing risks
- Evaluating risks
- Treating risks
- Monitoring and review
- Communication and consultation.

This Guide follows the basic framework outlined in AS/NZS 4360.

4.4 Integration with Quality Assurance Programs

Many organisations follow formal quality assurance programs such as ISO 9000 series (Quality Management Systems), ISO 14000 series (Environment Management Systems), AS 4804 (Occupational Health and Safety Management Systems). The development of an RMP should ideally be integrated into these programs where appropriate. Businesses considering this approach should note that it may make the auditing of the plan more complex than if it were a separate document.

4.4.1 SafetyMAP

This is an audit tool designed to assist organisations of all sizes and functions 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. Cooling tower systems are a potential hazard. They must be assessed and should have documented control measures.

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 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 cooling tower system water, breathing these aerosols can result in infection.

Figure 3 Mechanism of Heat Exchange in a Cooling Tower

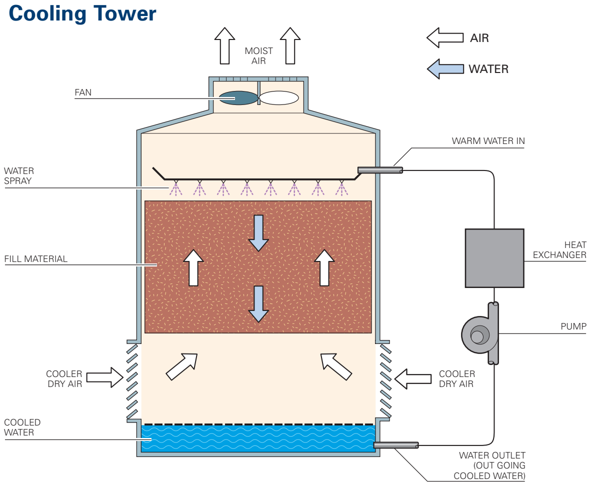
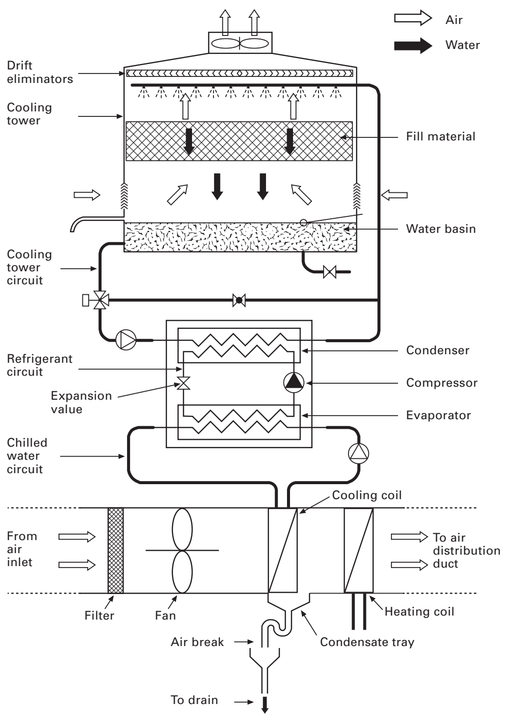


Figure 4 Typical Layout of Air Conditioning System



5.1 Problems with Cooling Tower Systems

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 system.

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

5.2 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. Figure 3 shows this process. Cooling tower systems temporarily store water in a basin, which is usually recirculated. 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.

The typical layout of air conditioning systems that use cooling towers is shown in Figure 4. These cooling towers contain fill material inside the tower. Usually made of plastic, it allows the falling water to spread over a greater area. This increases the surface area of the water to be cooled, allowing better and more effective cooling.

Industrial processes often have a device called an evaporative condenser to reject 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 towers' as described in the Building Act and related Regulations. The design of a typical evaporative condenser is shown in Figure 5.

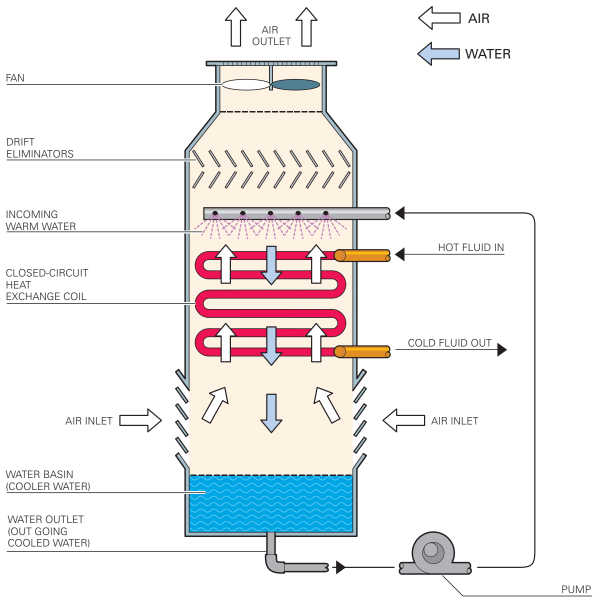
Cooling towers are often confused with evaporative coolers. An evaporative cooler uses the same general principle of recycling water. The main difference is that cooling towers use air to cool the water, whereas evaporative coolers use water to cool the air. There has been no evidence linking evaporative coolers or evaporative air conditioners to cases of Legionnaires' disease.

The definition of cooling tower within the Health (*Legionella*) Regulations 2001 clearly states that evaporative air coolers or evaporative air conditioners are not cooling towers.

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

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

Figure 5 Typical Layout of an Evaporative Condenser



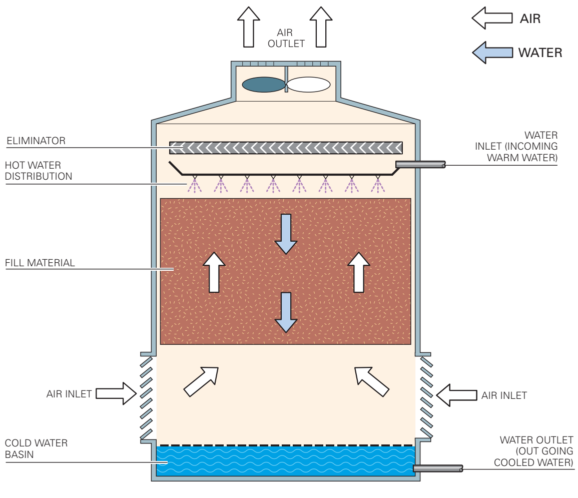
EVAPORATIVE CONDENSER

5 Identifying and Analysing the Risks of *Legionella*

5.2.1 Induced Draught Counter Flow

This type of tower is very common. It 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 6 shows a schematic of these types of cooling towers.

Figure 6 Induced Draught Counter Flow Cooling Tower

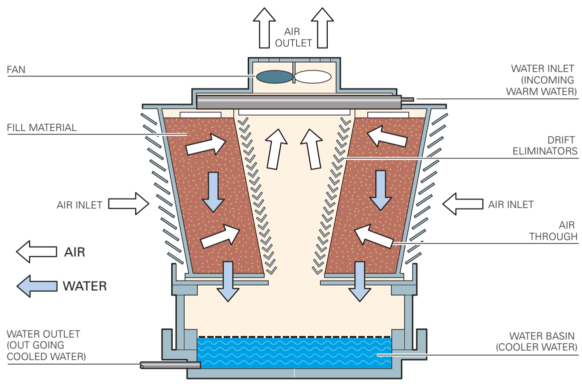


INDUCED DRAUGHT COUNTER FLOW COOLING TOWER

5.2.2 Induced Draught Cross Flow

The fan is also mounted on the top. However, in this type of tower the fan draws or induces the air across the water falling from the top of the tower to the basin. Figure 7 shows a schematic of these types of cooling towers.

Figure 7 Induced Draught Cross Flow Cooling Tower

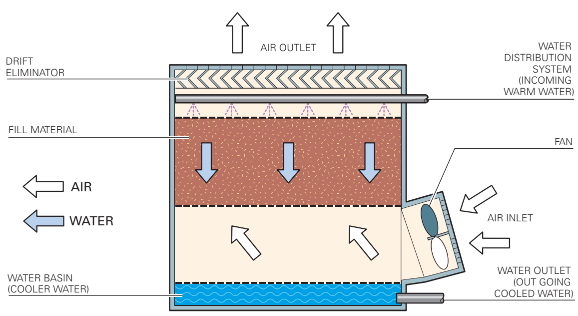


INDUCED DRAUGHT CROSS-FLOW COOLING TOWER

5.2.3 Forced Draught Counter Flow

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 8 shows a schematic of these types of cooling towers.

Figure 8 Forced Draught Counter Flow Cooling Tower

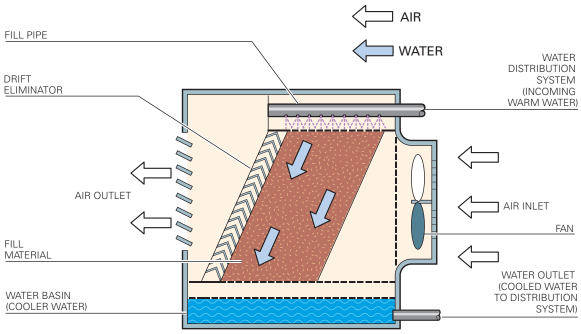


FORCED DRAUGHT COUNTER FLOW COOLING TOWER

5.2.4 Forced Draught Cross Flow

The fan is mounted on one side and pushes the air in a cross flow manner past the falling water. Figure 9 shows a schematic of these types of cooling towers.

Figure 9 Forced Draught Cross Flow Cooling Tower



FORCED DRAUGHT CROSS-FLOW COOLING TOWER

5.3 Why Outbreaks Happen

Cases of Legionnaires' disease associated with a cooling tower system usually occur as a result of one or more of the following scenarios:

- Failure to treat the water to an adequate standard, which can in turn be due either to a lack of or breakdown of:
  - a regular treatment schedule or system equipment
    or
  - human error.
- Environmental contamination of the cooling tower water, for example from nearby construction works.
- Poor cooling tower system design or location.
- Inadequate or non-existent maintenance (including plans for replacement of ageing cooling tower systems).

5.4 Incubation Period

Legionnaires' disease has an incubation period of between two and ten days. This means that symptoms do not appear until two to ten days after a person has been exposed to *Legionella* bacteria. More cases may continue to be diagnosed for up to ten days after the source of the infection has been successfully eliminated.

5.5 Risk Factors for Cooling Towers

Twenty risk factors associated with cooling towers are listed in the Australian/New Zealand Standard 3666.3:2000 Air-handling and water systems of buildings – Microbial control Part 3: Performance-based maintenance cooling water systems (AS/NZS 3666.3):

- Presence of water (especially if stagnant, for example, 'dead legs' or system not in use)
- Presence of *Legionella*
- *Legionella* concentration
- Presence of other heterotrophic bacteria
- Presence of protozoa and algae
- Presence of nutrients
- System size [(surface area available for biofilm development (compared with water volume)]
- Presence of biofilm
- Water quality:
  - cleanliness
  - pH
  - presence of corrosion products
  - presence of scale and fouling
  - conductivity/Total Dissolved Solids
  - control limits out of range
  - suspended solids
  - control of water treatment chemicals, bleed
- Water temperature
- Characteristics of make-up water
- Direct sunlight
- Physical condition of system
- Microbial control program
- Open system
- Aerosol generation
- Mode of operation
- Intermittent operation
- Seasonal usage
- Drift elimination
- Aerosol dispersion
- System location (distance to other cooling water systems, air intakes and passers by).

5 Identifying and Analysing the Risks of *Legionella*

5.6 Critical Risks for Cooling Towers

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

- Stagnant water
- Nutrient growth
- Poor water quality
- Deficiencies in the cooling tower system
- Location and access to cooling tower systems.

The Building *(Legionella)* Act 2000 and the Building *(Legionella* Risk Management) Regulations 2001 require each of these critical risks to be addressed in the Risk Management Plan. Failure to address these risks in the RMP will result in the independent accredited auditor being forced to fail the Plan and advise the Department of Human Services of the issue. Similarly, if the Plan does address the critical risks but is not implemented, the auditor will also have no choice but to fail the Plan and advise the Department. Addressing these risks will significantly reduce the likelihood of the cooling tower system contributing to an outbreak of Legionnaires' disease.

5.6.1 Stagnant Water

Stagnant water covers four risk factors outlined in AS/NZS 3666.3:

- Presence of water
- Mode of operation
- Seasonal usage
- Intermittent operation.

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 5.6.2) and also causes corrosion.
- Any biocide delivered into 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 micro-organisms). This can then reinfect the entire system, whenever the biocide levels drop.

Stagnant water often occurs if a cooling tower system is not used for periods of more than a month, where there are disused or superfluous pipes (also called 'dead legs') full of water, or where there are 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 point where potential problems can occur if it is not handled well. Well maintained cooling tower systems in use for most of the year are generally of lower risk than those that remain idle for more than one month. This is because the biofilm is not as readily disturbed with starting and stopping operations.

Where 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, where the biocide may not have reached all parts of the system.

'Dead legs': These pipe extensions are potential 'dead legs' that should be investigated, and if confirmed, either removed or activated

The lack of a recirculating pump controlled by a timer to circulate water through the system in 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. The biocide may not reach all extremities of the system, allowing *Legionella* to grow and potentially regularly reinfect the system.

5.6.2 Nutrient Growth

Nutrient growth covers four risk factors outlined in AS/NZS 3666.3:

- Presence of nutrients
- Presence of biofilm
- Water temperature
- Direct sunlight.

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

Environmental contamination can cause nutrients to enter into a cooling tower system. Dust generated on or off the 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 or car parks may all generate dust. Other sources of nutrients include leaf litter from overhanging trees, bird droppings falling into the cooling tower or kitchen exhausts.

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

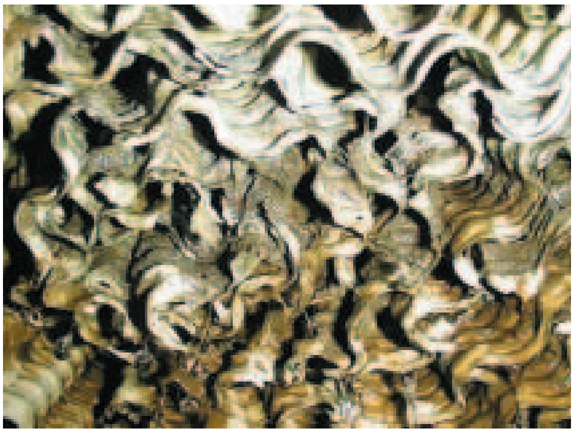
Algae can grow rapidly if the cooling tower water is exposed to sunlight. This most commonly happens when the tower basin or other wetted areas, such as the top wet deck of some types of cooling towers, are exposed to sunlight. Other types of cooling towers often have no sunlight protection for the tower basin. Inspection openings may be missing and also 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. *Legionella* bacteria are relatively easily killed by moderate concentrations of many biocides, provided the bacteria are free-floating in the water and exposed to the biocide.

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

However, *Legionella* has adapted to survive in potentially adverse conditions with an ability to live and multiply within organisms called protozoa. These engulf the *Legionella* bacterium, but the bacterium continues to grow and multiply inside the larger organism. Protozoa can resist much higher concentrations of biocides. *Legionella* survives 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. The *Legionella* bacteria may then be released into the recirculating water and be discharged out of the tower inside water aerosols, before any biocide has had a chance to kill the bacteria. Biofilm can form on any of the wetted surfaces of the cooling tower system.

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.



Biofilm build-up: Fill inside a cooling tower with biofilm showing as visible slime, preventable with use of biodispersants and regular cleaning

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

The temperature of the recirculating water can have an impact on the growth of nutrients. It is impossible to eliminate bacteria from a cooling tower system, so water temperature will be a factor in bacterial growth rates.

5.6.3 Poor Water Quality

Poor water quality covers seven risk factors outlined in AS/NZS 3666.3:

- Presence of *Legionella*
- *Legionella* concentration
- Presence of other heterotrophic bacteria
- Presence of protozoa and algae
- Water quality
- Characteristics of make-up water
- Microbial control program.

This is a risk because poor water quality has a direct effect on the likelihood of *Legionella* multiplying in a cooling tower system. Water quality is affected by things such as the:

- External contamination of the water with dust or soil.
- Accumulation of solids in the system.
- Choice and levels of biocides and anti-corrosives.
- Presence of high levels of bacteria and *Legionella*.
- Provision of nutrients supporting microbiological growth.

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

5.6.4 Deficiencies in the Cooling Tower System

Deficiencies in a cooling tower system covers five of the risk factors outlined in AS/NZS 3666.3:

- System size
- Physical condition of system
- Open system
- 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. Consider the method and condition of access to the towers and other parts of the system for authorised maintenance workers, to ensure a safe working environment.

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, this increases the potential for rapid bacterial growth. The risk of aerosol distribution is much greater without design modifications such as fitting an effective drift eliminator.

System size is also important, because towers with low water volume will have a high water turnover and the biocide is less likely to be effective. In this case, the choice and concentration of biocide needs to be matched to the low water volume.

5.6.5 Location and Access to Cooling Towers

The location of and access to cooling towers covers two risk factors outlined in AS/NZS 3666.3:

- Aerosol dispersion
- System location.

The location of, and access to, cooling towers can be a risk because:

- A poorly located tower can be subject to environmental contamination, for example, from building sites. This can increase the level of nutrients and with it, the number of bacteria, including *Legionella*.
- A cooling tower system located in an area where large numbers of people have access can be a particular problem if the system becomes contaminated with *Legionella*. The number of people that will be potentially exposed to the tower is high. If the people exposed to the tower are from a susceptible group, the risk will be higher.

The extent to which people are exposed to aerosols is an important factor when assessing the risks associated with a cooling tower system.

First consider whether the tower is located in or near an acute health or aged residential care facility. This is important, because of the potential for highly susceptible people to be exposed to the tower aerosols. The residents of these types of facilities are most at risk of serious health consequences if an outbreak of Legionnaires' disease occurs.

Then estimate the number of people who come within close proximity of the tower in a day. The number of people who may be exposed to the tower aerosols will impact on the size of an outbreak. It 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 with a policy of not allowing smoking inside buildings have developed practices where smokers 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, given the potential for cooling towers to discharge *Legionella* contaminated aerosols and the evidence that smoking is a risk factor for Legionnaires' disease.

6 Evaluating the Critical Risks

The previous section identified and analysed the critical risks. In this section we evaluate these risks.

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

6.1 Risk Classification Criteria

The critical risks described in the previous section can, if worked through carefully, allow for an accurate judgement to be made about the quality of a cooling tower system. A further process is needed to turn that judgment 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 your cooling tower system. In section 7, this recommendation is used to help you treat these risks and develop your operational program.

- **Stagnant Water**

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

Comment: 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. Similarly, lack of circulation will almost certainly mean that any biocides or other chemicals being added will not reach all parts of the system. Well maintained systems 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?
Comment: Fitting a recirculation pump to move the water around all parts of the system is an effective risk reduction strategy in these situations.

Are there ‘dead legs’ present?
Comment: ‘Dead legs’ in a cooling tower system are characterised by pipes that are full of water, but with little or no flow through the pipes. 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. A potential ‘dead leg’ is regarded as any pipe that branches off from another main pipe and has a length longer than the diameter of the main pipe. Other components of a cooling tower system such as off-line chillers or stand-by pumps may also become potential ‘dead legs’.

‘Dead legs’ have been linked to consistent problems with maintaining water quality and the presence of *Legionella,* due to the difficulty in killing *Legionella* in such areas.

• 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?
Comment: 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. Inspect the site and identify potential nutrient sources.

Nutrients may be introduced through dust from building demolition or construction sites, heavy traffic, unmade roads or car parks, 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?
Comment: 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 anti-corrosion 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. These are made of identical metals to those used in the system. Under some circumstances, chemical testing to measure the concentration of soluble copper and iron in solution is used as a supplement to the use of corrosion coupons. It is also important to regularly inspect components such as condensers for corrosion on an annual basis.

Are any of the wetted surfaces exposed to sunlight?
Comment: 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?
Comment: Biodspersants should be applied to continually break down biofilm as it forms. Biodispersants need to be compatible with the other chemicals that are to be used.

• Poor Water Quality

Has an automated biocide dosing device been fitted?
Comment: Siphon devices intended to deliver biocide into the cooling tower water are known to block up regularly and as a result, biocide may not be delivered to the cooling tower water. Similarly, manual dosing is totally reliant on operator reliability and quality. An automated biocide dosing device is a significant improvement over a siphon device or manual dosing, in that a pre-set amount of biocide (and other chemicals) can be injected into the recirculating water at regular intervals. There are various types of automated devices; the most sophisticated types monitor chemical parameters and add varying amounts of biocide, depending on the water quality.

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, a calculation of the total water volume of the system must be made, so that the correct amount of biocide is used to obtain the manufacturers' recommended concentration required to kill *Legionella*. This concentration will vary, depending on the particular biocide used. Automated biocide dosing devices with poorly calculated dosing will not be effective, so both aspects must be addressed.

Is a comprehensive water treatment program in place?
Comment: 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. These 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.
- Control measures relevant to the water treatment process involved, monitored very frequently, which collectively inspire confidence that the cooling tower system water chemistry is under effective control. These control measures may include parameters such as the concentration of

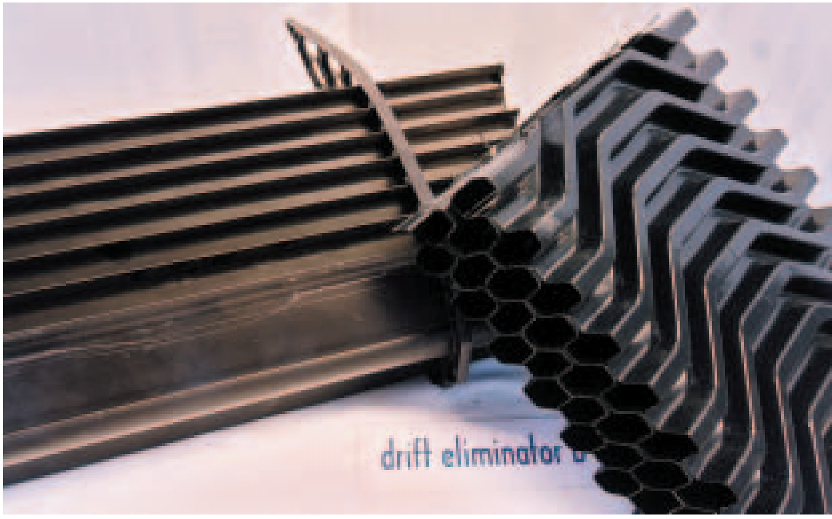
biocides, levels of solids/conductivity, pH and water clarity.
- Effective biocide dosing to maximise the impact of the biocides.

• Deficiencies in the Cooling Tower System

Is a modern, high efficiency drift eliminator fitted to all cooling towers in the system?
Comment: Cooling tower systems that have towers that are not fitted with an effective, modern drift eliminator present a higher risk of an outbreak of Legionnaires' disease in the event that the water treatment regime fails. A drift eliminator fitted and installed to Australian Standards can significantly reduce the amount of aerosols that would otherwise leave the tower. If the water treatment fails or is ineffective, these aerosols can contain *Legionella*. The Australian Standard (AS/NZS 3666) establishes a performance standard for drift eliminators. This is highly difficult to verify in practice, so check with the manufacturer. As a minimum, check the drift eliminator is of modern, high efficiency design. Where the drift eliminator **does** meet the Standard, its condition and position should be checked to ensure it has not been bypassed.

Has a review of system design been conducted?
Comment: A review of the system design may highlight issues that impact on overall system risk. For example, automated valves that shut off part of the system for lengthy periods of time may create stagnant water.

Detailed operational manuals will assist this process greatly, but where these are not available, the review ought to 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.



Drift eliminator: This shows a typical modern drift eliminator

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

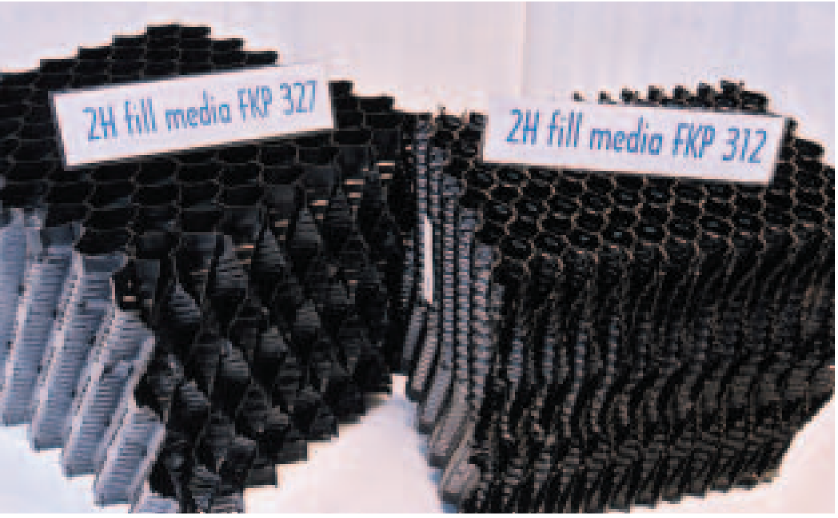
- Easy and safe access for maintenance
- Automatically controlled water treatment systems
- Materials used in construction
- Tower fill
- Ease of cleaning including drainage of basins
- Drift eliminators
- Splash prevention
- Location
- Bleed-off
- Sunlight protection.

As constructed plans may assist with this review.

To respond positively to this question in the risk assessment it is expected that as a minimum an assessment be made to check that:

- There is easy and safe access to the towers to allow for cleaning and maintenance. Without such access it may not be possible to adequately clean or maintain the system.

6 Evaluating the Critical Risks



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

- The tower fill and drift eliminator are installed correctly and in good condition.
- Wetted surfaces are protected from sunlight.
- The towers discharge exhaust away from occupied areas, pedestrian thoroughfares, air intakes, building openings, trafficable areas and avoids contamination by the exhaust discharges of air-handling systems such as kitchen exhausts or other cooling tower systems.

Has a review of system operation and performance been conducted?

Comment: A review of the operation of the system can detect practices or procedures that actually increase the risks 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.

• Location and Access

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

Comment: There is potential for highly susceptible individuals to be exposed to the tower aerosols in these types of facilities. Typically, their occupants are at greater risk of infection than other members of the community. Cooling tower systems located in acute health or aged residential care 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 regarded as high risk. Where an RMP is being developed for a cooling tower system located near an acute health or aged care residential facility, it is good practice to discuss the development of the plan with the facility's management.

• Location and Access

How many people come within close proximity to the tower within a day?

Comment: People who come into close proximity to the tower may become exposed in the event that the system becomes contaminated and allows *Legionella* to escape as aerosols. There is no exact or defined distance beyond which a tower is regarded as safe, so it is difficult to make this estimate[1]. Clearly anyone working, visiting or living on or near the site of the tower is at a higher level of risk than someone who does not pass anywhere near to the tower.

Later we will use the term 'very high', 'high', 'moderate' and 'low' to describe the potential numbers of people exposed to a tower system. Figure 10 describes examples of sites that fit these descriptions.

1 One study suggested that there is higher risk of contracting Legionnaires' disease where the cooling tower is located within 500 metres of the place of residence (Bhopal, Fallon, Buist, Black, Urquhart, 'Proximity of the home to a cooling tower and risk of non-outbreak Legionnaires' disease', BMJ 1991 Feb;302 (6773):378-83).

Figure 10

Potential numbers of people who may be exposed to a cooling tower system	Examples of sites which fit the description
Very High	All buildings within large business districts For example, Melbourne Central Business District, Southbank, Geelong Business District.
	Major place of assembly or entertainment.
	Large suburban and regional shopping complexes.
	Office towers.
High	Large strip shopping precincts.
	Workplaces including factories with significant staff numbers.
	High density residential areas.
	Apartment buildings in city fringe areas.
Moderate	Small strip shopping precinct.
	Smaller workplaces.
	Low density residential areas.
Low	Rural site. For example, dairy milking sheds.
	Tower located well away from public gathering places, or thoroughfares with few workers.

Of those exposed to the aerosols from a tower, not all may be susceptible to Legionnaires' disease, but generally it will be difficult to make an estimate of those numbers. For this reason, unless there are special circumstances where significant numbers of groups at risk come in close proximity to the tower, the overall number of people can be used as a guide.

Where you have special local circumstances, these need to be taken into consideration in your risk assessment. For example, if the cooling tower is located next to a senior citizens club, a higher risk classification should be used. Similarly, where the number fluctuates greatly to a much larger number, say once or twice a year with a special event, use the highest estimate for the purposes of categorising the system.

6.2 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. Figure 11 lists the questions that should be considered for each critical risk, based on the earlier risk analysis.

6.2.1 Risk Classification

Responses to these questions will enable you to establish the overall risk associated with a cooling tower system using the Cooling Tower Risk Classification Table (Figure 12).

We have evaluated possible responses to these questions. For the various combinations, we have evaluated the combined risk and developed a logical

Figure 11 Risk Evaluation Table

Critical risk	Question
Stagnant water	Is the 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 there 'dead legs'?
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 a review of system design been conducted?
	Has a review of system operation and performance been conducted?
Location and access	Is the tower system located in or near an acute health or aged residential care facility?
	How many people come with close proximity to the tower within a day?

grouping within the table. Different cooling tower systems are grouped into a category with similar overall risks. There are four risk categories: A, B, C and D.

These risk categories are used in Section 7 to help you select an appropriate maintenance or operational program.

6.2.2 Using the Risk Classification Table

The table (Figure 12) lists each of the critical risks in the left hand column and for each risk, the possible combinations of responses to the questions in Figure 11 are listed to the right.

You should be able to find a response that matches the situation with your system for each question.

If your system matches any of the combinations of responses in a particular row (for example the row associated with the stagnant water critical risk), then the risk classification is to be found at the base of the column in which the combined response is located (A, B, C or D). A is the highest risk and D is the lowest risk.

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 then the overall risk classification is Risk 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 then the overall risk classification is Risk 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 then the overall risk classification is Risk 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 then the overall risk classification is Risk Category D.

This process of categorising the cooling tower system should be:

- Completed prior to 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 7 discusses how to treat each of the critical risks and strategies for reducing your overall risk classification.

Figure 12 Cooling Tower System Risk Classification

Critical Risk	Higher risk →			Lower risk
	Cooling Tower System Risk Classification			
Stagnant Water	System is idle more than one month **and** Recirculating pump with timer not fitted **and** 'Dead legs' exist	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 for 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 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 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**[1]	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

1 The only exception to this table is with regard to Category A systems which would fall into this category only because of the **number** of people who are potentially exposed to the cooling tower system. In this case, an exception is provided to classify these systems within Category B provided that the system meets the prerequisites described in Section 6.2.2.1.

6.2.2.1 Exceptions to Cooling Tower System Risk Classification

It is important to strive for ongoing improvement and continual minimisation of risks associated with cooling tower systems. Capital improvements can assist in this objective. As an incentive for organisations to continue upgrading their cooling tower systems, the risk classification table makes an exception with regard to systems classed as Category A, only because of the **number** of people who are potentially exposed to the cooling tower system. In this case, an exception is provided to classify these systems within Category B, **provided that the system meets the prerequisites described below.**

These systems can be categorised in Category B where the system meets the following prerequisites:

- There are either no ‘dead legs', or where potential ‘dead legs' exist, they have been activated.
- The system or part of the system is either not idle for more than a month, or where it is idle, a timer has been fitted to control a recirculating pump that circulates the water in the system at least once a day.
- There is a corrosion control program involving both anti-corrosive chemicals and corrosion monitoring, using corrosion coupons or an equivalent technique.
- The water in the system and the wetted surfaces of the system are protected from sunlight.
- Control measures are established and monitored.
- The system is fitted with a high degree of automation to monitor the water chemistry, incorporating:
  - Effective automated dosing systems to deliver all chemicals into the recirculating water. These are connected to alarms (and preferably building automation systems) to warn of pump failure or a failure in the supply system (to warn a human operator of the problem).
  - Chemicals or other agents to effectively minimise scale formation and fouling.
  - Biodispersant is applied which is compatible with chemicals in use (including chlorine).
  - At least two biocides, including at least one oxidising biocide, that have separate chemical stores and separate dosing mechanisms.
  - Automated bleed–off systems using conductivity probes with a locking device to prevent bleed at the time of chemical dosing. This should ideally be connected to the building automation system.
  - pH meters connected to the building automation system.
- After all of the above actions have been taken, six months of intense testing to demonstrate consistent chemical and bacterial test results that indicate that the system is under control.

Note that acute health or aged residential care facilities should *always* be classified as Category A, because of the population of vulnerable people.

7 Treating the Critical Risks

In evaluating the overall standard of the cooling tower system including the related pipework, you should consider the impact that capital investment on the tower system may have on reducing ongoing maintenance costs. Without capital investment, you will need to considerably increase the maintenance or operational program for the system.

7.1 General

It should be the objective of all cooling tower system owners to lower the overall risk associated with their system, if possible, such that the overall risk classification is reduced, for example, from A to B. In most cases, the only way this can be done is via capital investment; fitting drift eliminators, automated dosing devices and recirculating pump timers.

As discussed previously, there are a number of critical questions that need to be considered in relation to the existing condition of your cooling tower system.

This section explains how to use the risk classification process from Section 6 to identify an operational program for your cooling tower system.

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

7.2 Strategies to Address the Critical Risks

There are numerous possible responses to the critical risks and many are described below. Some relate to the improvement to the cooling tower system itself, others concern maintenance or operational aspects of the system.

7.2.1 Stagnant Water Risk Control Strategies

7.2.1.1 Cooling Tower System Improvements

Key strategies to minimise the risk associated with stagnant water include:

- **Installation of a timer connected to a recirculating pump, set to operate at least once a day to circulate the biocide and other chemicals.** Where the tower system, or part of a system, is idle for more than one 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 where they exist, removing or activating them.** The first step is to locate any potential 'dead legs'. As a rule of thumb, this is a pipe that branches off from the main pipe and is longer than the 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 to identify potential 'dead legs'.

  On larger sites or with more complex systems, the process of checking for 'dead legs' should include reviewing information from 'as constructed' plans of the tower system, anecdotal information from staff and contractors and visually inspecting the system.

  Where potential 'dead legs' are identified, it may be possible to confirm their status by draining them. This may require liaison with your 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 any aerosols.

  Once 'dead legs' have been identified, make a commitment to address the risk. This can be achieved by removal. The length of time taken to remove the pipe should be based on the overall risk assessment. Removing 'dead legs' can be a relatively straightforward task on small sites. On large 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.

  Activating a 'dead leg' may be achieved by:

  - Installing a pipe connected to a pump, drawing water from the 'dead leg' and injecting it into another part of the system. This has the effect of achieving circulation in the pipe and reduces deposition of sludge in the pipes, allowing biocides to reach all parts of the system
  - Having a program to drain or flush 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 of time:

- Pass this information on 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.

7.2.2 Nutrient Growth Risk Control Strategies

7.2.2.1 Cooling Tower System Operation

Key strategies to minimise the risk of nutrient growth include:

- **Identify sources of environmental contamination and attempt to reduce the amount.**
  Identify all possible sources of environmental contamination. For example, dust from demolition or construction sites, dirt car parks or roads, heavily used roads or birds nesting. Where possible, try to reduce the level of contamination. For example, during periods of construction or demolition, water might be used to reduce the levels of dust being generated. Where this is not possible, you will need to rely on other strategies to reduce the impact of the contamination.

- **Use of a biodispersant.**
  A biodispersant will help break down the biofilm on the wetted surfaces in the tower system.

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

  It is important to note that corrosion control is critical to some business operations. In that event, independent specialist advice should be sought on the appropriate control and monitoring techniques.

- **A more frequent cleaning program.**
  The Health *(Legionella)* Regulations 2001 require cooling tower systems to be disinfected, cleaned and re-disinfected at least every six months. This needs to include the cleaning of all wetted surfaces in the system.

7.2.2.2 Cooling Tower System Improvements

Key strategies to minimise the risk of nutrient growth include:

- **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 form. The risk may be reduced by installation or re-fitting (where they have been removed) of sides to the tower structure. The material used to protect the sides must be durable and easily cleaned. Material such as UV stabilised polypropylene is commonly used and is appropriate for this purpose. Other materials used include reinforced glass fibre.

- **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.

7.2.3 Poor Water Quality Risk Control Strategies

7.2.3.1 Cooling Tower System Operation

Key strategies to minimise the risk of poor water quality include:

- **A comprehensive water treatment program.** The Health *(Legionella)* Regulations 2001 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.

  The water treatment program must involve the use of biodispersants, anti-corrosives and one or more biocides.

  The choice of biocides is important. Make sure that they have been proven to be effective under local conditions in killing *Legionella* and other bacteria. Material data sheets should be reviewed to ensure such evidence is available and what, if any, occupational health or environmental issues are associated with the product[2]. Administer the biocide so as to maintain the recommended concentration at all times. This requires an accurate calculation of the total water volume and of 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 they are capable of killing microorganisms including *Legionella*.

  Chemical biocides are the most commonly used in cooling tower systems and these are of two types:

  – Oxidising
  – Non-oxidising.

  Oxidising biocides include commonly used chemicals such as chlorine and bromine. These chemicals kill bacteria relatively quickly. Concentrations in water can be monitored relatively easily using simple test kits commonly used by swimming pool operators. However, they tend to be associated with corrosion, so close attention is needed in terms of corrosion control.

  Non-oxidising biocides include chemicals such as isothiazalone, which is also relatively commonly used in cooling tower water treatment. These chemicals kill bacteria more slowly. Also, concentrations cannot easily be monitored in the field. A relatively complicated laboratory test is required to determine the concentration in the water.

  Best practice usually involves the use of multiple biocides (both non-oxidising and oxidising) that are rotated periodically to avoid problems with the bacteria adjusting to tolerate a particular biocide. This involves separate chemical stores and dosing mechanisms.

  Some systems use non-chemical biocidal devices. These include devices that generate ultraviolet light, ozone or electromagnetic fields. Solid biocides also exist, including mineral crystals.

- **Regular monitoring of the chemical parameters as a measure of water quality.** Establishment and frequent monitoring of control measures to indicate whether a cooling tower system is in control is an important aspect of risk management. Once a control measure has been identified, a target range should be established beyond which corrective action is indicated.

  Chemical parameters such as the concentration of biocides[3], pH, conductivity (to measure the build up of solids) and water temperature are good control measures. Rather than list all possible combinations of water quality parameters and

2 For example, chromates have both biocidal and anti-corrosive properties, but have been associated with adverse health impacts and their use should be strictly limited.

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

Figure 13 Indicative Water Quality Table

Indicative Water Quality Target Ranges	
Bacteria	
Legionella	Not detected (<10 CFU/mL)[3]
HCC	Less than 100,000 CFU/mL[4]
Solids	
Total dissolved solids	Less than 1000 ppm
Conductivity	Less than 1500 µS/cm
Suspended solids	Less than 150 ppm
Calcium hardness	Less than 180 ppm
pH	
pH (for bromine compounds)	7 – 9
pH (for chlorine based compounds)	7 – 8
Total alkalinity	80 – 300 ppm
Other additives	
Biodispersant	Follow the manufacturers' specifications
Corrosion inhibitor	Follow the manufacturers' specifications

desirable ranges, Figure 13 describes the more commonly used parameters and the indicative ranges for each parameter. Note that they are only indicative ranges. More precise levels may be required for particular systems. These can be determined in conjunction with your water treatment provider.

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

Automation is available for many of these tasks. Devices to monitor chemical parameters on a continuous basis can be linked to building automation systems or to more conventional alarms, with pre-set 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 as a way to minimise the risks.

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

3 The Health *(Legionella)* Regulations 2001 prescribe a series of actions which must be taken following the detection of *Legionella* in a cooling tower system sample.

4 The Health *(Legionella)* Regulations 2001 prescribe a series of actions which must be taken where a cooling tower system sample is found to have a HCC of greater than 100,000 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 systems' RMP.

  Heterotrophic Colony Count (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. It is reported as the number of colony forming units per millilitre (CFU/mL).

  A high HCC level (which is regarded as any count of greater than 100,000 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 levels and *Legionella* concentration. It is possible to have very low HCC levels and still detect *Legionella* and conversely, very high HCC levels but not detect *Legionella.*

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

  – Taken in containers as described in AS 2031.2 in terms of the selection of a suitable sampling container and preservation of the sample for later testing.
  – Collected as described in AS/NZS 3666.3. This involves the sample being stored at between 2 and 10°C prior to analysis.Analysis should be commenced within 24 hours of the sample being taken.
  – Analysed in accordance with the relevant method in AS 4276.3. using Plate Count Agar incubated at 37°C for 48 hours.

  The Health *(Legionella)* Regulations 2001 require monthly HCC testing. If the HCC level is above 100,000 CFU/mL, the Regulations also require that action must be taken as described in Section 3.4. This includes re-sampling.

  Testing should occur at least monthly, but the frequency should be proportionate to the risk posed by the system. Later in this section, recommendations are given as to appropriate frequencies of testing for HCC.

  As part of a risk assessment, it is important to look at past results for the testing of HCC. A graph can be charted to illustrate the levels over time, as compared to the action limit of 100,000 CFU/mL set in the Health *(Legionella)* Regulations 2001.

- **Testing for *Legionella.***
  Legionella testing is the ultimate performance test of a cooling tower system. The Health *(Legionella)* Regulations 2001 requires action to 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'.

  The Department of Human Services *Legionella* Working Party, when it considered the issues in mid-2000, did not support mandatory routine *Legionella* testing of all cooling tower systems. The rationale was that there are long delays of up to ten days after sampling before results become available, the cost involved and the potential for negative results to give a false sense of security.

  However, testing for *Legionella* is:

  – Required by the Health *(Legionella)* Regulations 2001, under certain circumstances described earlier in Section 3.4.
  – Strongly recommended by the Department at a frequency based on the risk assessment for the system and proportionate to the risks posed by the system. Later in this section, recommendations are given as to appropriate frequencies of testing for *Legionella.*

  Put simply, the use and frequency of *Legionella* testing should be determined based on the risk of potential growth of *Legionella*, combined with the potential for exposure of people to aerosols from the system. It should be seen as an indicator of system performance. However, because of the inherent difficulties associated with *Legionella* testing, the absence of *Legionella* in an isolated test cannot be seen as definitive proof that the system is operating well at another point in time.

Another important consideration is the impact of a positive *Legionella* result following a test. This is discussed further in Section 9.

Testing for *Legionella* requires samples to be:

- Taken in containers as described in AS 2031.2.
- Collected as described in AS/NZS 3666.3.
- Stored and transported as described in AS 3896. This standard requires that the samples be transported to the testing laboratory as soon as possible and then analysed in accordance with AS 3896. The testing is much more sophisticated than for HCC and results can take up to ten days to obtain.

In selecting a testing laboratory to perform these tests, the following considerations may assist:

- Is the laboratory accredited with the National Association of Testing Authorities (NATA) for these types of tests? (Note: NATA is an internationally recognised provider of laboratory accreditation)
- Does the organisation follow the relevant Australian Standards in their testing processes?

- **Appropriate bleed-off rates suited to the system in use.**
  To overcome the problem of the 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. This water is drained from the system to the sewer and is replaced with fresh water. Automated devices are available to assist in this process. For example, a flow-controlled device that drains a pre-set volume of water at regular intervals can achieve this in some systems. Other devices available are fitted with a conductivity controller to measure the conductivity level at frequent intervals. Conductivity has a relationship to the levels of solids in the water. These devices should be linked to the dosing device to prevent bleed-off at the same time that chemicals are being added.

Conductivity meter: This meter measures conductivity of the water and controls a bleed-off valve to ensure the solids in the water do not exceed a pre-determined level

7.2.3.2 Cooling Tower System Improvements

Key strategies to minimise the risk of poor water quality include:

- **Installation of automated dosing devices.**
  The method of adding chemicals such as biocides, anti-corrosive additives and biodispersants to the water can significantly affect the overall risk. Manual dosing, drip-feed or siphon devices are regarded as relatively unreliable in the context of cooling tower system water treatment. Manual dosing relies totally on the operator. Drip-feed or siphon devices tend to block and fail to dispense the chemicals.

  An automated dosing device is more reliable, because a pre-set volume of biocide (and other chemicals such as biodispersants and anti-corrosives) can be injected into the recirculating water at regular determined intervals. Many of these systems have alarms fitted to warn of problems such as pump failure.

There are several types of automated devices for chemical dosing:

- Timer controlled dosing pumps
- Feedback controlled dosing using ORP probes
- Feedback controlled dosing using direct measurement of chlorine and bromine concentrations.

Timer controlled dosing pumps rely on a pump and timer being connected to a drum containing the chemical to be dosed. This relies on a manual setting based on an operator 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 administration of oxidising chemicals such as chlorine and bromine. It can be used to keep these biocide concentrations in the target range at all times. This equipment can be connected to building automation systems and alarms to advise of problems or to track the dosing performance.

Feedback controlled dosing using ORP probes measures a parameter that has a relationship to the oxidising chemicals concentration in the water. Devices are also now available that directly measure either chlorine and bromine concentration.

In large installations where there are multiple cooling towers connected in series (cells), there may be a practice where some cells are shut down in rotation for lengthy periods of time. The automated dosing device though may sometimes only be connected to one cell and it may be necessary to have multiple dosing points to cater for 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 biocides that dissolve to release biocides into the circulating water may be regarded as an automated dosing device for the purposes of risk classification.

- **Selection of 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. This is 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, the bacteria levels in the water immediately around the dosing point may be relatively 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 why the dosing happens at a different point, it is recommended that dosing of chemicals occur immediately or soon after the cooled water leaves the cooling tower. This means that a lower volume of chemicals would be lost due to splashing in the cooling tower.

- **Provision of a dedicated water sampling point.**
  The selection of a bacterial sampling point is important. It should be well away from the dosing point. Ideally, where 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 positioned as close to the main pipe as possible. The tap should be run for at least 30 seconds prior to 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 water as it falls from the fill into the basin.

In either case, the sampling point should be clearly marked on the tower and its location described in the RMP.

- **Installation of side stream water filtration in dirty environments.**
  An appropriately installed side stream filter can be a very effective component in a cooling tower system 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 either use sand, cartridges or a centrifugal design to filter the water.

Sand filter

7.2.4 Deficiencies in the Cooling Tower System Risk Control Strategies

7.2.4.1 Cooling Tower System Improvements

Key strategies to minimise the risk involve improvements to the tower system:

- **A comprehensive review of the system design, to confirm that it complies with AS/NZ 3666.**
  This should be the first step in a capital works program. As discussed earlier in Section 6 it can be performed by contacting the original supplier or by full or partial comparison with AS/NZS 3666.
- **A comprehensive review of the current operation and performance of the system.**
  A review could include a check of the water temperature in the basin as it leaves the tower. Ideally, this is then compared to the operating design specifications to ensure that the system is not working at an excessively high temperature or above its original design capacity. If these design specifications are not available, check all equipment to ensure that it is operating effectively.
- **Development of operating and maintenance manuals.**
  AS/NZS 3666.2 states that operating and maintenance manuals shall be provided for cooling tower system. The Standard describes these manuals as having:
  - Physical details, including drawings, of the plant, equipment and systems.
  - Suppliers' 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.

- **Assessment of Useful System Life.** Like other mechanical assets, cooling tower systems have a limited useful life. There is a point beyond which further maintenance is uneconomical and complete replacement of the tower considered. An assessment should be made of the useful life of the tower system and how well it is meeting business needs. This information, combined with risk considerations, will allow cooling tower system owners to make a decision as to when the system should be replaced or upgraded. Consider whether there are alternatives to the cooling tower system because of new technology, for example, in the case of small air conditioning or refrigeration related cooling towers. Air cooled systems generally have higher capital costs, higher energy consumption, occupy more floor area and create higher noise levels, but they do eliminate the risk of *Legionella* and the cost of maintenance of a water system. This should particularly be considered where the required heat rejection is below 750 kW. 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 comparing energy consumption.

- **Installation of an effective drift eliminator to AS/NZ 3666.** Cooling towers not fitted with effective, modern drift eliminators present a greater risk of an outbreak of Legionnaires' disease, in the event that the water treatment regime fails. A drift eliminator constructed and fitted to Australian Standards can significantly reduce the amount of aerosols leaving a tower. However, there is not a simple field test to confirm that a drift eliminator is working effectively, so an assessment needs to be made about its condition. For example, contact can be made with the supplier to confirm that the drift eliminator did meet the Standard at the time of installation. Drift eliminators are generally constructed of modern materials such as propylene. Where possible, check the drift eliminator is still in good condition and has not become dislodged from its installation position.

- **Review and monitor 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.

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

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

- **Using suitable materials for external components.**
  Wood is not regarded as a suitable material for use with cooling towers as it deteriorates rapidly in a warm and moist environment. However, in some large industrial cooling towers it may be the only material suitable for the operation, in which case it will require careful and regular maintenance.

Wooden tower: An aged tower constructed largely of wood

- **Using suitable materials for internal components.**
  Many older tower systems have inappropriate materials used inside the cooling tower, for example, wood for drift eliminators or fill. These should be replaced with durable modern materials such as UV stabilised polypropylene.

7.2.5 Location and Access Risk Control Strategies

7.2.5.1 Cooling Tower System Operation

Key strategies that address the issue of location and access include:

- **Restricting access to the tower and its surrounds to only those staff or contractors with a direct need to access the area.**
  This is a way of reducing the number of people who may be exposed to aerosols and is best achieved in an operational sense through clarity about individual roles. Identifying those people who require access to the area and establishing a security system is one method of achieving this.

- **Using high standards of maintenance for towers located in high risk locations.**
  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 the aerosols from the system, the highest standards of maintenance (including frequency of inspection and service) and bacterial testing are needed

- **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.

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

7.2.5.2 Cooling Tower System Improvements

Improvements to the cooling tower system that address the issue of location and access include:

- **Display of 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.'

- **Prevent area around cooling tower system being used as a gathering place for staff or other people.**
  On some sites, smokers use the area around the cooling tower as a place to congregate outside of the factory area (generally a non-smoking area). Such a practice should be discouraged; smokers are regarded as being at higher risk of contracting Legionnaires' disease if exposed to *Legionella.*

  Best practice is to clearly mark or label each cooling tower as a 'Cooling Tower'. Where this is done the Building Control Commission Cooling Tower System Number and a tower reference number could also be marked on the tower for ease of identification by contractors, for example, 'Cooling Tower 1 – CTS 1234'.

- **Restricting access to the tower.**
  Restricting access to the tower by methods such as locking access points (where access cannot currently be restricted) and erecting fencing with locked gate access.

- **Relocation of the tower to a more remote site or less contaminated environment (where possible).**
  This is particularly the case with 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' hostel. Such a decision would need to consider not just the engineering issues involved, but the potential impact on highly vulnerable people.

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

- **Ensuring there is a safe and stable area for maintenance workers to access the tower system.**
  It is important that those who have to access the cooling tower system for maintenance or inspection purposes can do so safely. This includes having safe access to the area near the cooling towers, including ladders, ramps or platforms. In addition, the access area around the platform needs to be sufficiently large to facilitate all of the major operations that need to be performed on the cooling tower system, including access to and removal of key components for cleaning.

- **Installation of a side stream filter as discussed in 7.2.3.2**
  Where a tower is exposed to significant environmental contamination, the use of side stream filtration can reduce the level of solids and improve water quality.

7.3 Operational Programs

Section 5 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.

No matter what the quality of the operational program, the way that it is implemented will have a dramatic impact on the overall risk associated with a cooling tower system. A well considered and 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 7.4.2 describes the considerations in selection and monitoring of a maintenance contractor.

The first element to consider in the treatment of the risk is the standard and frequency of the maintenance and cleaning programs. It addresses the following critical risks:

- Stagnant water
- Nutrient growth
- Poor water quality.

A well structured operational program will include the following components:

- Competent personnel trained for the tasks
- Inspection
- Service
- HCC test
- *Legionella* testing
- Cleaning
- Performance measures
- Record-keeping.

7.3.1 Training for Personnel

The operation and maintenance of a cooling tower is not a task that can be performed by personnel without appropriate skills and experience. People involved 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 all of the necessary tasks described below would include:

- 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.

7.3.2 Inspection

Inspection means a simple monitoring of a small number 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 within the tanks to confirm that they have decreased since the last inspection.

Inspections can be performed frequently by a non-technical person with minimal training. Where problems are noted, they need to be reported to the responsible person, who can then authorise remedial works.

7.3.3 Service

Services 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, biocide levels etc.
- 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 taken to remedy any problems immediately.

7.3.4 HCC Test

This test is described in Section 7.2.3.1.

7.3.5 Testing for *Legionella*

This test is described in Section 7.2.3.1.

7.3.6 Cleaning

Cleaning a cooling tower system should only be performed by a competent person trained for that task.

7.3.7 Performance Measures

Another critical element of operational program is the use of performance measures such as those listed in Section 7.2.3.1. In the case of the outsourcing of operational programs, these should ideally be clarified before the program is defined in a contract.

7.3.8 Record-Keeping

A written record must be kept of all work associated with the system and copies kept on-site. The Building *(Legionella)* Act requires that records must be kept of any repair, maintenance and testing work for at least seven years. Attachment 3 gives some guidance on the types of information that should be kept as a minimum. These records must be kept on-site.

7.4 Selecting an Appropriate Operational Program

Once you have completed a risk assessment, you can classify the risks posed by your cooling tower system. The next task is to develop an operational or maintenance program that is proportionate to those risks. To help you decide on the appropriate operational program (that is, the standard of maintenance), for your tower system, we have recommended a series of standard operational programs, together with a means of selecting the appropriate one for your system.

They represent the Department's view on what is reasonable practice for maintenance of a cooling tower system.

Using the table in Figure 12 you should be able to identify a particular risk classification. Figure 14 shows the recommended operational program based on that risk classification.

In summary, if your system is classified as Risk Category A the recommended Operational Program is Program A, whilst if your system is categorised as Risk Category B the recommended Operational Program is Program B and so on.

It is important to note that each of these operational programs meets the ongoing maintenance requirements of the Health (*Legionella*) Regulations 2001.

Figure 15 describes the details of the recommended Operational Programs.

Figure 14 Operational Programs Selection Table

Risk Classification	Recommended Operational Program
A	A
B	B
C	C
D	D

Figure 15 Recommended Operational Programs Table

Recommended Operational Programs based on Risk Classification			
Program A for Risk Category A	**Program B for Risk Category B**	**Program C for Risk Category C**	**Program D for Risk Category D**
Weekly inspection	Monthly inspection (two weeks after service)	Monthly inspection (two weeks after service)	Monthly service
Fortnightly service	Monthly service	Monthly service	Monthly service
A minimum of monthly HCC tests	Monthly HCC test	Monthly HCC test	Monthly HCC test
Six-monthly cleaning, more frequently where environmental contamination is a problem. Note the system must also be cleaned prior to initial start up following commissioning.			

Recommended *Legionella* Testing Frequency as a Performance Measure			
Risk Category A	**Risk Category B**	**Risk Category C**	**Risk Category D**
At least every month	Every month	Every two months	Every three months

It is also important to consider increasing the frequency of bacterial testing and monitoring of chemical parameters above those listed here, whenever major changes are made to the system. For example, even if upgrading the system by installing increased automation, it is important to monitor the system closely to confirm it is under control before reverting to the lower testing frequency. Similarly, seasonal variations may increase risks of *Legionella* growth and as a result it may be appropriate to increase the service or testing frequencies over such periods.

7.4.1 Model Operational Program

Attachment 2 is a Model Operational Program that can be completed after you have worked through your risk assessment. It will form part of your RMP.

Attachment 4 contains the key elements of a model service contract, which again can be completed and tailored to suit your needs.

7.4.2 Maintenance Contractors

In most cases, cooling tower system owners 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 that you require and for this to be specified in writing.

Carefully consider the qualifications and experience of companies before engaging them for these types of services. The outsourcing of a service such as cooling tower system maintenance does not mean a company has eliminated its legal responsibility—the owner of the land and the owner of the cooling tower system still have the same legal responsibilities described in Section 3 of this Guide.

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

You can reduce the risk of problems with your cooling tower system by using appropriately skilled people or organisations to maintain it. A Code of Practice for Water Treatment Providers has been developed. The Code aims to provide an expected minimum standard for water treatment providers to meet when performing work on cooling tower systems. It can be used as part of the selection criteria for organisations seeking to engage a water treatment provider.

Some key selection criteria include:

- Is the organisation a member of relevant industry bodies? For example, the Australian Institute of Refrigeration Air-conditioning & Heating (AIRAH) and/or the Plastics and Chemicals Industries Association (PACIA)
- What is the formal training level of their personnel? For example: water science, chemistry, and 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?

It is important to note that when evaluating tenders or proposals from companies interested in providing these types of services, that the lowest price is not always the best service provider for your needs.

Attachment 3 is a model service report that is provided as a guide to the detail that is required at each service. Many contractors have developed their own service reports and you should check that the details provided in their reports meet or exceed the details in Attachment 3.

Maintenance contractors should be monitored closely to ensure that the required service is being delivered consistently and in the required manner. Regular reporting arrangements and meetings at which the performance measures 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.

8 Monitoring and Review

The RMP is required to be reviewed and updated annually, prior to renewing the registration of your cooling tower system 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 water system or its use.
- Changes to the use of the building in which the water system is installed.
- The availability of new information or technology about risks or control measures.
- The results of checks indicating that control measures are no longer effective.
- A case of Legionnaires' disease possibly associated with the system.
- Unusual factors, for example demolition or construction of buildings on or near the site or road works or other construction activities generating dust[5].
- Special events that will bring large numbers of people onto or near the site[6].
- 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, consider re-evaluating the adequacy of the maintenance program. Good quality record-keeping—as required by Victorian law—will assist such a review by allowing trends to be monitored. If your site or organisation has multiple cooling tower systems and *Legionella* has been detected in one system, you should strongly consider reviewing the maintenance program and risks associated with **all** of your systems. This may identify any common problems. In more high risk or complex sites, or where large workforces are involved, it is also recommended that you engage an independent consultant to conduct this review.

It is important that a single person with sufficient authority to initiate action and commit funds has responsibility and accountability for the operation of the cooling tower system. It will assist with the overall management of the cooling tower system 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.

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

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

9 Communication

You need to be clear on what to do, who to notify and how it will be done, in the case of an adverse event.

9.1 Adverse Events

An adverse event in this context includes:

- A HCC level of greater than 100,000 CFU/mL
- Detecting *Legionella* at any concentration
- Being advised of a case of Legionnaires' disease possibly associated with your cooling tower system.

It is strongly recommended that every organisation with a cooling tower system develops and maintains an action plan to deal with the adverse events described above. A communication plan needs to contain responses to events of varying seriousness.

9.1.1 Significance of High HCC Levels

HCC test results as stated earlier in Section 7.2.3.1 indicates to those responsible for the system the extent of control over the system and in particular, the water chemistry. There is no direct correlation between HCC levels and *Legionella* concentration. For example, it is possible to have very low HCC levels and still detect *Legionella.* Equally, it is possible to have very high HCC levels, but not detect *Legionella.* However, a high HCC level (which is regarded as any count of greater than 100,000 CFU/mL) is an indicator that the system is moving out of control and that the system may support *Legionella* growth unless action is taken to bring the system back under control. The Health *(Legionella)* Regulations 2001 specify the action that must be taken for HCC levels above 100,000 CFU/mL.

HCC levels are not directly related to Legionnaires' disease and so are not regarded by the Department of Human Services as of the same public health significance as the detection of the disease-causing *Legionella* bacteria.

9.1.2 Significance of *Legionella* Detection

Detecting *Legionella* in the recirculating water of a cooling tower system has public health implications. Consequently, the Health *(Legionella)* Regulations 2001 require a response within 24 hours, including the disinfection of the system and re-sampling and testing for *Legionella* two to four days later.

9.1.3 Legionnaires' Disease

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

9.2 Developing an Action Plan

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

In deciding who you would advise in the event of an adverse result, consider:

- **Due diligence.**
  This is a legal principle that says 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 that 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 reviewed the risks associated with the cooling tower system and developed an action plan that was carried out efficiently.

  However, where a cooling tower system has been tested and *Legionella* detected, you need to consider the potential impact of the system causing Legionnaires' disease.

- **Minimising the adverse impact on your business.**
  Experience with major outbreaks of Legionnaires' disease has shown that the linking of 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. Enabling people who have been exposed to *Legionella* to minimise the impact of the disease through early diagnosis and treatment could all help limit the impact to your business.

  This approach has to be carefully balanced with a need not cause undue anxiety among those involved.

- **Minimising the adverse health impacts to potentially exposed people.**
  The potential for serious health effects from Legionnaires' disease need to be considered when deciding whom to notify in the event that *Legionella* is detected. Considerations could include whether the tower system is located in or close to an acute health or aged residential care facility, or if other susceptible groups have been exposed to aerosols from the system. This could influence your decision on who and how to notify at an early stage. Such a notification would 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 due to 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.

9.2.1 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.

For this reason, where *Legionella* testing is routinely used, you may wish to consider adopting a standard preventative disinfection procedure. Immediately after the sample is taken, manually disinfect the system by 'slug dosing' with an additional amount of biocide (or an alternative biocide). This is a conservative practice, but deals with the ten-day time lag between testing and results and the implications of obtaining a positive result.

What would your response be if you took a sample and then ten days later you are informed that is positive for *Legionella?* Your workforce or others may be alarmed and want to know what action you have taken and will take.

If you have not manually dosed the system immediately after the sample was taken, you can at best respond by saying that you have followed best practice before the testing and since you were advised. However, if after taking the sample you had manually disinfected the system, you can advise staff and others of that fact and that you are following the Health *(Legionella)* Regulations by disinfecting the system, reviewing cooling tower related programs and correcting any faults and retesting between two and four days later. In this way, the information can be accompanied by details of the preventative action already taken to disinfect the system, as well as action being taken after the positive test.

9.2.2 Who to Inform If *Legionella* Is Detected

Employers have a legal obligation under the *Occupational Health and Safety Act 1985* to fully inform the elected health and safety representatives at the workplace about all health and safety aspects of the working environment. **The detection of *Legionella* in a cooling tower system should be notified to elected health and safety representatives.**

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

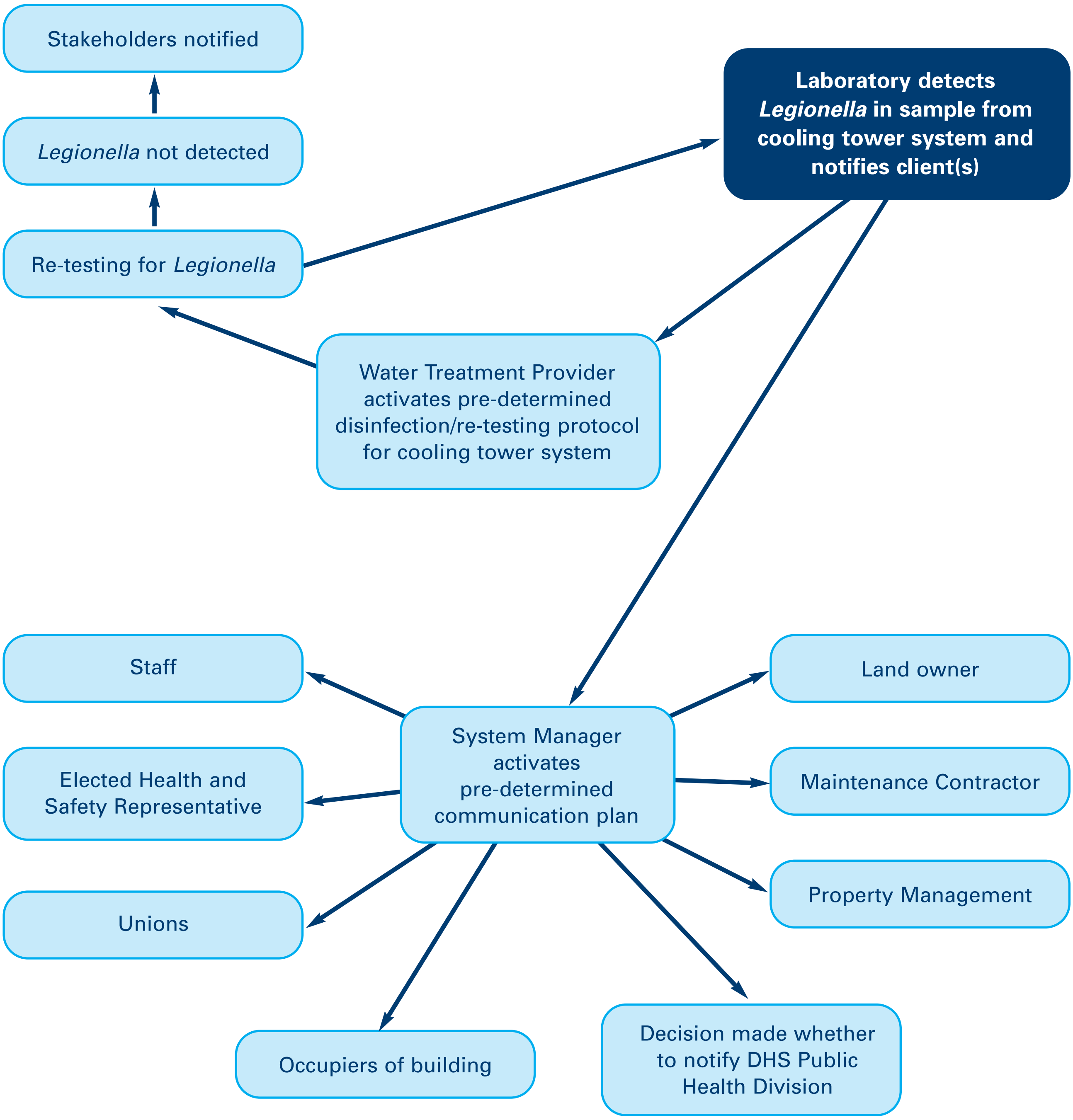
Other people you should also consider notifying are:

- Staff who may be affected by the cooling tower.
- Your medical officers and occupational health officers.
- Relevant unions.
- Other relevant service contractors.
- Other occupiers of the building.
- Site owners.
- Your employee assistance program (where it exists) to brief them on the issues so they can deal with enquiries from concerned staff if they need counselling.
- The Department of Human Services Public Health Division[7].
- Your local Council Environmental Health Officer.
- Your media liaison staff (where they exist).
- Your company's public spokesperson.
- Your customers.
- Neighbours to the site who may have been exposed to the aerosols from the system.

You need to consider your policy on how and what you will communicate about the problem and the action that you are taking. Figure 16 is a flow chart that summarises the flow of information in such a situation. It is not uncommon in industry to have complex management relationships in place on a site. 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 cooling tower system water treatment. 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.

7 This is a mandatory action under the circumstances described in Section 9.2.

Figure 16 Recommended Legionella Detection Communication Plan



The Department provides explanatory information for you to use in helping those notified understand the issues. Such an education program should ideally occur before the adverse event. It should include basic information about where the cooling tower systems exist, what is done to manage the risks of Legionnaires' disease and what procedures are in place to deal with the detection of *Legionella*.

Action plans will vary from site to site but a model procedure for cooling tower systems detected with *Legionella* is Attachment 5.

9.2.3 Who to Inform if High HCC Levels are Detected

Some organisations are opting to take a totally transparent approach and inform all stakeholders of all bacterial test results. However, the Department considers **as a minimum** that a high HCC result (greater than 100,000 CFU/mL) should be communicated to:

- Those who are responsible for the cooling tower system.
- The Occupational Health and Safety Committee. This could be in the form of a report to the next scheduled meeting of the Committee, describing the result and what action has been taken to address the issue, including water treatment and re-testing.

9.3 Developing a Communication Plan

It is strongly recommended that the development of communication plans be done in an open and participative manner that involves key stakeholders and particularly staff. This can best done using existing structures such as an Occupational Health and Safety Committee.

9.4 Notification to the Department of Human Services

As stated earlier, the Health *(Legionella)* Regulations 2001 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 three days of the third detection of the organism.

However, wherever consecutive adverse results such as high HCC levels or the detection of *Legionella* are obtained it is suggested that an independent review of the RMP be made to attempt to identify any weaknesses in the system which can be further addressed to improve the system and reduce the overall level of risks.

10 The Auditing Process

The Building Act requires that your RMP be independently audited by an approved auditor. This is the so-called 'statutory audit'. It should not be confused with a review of an RMP, which may be conducted at any time by a competent person.

10.1 Why Do I Need an Audit?

The purpose of the audit is to confirm that the RMP addresses the critical risks prescribed in the Building *(Legionella* Risk Management) Regulations:

- Stagnant water
- Nutrient growth
- Poor water quality
- Deficiencies in the cooling tower system
- Location and access.

Further, it demonstrates that the RMP is being implemented.

10.2 When and How Often Is the Audit Required?

The first audit will be required within three months of the date for renewal of registration in the registration year following the development of the RMP. The plan will then have to be audited on an annual basis thereafter in the three months before the registration is due to expire.

During 2001 relatively few cooling tower systems will require statutory audits. Only those cooling tower systems commissioned between 1 March 2001 and 31 December 2001 will require a statutory audit during 2002. Most cooling tower systems in Victoria will not require an audit until mid-2003.

10.3 Where Can I Find an Approved Auditor?

The Department of Human Services will be responsible for the approval of auditors. A process for this will be developed during 2001 for those few cooling tower systems that require audits during 2002. The Department will contact those land owners requiring audits during 2002, to provide them with a list of approved auditors.

From 2003 onwards, you will be able to obtain a list of approved auditors by accessing the Web site at www.legionella.vic.gov.au or by ringing 1800 248 898.

The auditor will be required to satisfy themselves that the RMP meets the requirements of the Building *(Legionella)* Act 2000, the Building *(Legionella* Risk Management) Regulations 2001 and the Health *(Legionella)* Regulations 2001. The auditor must be satisfied that the risk factors have been considered and addressed as required, based on your risk analysis. They will also need to view the maintenance logbooks and any other documents referred to in the plan to satisfy themselves that what was committed to be done in the RMP has in fact been done. For example, where the plan identifies a work program to install a drift eliminator by a particular date, then they will need to see proof that it has been installed, such as a statement from the supplier.

10.4 Does the Auditor Need to Visit the Site?

The audit is essentially a paper audit and may be undertaken by forwarding copies of all relevant documents to the auditor for them to do 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. It is important to note though that the original documents must remain on-site at all times.

10.5 What if the Auditor Does Not Approve the RMP?

If the auditor believes that you have not met the requirements of the legislation, they must notify the Department of Human Services Environmental Health Unit, who will investigate the report.

10.6 What Records Do I Need to Maintain for the Audit?

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

The Health *(Legionella)* Regulations 2001 require the responsible person to keep a maintenance log of the cooling tower system that records details of:

- All maintenance activities undertaken in relation to the system.
- All microbiological test results of samples taken from the system.
- Any approval issued by the Secretary of the Department of Human Services to use a different method of maintenance and testing.

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.

BCC Building Control Commission.

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

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

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 of sample. Refers to bacterial levels detected in a sample.

Clean To render free from visible sludge, foam, slime (including algae and fungi), rust, scale, dirt, and any deposit of impurities or other foreign material.

Cleaning Maintenance work including disinfection, draining, dispersion and removal of solids, manual scrubbing and flushing.

Cooling tower A device for lowering:

(a) the temperature of recirculated water by bringing the water into contact with fan forced or fan induced atmospheric air; or

(b) 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 The structure located at the top of a cooling tower designed to create an extensive wetted surface area through which air passes.

Cooling tower system is:

(a) a cooling tower or number of interconnected cooling towers that use the same recirculating water; and

(b) any machinery that is used to operate the tower or towers; and

(c) 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 infection of Legionnaires' disease. The decontamination process is usually determined in consultation with the Department of Human Services Environmental Health Unit. It involves a series of actions to disinfect, clean and re-disinfect the cooling tower system. The process is described in detail in Attachment 8.

Disinfect To carry out a process:

(a) intended to kill or remove pathogenic microorganisms, including *Legionella*; and

(b) in the case of a cooling tower system, consists of dosing the water of a system with either:

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

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

Heterotrophic Colony Count or **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 the service frequency.

Owner of any land Owner in relation to the land or Crown land within the meaning of the Building Act 1993.

PIC Plumbing Industry Commission.

Responsible person The 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. Includes a check of the water quality as well as physical components.

Slug dosing The process of adding in a single dose 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.

Attachment 1

Cooling Tower System
Risk Management Plan Template

Components and Format of an RMP

Generally an RMP should have a number of basic components that would include:

- 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 reference to other documents such as operational plans, shut-down procedures and so on.

Whilst there is no prescribed format for an RMP this template is provided as a guide. Other formats may, of course, be used.

About the Template

The template is designed to be completed:

- By landowners who have cooling tower systems on their land.
- After first reading the preceding Guide.
- After completing a thorough risk assessment as outlined in the Guide.

This process will meet the requirements of the Building Act and Regulations in terms of the development of a risk management plan.

A Risk Management Plan must be developed for every cooling tower system on the site. The Plan once developed must be kept on site.

Implementation of an Operational Program outlined in the above mentioned document would also meet the requirements of the Health *(Legionella)* Regulations.

The template is also available in Microsoft Word 2000 format at www.legionella.vic.gov.au and can be modified to use in the development of your plan.

1 Site and Key Contact Details

Record	Your details
Site location *(property address)*	
Type of cooling towers in the cooling tower system *(tick box)*	☐ Induced draught cross flow ☐ Induced draught counter flow ☐ Forced draught counter flow ☐ Forced draught cross flow ☐ Evaporative condenser ☐ Various (more than one type)
Number of cooling towers in system	
Cooling Tower System Number[1]	
Tower location reference *(If one exists)*	
Site owner's name/contact details *(Include company name, contact person's business and after hours telephone numbers)*	
Cooling tower system owner's name/contact details *(Include company name, contact person's business and after hours telephone numbers)*	
Who is responsible for day-to-day operation of the cooling tower system? *(Include company name, contact person's business and after hours telephone numbers)*	
Water treatment provider name/contact details *(Include company name, contact person's business and after hours telephone numbers)*	
Water sampling/laboratory contractor/contact details *(Include company name, contact person's business and after hours telephone numbers)*	
Department of Human Services Environmental Health Unit	1800 248 898

1 This is marked on the Certificate of Registration supplied by the Building Control Commission.

2 Critical Risks

2.1 Stagnant Water

Stagnant Water Risk Control Strategy	Assessment of Cooling Tower System *(Tick box)*	Operational or Tower System Improvement Response[2]
Installation of 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[3]	
Removal or activation of any 'dead legs'	Are there 'dead legs' in the system? ☐ Yes[4] ☐ No	
Other[5]		

Risk Classification for Stagnant Water Risk[6]	☐ A ☐ B ☐ C ☐ D

2 Indicate the operational program or improvements you will put in place as a result of this assessment
3 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, then you should describe how you will address the risk in the response column.
4 If you do have 'dead legs', you can address the risks by committing to removing or activating them progressively. If you have not confirmed whether you have potential 'dead legs' or where they exist to removing or activating them, you should describe how you will address the risks in the response column.
5 Use this row to describe other risks and response strategies that relate to this risk
6 Refer to Figure 12 in Section 6.2.2 of the guide and find the scenario that matches your system to evaluate the risk associated with stagnant water and your system.

2.2 Nutrient Growth

Nutrient Growth Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[7]
Identify sources of, and where possible, reduce the amount of environmental 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 cooling tower system? ☐ Yes ☐ No	
	If Yes, can you reduce the levels of contamination? ☐ Yes[8] ☐ No[9]	
Use a comprehensive water treatment program that includes a biodispersant	Do you use a biodispersant compatible with the chemicals in use (including chlorine) ☐ Yes ☐ No[10]	
Control corrosion	Do you have a corrosion control program? ☐ Yes ☐ No[11]	
Increase the frequency of cleaning	How frequently is the tower cleaned?[12] …………………………………….	
Protect the basin and 'top deck' of the tower from sunlight	Are any of the wetted surfaces exposed to sunlight? ☐ Yes[13] ☐ No	
Reduce the water temperature where possible	Can the water temperature of the tower be reduced? ☐ Yes[14] ☐ No[15]	
Other[16]		

Risk Classification for Nutrient Growth Risk [17]	☐ **A** ☐ **B** ☐ **C** ☐ **D**

7 Indicate the operational program you will put in place as a result of this assessment
8 Describe the strategies in the response column.
9 Describe how you will address the risk in the response column.
10 The Health (Legionella) Regulations require the use of a chlorine compatible biodispersant as part of the disinfection, cleaning and re-disinfection process, (as a minimum) prior to initial start up or any shut down period of greater than one month and at intervals not exceeding six months.
11 The Health (Legionella) Regulations require the treatment of the cooling tower system water with chemicals or other agents to minimise corrosion
12 The Health (Legionella) Regulations require the disinfection, cleaning and re-disinfection process to be performed prior to initial start up or any shut down period of greater than one month and at intervals not exceeding six months
13 Describe how you will address the risk in the response column
14 You should describe how and when you will reduce the temperature in the response column
15 Describe how you will address the risk in the response column
16 Use this row to describe other risks and response strategies that relate to this risk
17 Refer to Figure 12 in Section 6.2.2 of the Guide and find the scenario that matches your system to evaluate the risk associated with Nutrient Growth and your system

2.3 Poor Water Quality

Poor Water Quality Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[18]
Comprehensive water treatment program	Do you use two or more biocides in some form of rotation? ☐ Yes ☐ No[19]	
	Do you use a biodispersant compatible with the chemicals in use (including chlorine)? ☐ Yes ☐ No[20]	
	Do you treat the water with anti-corrosive chemicals? ☐ Yes ☐ No[21]	
	Have you developed control measures that are frequently measured to confirm that the water chemistry is under control? ☐ Yes[22] ☐ No[23]	
Testing for HCC	How frequently do you test for HCC?	
Testing for *Legionella*	Do you test for *Legionella?*[24]	
	How frequently do you test for *Legionella?*	
Appropriate bleed-off rates to prevent a build-up of solids	Is an automated bleed-off device installed?[25] ☐ Yes ☐ No[26]	
Install automated biocide dosing device	Do you have an automated biocide dosing device? ☐ Yes ☐ No[27]	
Install automated dosing devices for all chemicals or agents	Do you have an automated dosing devices for all chemicals/agents? ☐ Yes ☐ No[28]	
Selection of an appropriate point for chemical dosing	Does the chemical dosing occur well away from where the sampling point for bacterial tests is taken? ☐ Yes ☐ No[29]	

Poor Water Quality Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[18]
Provision of a dedicated water sampling point	Are water samples always taken from the same point? ☐ Yes ☐ No	
	If Yes, is that point clearly labelled? ☐ Yes ☐ No	
	Has a sampling tap been fitted? ☐ Yes ☐ No	
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[30]	
Other[31]		

Risk Classification for Poor Water Quality Risk[32]	☐ A ☐ B ☐ C ☐ D

18 Indicate the operational program you will put in place as a result of this assessment.
19 The use of two biocides is recommended as a way to minimise the risks of bacteria becoming resistant to the biocide.
20 The Health *(Legionella)* Regulations require the use of a chlorine compatible biodispersant as part of the disinfection, cleaning and re-disinfection process, (as a minimum) prior to initial start up or any shut down period of greater than one month and at intervals not exceeding six months.
21 The Health *(Legionella)* Regulations require the treatment of the cooling tower system water with chemicals or other agents to minimise corrosion.
22 Describe these in the response column.
23 The monitoring of control measures 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.
24 The Department recommends every cooling tower system be tested regularly for *Legionella* as per Section 7.4 of the RMP Guide. If you are not testing for *Legionella* describe how you will address the risks in the response column.
25 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
26 Describe how you will address the risk of poor water quality in the response column.
27 Manual procedures or siphon dosing devices have inherent potential to fail and not add sufficient biocide on a continuous basis. You should describe how you will address the risks of biocide failure in the response column.
28 Manual procedures or siphon dosing devices have inherent potential to fail and not add sufficient chemicals on a continuous basis. You should describe how you will address the risks of inadequate chemical dosing in the response column.
29 You should modify your sampling program to ensure you are getting representative results.
30 Describe how you will address the risk in the response column.
31 Use this row to describe other risks and response strategies that relate to this risk.
32 Refer to Figure 12 in Section 6.2.2 and find the scenario that matches your system to evaluate the risk associated with poor water quality and your system.

2.4 Deficiencies in the Cooling Tower System

Deficiencies in the Cooling Tower System Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[33]
Review the system design against AS/NZ 3666	Has a review been conducted? ☐ Yes ☐ No[34]	
	Are there any improvements that can be made to the system design to reduce risks? ☐ Yes[35] ☐ No[36]	
Review current operation and performance of system	Has a review been conducted? ☐ Yes[37] ☐ No[38]	
Develop operating and maintenance manuals	Are operating and maintenance manuals developed? ☐ Yes ☐ No[39]	
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[40] ☐ No[41]	
Install an modern high efficiency drift eliminator	Is there a modern high efficiency drift eliminator fitted to every tower in the system? ☐ Yes ☐ No[42]	
	Are the drift eliminators in good condition? ☐ Yes ☐ No[43]	
	Have the drift eliminators been certified by the manufacturer as meeting AS/NZS 3666? ☐ Yes ☐ No[44]	

Deficiencies in the Cooling Tower System Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[33]
Use suitable materials for external components	Have you reviewed the condition of the tower structure? ☐ Yes[45] ☐ No[46]	
Use suitable materials for internal components	Have you reviewed the materials and condition of the internal components of the tower system? ☐ Yes[47] ☐ No[48]	
Other[49]		

Risk Classification for Deficiencies in the Cooling Tower System Risk[50]	☐ A ☐ B ☐ C ☐ D

33 Indicate the operational program you will put in place as a result of this assessment.
34 Describe how you will address the risk in the response column.
35 Describe the improvements in the response column.
36 Describe how you will address the risk in the response column.
37 Describe the improvements in the response column.
38 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.
39 Describe how you will address the risks in the response column.
40 Describe when in the response column.
41 Describe how you will address the risks in the response column.
42 Describe how you will address the risks of excessive drift leaving the towers in the response column, for example by installing a drift eliminator that complies with AS/NZS 3666.
43 Describe how you will address the risks of excessive drift leaving the towers in the response column, for example by installing a drift eliminator that complies with AS/NZS 3666.
44 Describe how you will address the risks of excessive drift leaving the towers in the response column, for example by installing a drift eliminator that complies with AS/NZS 3666.
45 Describe the improvements in the response column.
46 Describe how you will address the risk in the response column.
47 Describe the improvements in the response column.
48 Describe how you will address the risk in the response column.
49 Use this row to describe other risks and response strategies that relate to this risk.
50 Refer to Figure 12 in Section 6.2.2 of the guide and find the scenario that matches your system to evaluate the risk associated with deficiencies in the cooling tower system and your system.

2.5 Location and Access

<table>
<tr><th>Location and Access Risk Control Strategy</th><th>Assessment of Cooling Tower System</th><th>Operational or Tower System Improvement Response[51]</th></tr>
<tr><td rowspan="2">Understand the extent of potential exposure to the cooling tower</td><td>Is the cooling tower system located in an acute health or aged residential care facility?
☐ Yes[52]
☐ No</td><td></td></tr>
<tr><td>If No, is the cooling tower system located near an acute health or aged residential care facility?
☐ Yes[53]
☐ No</td><td></td></tr>
<tr><td rowspan="4">Minimise access to tower and surrounds</td><td>How many people have access to the tower and its surrounds?
☐ Very high numbers[54]
☐ High numbers[55]
☐ Moderate numbers[56]
☐ Low numbers[57]</td><td></td></tr>
<tr><td>Are warning signs[58] displayed around the tower?
☐ Yes
☐ No[59]</td><td></td></tr>
<tr><td>Is the area around the cooling tower system used as a gathering place for staff and visitors, particularly smokers?
☐ Yes[60]
☐ No</td><td></td></tr>
<tr><td>Is access to the tower restricted?
☐ Yes
☐ No[61]</td><td></td></tr>
<tr><td>Relocation of tower to more remote site or less contaminated environment (where possible)</td><td>Have you reviewed whether it is possible to relocate the tower to a safer location?
☐ Yes[62]
☐ No[63]</td><td></td></tr>
</table>

Location and Access Risk Control Strategy	Assessment of Cooling Tower System	Operational or Tower System Improvement Response[51]
Ensure 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?[64] ☐ Yes[65] ☐ No[66]	
Other[67]		

Risk Classification for Location and Access Risk[68]	☐ **A** ☐ **B** ☐ **C** ☐ **D**

51 Indicate the operational program you will put in place as a result of this assessment.
52 Classify as Risk Category A and respond with highest standards of maintenance and surveillance.
53 Classify as a minimum of Risk Category B and respond with high standards of maintenance and surveillance.
54 Refer to Figure 10 of Guide to Developing Risk Management Plans for Cooling Tower Systems.
55 Refer to Figure 10 of Guide to Developing Risk Management Plans for Cooling Tower Systems.
56 Refer to Figure 10 of Guide to Developing Risk Management Plans for Cooling Tower Systems.
57 Refer to Figure 10 of Guide to Developing Risk Management Plans for Cooling Tower Systems.
58 For example, 'Authorised Persons Only'.
59 Describe how you will address the risks without such signs.
60 Describe how you will address the risks of smokers being in close proximity to the cooling towers.
61 Describe how you will address the risks until access to the tower has been restricted.
62 Describe outcomes of the review.
63 Describe how you will address the risk of location and access without such a review.
64 This is key area in terms of meeting your responsibilities under the Occupational Health and Safety Act.
65 Describe the outcomes of the review. For example, any actions to be taken.
66 Describe how you will address the risks without such a review.
67 Use this row to describe other risks and response strategies that relate to this risk.
68 Refer to Figure 12 in Section 6.2.2 of the guide and find the scenario that matches your system to evaluate the risk associated with location and access and your system.

3 Risk Assessment Summary

Critical Risk Classification[69]	
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

4 Attachments[70]

69 Tick the appropriate box based on your responses to the questions in Figure 12 in Section 6.2.2 of this Guide.
70 Other information which can be appended to the Risk Management Plan includes site plan, photographs, schematics of water flows, cooling tower makes and models, basic system parameters, for example system volume, system heat rejection capacity and system operating temperature.

5 Operational Program

Recommended Operational Programs Based on Risk Classification			
Program A	**Program B**	**Program C**	**Program D**
Weekly inspection	Monthly inspection (two weeks after service)	Monthly inspection (two weeks after service)	Monthly service
Fortnightly service	Monthly service	Monthly service	Monthly service
A minimum of monthly HCC test	Monthly HCC test	Monthly HCC test	Monthly HCC test
Six monthly cleaning or more frequently where environmental contamination (for example dust, soil, building works etc) is a problem.			

Recommended *Legionella* Testing Frequency as a Performance Measure			
Risk Category A	**Risk Category B**	**Risk Category C**	**Risk Category D**
At least every month	Every month	Every two months	Every three months

Element	Tick box
Describe your maintenance program	☐ Department of Human Services Program A
	☐ Department of Human Services Program B
	☐ Department of Human Services Program C
	☐ Department of Human Services Program D
	☐ Self-developed
	☐ Developed by consultant
If self-developed or developed by consultant, complete remainder of table[71]	
Service frequency	☐ Weekly
	☐ Fortnightly
	☐ Monthly
HCC testing frequency	☐ Monthly
	☐ Every …….. weeks/months
Legionella testing frequency	☐ No set frequency
	☐ Every …….. weeks/months
Tower cleaning frequency (select one and fill in blank if appropriate)	☐ Every 6 months
	☐ Every …….. months
Inspection frequency	☐ Every ………… weeks/months

71 Select one and fill in blank if appropriate

6 Monitoring and Review

Element	Details
Date RMP due for review	
Name/Title of person responsible for review	
Date RMP reviewed	
Does the RMP require amendment?	☐ Yes ☐ No
If RMP requires amendment, date amendments due and completed?	Due Completed

7 Communication

Element	Details			
	Category	**Name/Title**	**Telephone**	**Comment**
List parties (names and contact details) who will be informed in the event of a positive *Legionella* test	Staff			
	Occupational Health staff/contractors			
	Unions			
	Building owner			
	Other building occupiers			
	Medical officer			
	Staff counsellors			
	Department of Human Services Public Health Division		1800 248 898	
	Local Council	…………………………….. (Environmental Health Officer)		
	Media Liaison Officer			
	Company spokesperson			
	Chief Executive			

8 Endorsement of Risk Management Plan

Name/position of person responsible for Risk Management Plan	
Signature	

Attachment 2

Model Operational Program Specification

Scope of Work

The maintenance program includes the:

- Treatment of the cooling tower system (CTS) for the control of corrosion, scale formation, fouling and to minimise microbiological growth to 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 the use of a:

- Corrosion/scale inhibitor
- At least one biocide (preferably two used in rotation)
- Biodispersant to assist in the removal of any biofilm in the system.

Bacterial Testing

Bacterial testing is required as follows:

(a) Heterotrophic Colony Count (HCC)

- Sampling for HCC in accordance with AS/NZS 3666.3 and AS2031.2 for the sample collection and the selection of containers and preservation of water samples for microbiological testing.
- Analysis commenced within 24 hours of the sample being taken[1].
- Analysis of the water samples from the CTS for HCC **using a NATA accredited laboratory**[2] in accordance with AS 4276.3

(b) Legionella

- Sampling for *Legionella* in accordance with AS/NZS 3666.3 in terms of sample collection, AS 2031.2 for selection of containers and preservation of water samples for microbiological testing
- Testing for *Legionella* by a NATA accredited laboratory in accordance with AS/NZS 3896: 1998 Waters – Examination for Legionellae including *Legionella pneumophila*.
- Transport of the samples to the laboratory as soon as possible.

(c) Reporting

Reporting of all results to be consistent with NATA accreditation and include:

- Immediate notification by fax or email[3]. A follow up telephone call to confirm receipt of any results that exceed the limits set by legislation or this contract whichever is more stringent.
- Email copy of all results[4].
- Availability to discuss results either over the telephone or on-site as required.

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1 Note – in some more remote areas it is not always possible to achieve this objective but it must still be achieved in the least practicable time. Where it is not possible contact should be made with the testing laboratory to determine the best possible method.
2 The use of a NATA accredited laboratory accredited for these tests is strongly recommended
3 It is important that where the sampling and maintenance have been outsourced to one company who then sub-contract to another company for the microbiological analysis that you obtain a copy of the testing laboratory's results rather than a report from the maintenance contractor.
4 Where available

(d) Poor results

HCC

If the HCC level is greater than 100,000 CFU/mL the following procedure must be taken:

I. Within 24 hours of receipt of the advice from the testing laboratory, the cooling tower system must be manually treated with additional quantities of biocide or with an alternative biocide to the biocide in current use.

II. The water treatment program, tower operation and maintenance programs must be reviewed and a thorough inspection of the water treatment system is to be made and any faults corrected.

III. Between two and four days later resample for HCC.

IV. If the next test result also exceeds 100,000 CFU/mL the cooling tower system must be disinfected, cleaned and re-disinfected. A chlorine compatible bio-dispersant 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 one 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 one hour, while maintaining the pH of the water between 7.0 and 8.5.

V. Between two and four days later a further sample must be taken and tested for HCC.

VI. If after following this procedure, the result still exceeds 100,000 CFU/mL, the process outlined in IV and V must be repeated until the HCC result does not exceed 100,000 CFU/mL in two consecutive water samples taken approximately one week apart.

Legionella

Within 24 hours of receiving a report that *Legionella* has been detected in the cooling tower system, the following procedure must be followed:

I. Disinfect the cooling tower system as described above.

II. The water treatment program, tower operation and maintenance programs must be reviewed and a thorough inspection of the water treatment system is to be made and any faults corrected.

III. Between two and four days after completing the disinfection referred to above take a further sample of the recirculating water and test for *Legionella.*

IV. If the next test result also finds *Legionella* present the within 24 hours of receiving that advice the cooling tower system must be disinfected, cleaned and re-disinfected as above.

V. Between two and four days after completing the disinfection, take a further sample for testing for *Legionella.*

VI. if after following this procedure, *Legionella* is still present then the process outlined in IV and V must be repeated until *Legionella* is not detected in two consecutive water samples taken approximately one week apart.

Service Frequency

The service frequency shall be ………[5] and include a written service report provided at the time of the visit detailing all test results, observations and remedial actions taken.

This service shall ensure that:

- Water quality is checked
- Chemical dosing tanks are refilled
- Empty tanks removed from the site
- Dosing and control equipment is checked and is operating correctly and if problems are observed that remedial action is taken to fix the problem.
- Inspection of the wetted components and general integrity of the system including cleanliness and take action to remedy any problems noticed.
- …………[6].

In addition to the …………[7]. service the corrosion coupons (metal test plates) must be checked every three months for signs of corrosion. The corrosion coupons must be of the same types of metals used in

5 Insert frequency in marked spaces after reading the 'A Guide to Developing Risk Management Plans for Cooling Tower Systems' document
6 Insert other requirements
7 Insert the service frequency, for example monthly.

the cooling tower system and are to be immersed in the system water and checked as above.[8]

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

Tower Cleaning

Tower cleaning shall be conducted ………..[9] at least 2 weeks before/after the scheduled …………… service.

The tower cleaning process shall meet the requirements of the Health *(Legionella)* Regulations 2001.

Service Report

A service report must be completed at the time of each visit detailing all test results, observations and actions taken including any repairs, maintenance and testing work. The next page shows the information required to be provided as a minimum following each visit.

A copy of the service report is to be left on-site[10] at an agreed point and any points of significance are to be discussed with the Contract Manager.

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8 Note: in some circumstances may be supplemented by the use of corrosion coupons the measurement of soluble copper and iron in solution. You may need to seek independent specialist advice as to the risk of corrosion in your system and the best ways to control and monitor it.

9 Insert desired cleaning frequency, say 6-monthly

10 The Health *(Legionella)* Regulations require the responsible person for the cooling tower system to keep a maintenance log book with details of all maintenance activities, microbiological test results and approvals issued by the Secretary to the Department of Human Services for alternative maintenance or testing methods. The Building Act requires that these records be kept on-site for at least seven years.

Attachment 3

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 person and organisation conducting the inspection or service.
- Type/make/model of cooling tower(s).
- Water storage volumes for dosing calculations.
- Details of the inspection, for example what was purpose/scope?
- Details of any actions such as:
  – What if any chemicals were added and in what volumes?
  – Whether the bleed-off rate was checked?
  – Whether the tower(s) was cleaned?
  – Whether the cooling tower water was tested for chemical levels and what were 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?

Note that it is advisable for the desired or target range for each parameter to be listed as part of the result and a statement as to whether the test was within the range. Comments should be noted.

Attachment 4

Key Elements of a Model Service Contract

Disclaimer

This document only seeks to describe the key elements that ought to be considered in a contract for the treatment and servicing of a cooling tower system in order to manage the risk of *Legionella* infection. The precise terms and conditions of the contract, including its duration, 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 the 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 the 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 our staff, contractors or the public are not affected by the 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 the following indicators: Australian Standards (AS/NZS 3666, AS 2031.2, AS 4276.3.1, AS/NZS 3896) and legislation (this includes the Health *(Legionella)* Regulations 2001) and 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 Health (Legionella) Regulations in at least 95 per cent 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[1].
- Chemical control in accordance with an agreement to be reached prior to the commencement of the contract but the following ranges are provided for guidance:

1 Note: you may need to seek engineering advice as to an acceptable rate of corrosion for your business operation.

Attachment 4

Indicative Water Quality Target Ranges	
Bacteria	
Legionella	Not detected (<10 CFU/mL)[3]
HCC	Less than 100,000 CFU/mL[4]
Solids	
Total dissolved solids	Less than 1000 ppm
Conductivity	Less than 1500 µS/cm
Suspended solids	Less than 150 ppm
Calcium hardness	Less than 180 ppm
pH	
pH (for bromine compounds)	7 – 9
pH (for chlorine based compounds)	7 – 8
Total alkalinity	80 – 300 ppm
Other additives	
Biodispersant	Follow the manufacturers' specifications
Corrosion inhibitor	Follow the manufacturers' specifications

Where the results are outside the requirements of the Health *(Legionella)* Regulations 2001, the contractor must immediately notify the contract manager.

Occupational Health and Safety

The contractor is responsible for the safety of their 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 occupational health and safety legislative requirements.

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

Contractors shall have both professional indemnity and public risk insurances 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.[2]

2 The level of insurance should be at levels that you are comfortable with recognising the worst case scenario where your tower is demonstrated to have been the source of an outbreak of *Legionella*.

Attachment 5

Model Procedure for Cooling Towers Detected with *Legionella*

Background

State regulations require cooling tower systems to be continuously and effectively treated with biocide to control microorganisms including *Legionella*. *Legionella* bacteria are the bacteria responsible for Legionnaires' disease. *Legionella* should not be detected in a sample from the cooling tower system. The detection limit for *Legionella* is 10 CFU/mL.

The responsible person within our company for the operation of the cooling tower system is …………………..[1]

The maintenance, cleaning and bacterial testing of the cooling tower system is contracted to …….[2]

Sampling for Heterotrophic Colony Counts (a measure of total bacterial levels in the water) is carried out ………[3] on a routine basis and depending on the results additional testing is sometimes required.

Legionella testing is currently performed …………….
We also follow a standard preventative disinfection procedure where after each sample is taken for legionella testing we disinfect the system.

This company will telephone and then send an email or fax to …………[4] with the results of the bacterial testing for the cooling towers.

If the company's responsible person is absent the ………[5] is to be contacted. The cooling tower system contractors know whom to contact if the regular contact is not available.

Safety

Detection of *Legionella* may indicate that the biocide is not controlling the growth of the bacteria in the water system. Other possible explanations are that there may be lengths of disused pipework that are acting as reservoirs for *Legionella*.

Procedure

If *Legionella* is detected, the following actions shall be performed without delay:

1. Immediately upon the receipt of a test result indicating the presence of *Legionella*, contact the water treatment contractor to arrange to meet on-site as a matter of urgency.
2. Advise people in the manner described and listed in the attachment.
3. The water treatment company should follow the procedure as specified in the Operational Program.
4. Liaise closely with the water treatment company about test results.
5. Continue to communicate results to the parties mentioned above.
6. In the event that the disinfection and cleaning does not eliminate the *Legionella*, consider shutting down the cooling tower system.

---

1 Insert name and title of the person nominated by the company as being responsible for the safe operation of the cooling tower.
2 Insert company name and all contact details including after hours telephone number, fax and email.
3 Insert frequency of bacterial testing (refer 'Guide to Developing Risk Management Plans for Cooling Tower Systems') produced by the Department.
4 Insert name and title of the person nominated by the company as being responsible for the safe operation of the cooling tower.
5 Insert title of the person nominated by the company as being responsible for the safe operation of the cooling tower in the absence of the first named person.

Attachment 5

Positive *Legionella* Test Notification List

Details			
Category	**Name/Title**	**Telephone**	**Method of Notification/ Responsibility for Notification**
Staff			To be advised by ……….[6]
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……….
Department of Human Services Public Health Division		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……….

6 Once the decision to notify has been made, consideration must be given to the method. This will work best where staff (in particular) have had some explanation of the procedures and significance of the cooling tower and the test results significance well in advance of the adverse result notification. The procedure should also clearly advise who is responsible for notifying the parties.

Attachment 6

Reference Sources

Australian Standards

AS/NZS 3666 Air-handling and water systems of buildings – Microbial Control
AS/NZS 3666.1 Part 1: Design, installation and commissioning
AS/NZS 3666.2 Part 2: Operation and maintenance
AS/NZS 3666.3 Part 3: Performance-based maintenance of cooling water systems

AS 4276.3.1 Water microbiology - Heterotrophic colony count methods - Pour plate method using plate count agar

AS/NZS 3896 Waters – examination for legionellae including legionella pneumophila

AS 2031.2 Selection of containers and preservation of water samples for chemical and microbiological analysis Part 2-Microbiological

AS/NZS 1715: Selection, use and maintenance of respiratory protective devices

AS/NZS 1716: Respiratory protective devices

AS/NZS 1336: Recommended practices for occupational eye protection

AS/NZS 1337: Eye protectors for industrial applications

AS/NZS 4360 Risk Management

Australian Institute of Refrigeration, Air-Conditioning and Heating (Inc.) DA 17 Cooling Towers and DA 18 Water treatment

Organisations

Organisations	Telephone	Email	Internet
Department of Human Services Public Health Division	1800 248 898	lrmp@dhs.vic.gov.au	http://www.legionella.vic.gov.au
Building Control Commission	9285 6400		http://www.buildcc.com.au
Plumbing Industry Commission	9889 2211		http://www.pic.vic.gov.au
Victorian WorkCover Authority	1800 136 089	info@workcover.vic.gov.au	http://www.workcover.vic.gov.au
National Water Treatment Group	02 457 76800		
Australian Standards	1300 65 46 46	sales@standards.com.au	http://www.standards.com.au
National Association of Testing Authorities	9329-1633		http://www.nata.asn.au

Attachment 7

Indicative Water Quality Target Ranges

Indicative Water Quality Target Ranges	
Bacteria	
Legionella	Not detected (<10 CFU/mL)[3]
HCC	Less than 100,000 CFU/mL[4]
Solids	
Total dissolved solids	Less than 1000 ppm
Conductivity	Less than 1500 µS/cm
Suspended solids	Less than 150 ppm
Calcium hardness	Less than 180 ppm
pH	
pH (for bromine compounds)	7 – 9
pH (for chlorine based compounds)	7 – 8
Total alkalinity	80 – 300 ppm
Other additives	
Biodispersant	Follow the manufacturer's specifications
Corrosion inhibitor	Follow the manufacturer's specifications

Attachment 8

Procedure for the Decontamination of the Cooling Water System

Background

Decontamination may be required in cooling tower systems linked to a case or cases of Legionnaires' disease, as described in the Health *(Legionella)* Regulations 2001.

Procedure

The following process is considered by the Department of Human Services to meet the intent of the Regulations. Other processes can be used, providing 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 10mg/L of free chlorine for at least one hour, while maintaining the pH of the water between 7.0 and 7.6 or
   - A bromine-based compound, equivalent to at least 20mg/L of free bromine for at least one hour, while maintaining the pH of the water between 7.0 and 8.5.

   Add the disinfectant slowly, over five to ten 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[1]. The 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 three hours. Then switch off the recirculating pump. Drain cooling tower system to waste in a manner approved by the local water authority.

8. Inspect the drift eliminators and clean, repair or replace as necessary. If the eliminators are moved, ensure 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.

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1 Where this is not practicable, a very high bleed-off rate should be used during step 4. This will facilitate removal of suspended particulate matter from the system and the partial replacement of cooling water with clean make-up water.

10. Thoroughly internally clean all water filters, strainers, separators, water nozzles and fittings associated with the water distribution system.

11. Re-assemble all components and hose with clean water.

12. Repeat Step 4, but maintain the specified concentrations for three hours. Then switch off the recirculating pump. Drain 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.

14. Repeat Step 4 and then Step 13 if the water is not visually clear. Clean the water filters, strainers and repeat Step 13. Repeat this sequence until the water quality is satisfactory.

15. Immediately reinstate comprehensive effective water treatment including biocide(s), anti-corrosives and scale control.

16. Record all actions in maintenance logbook.

Attachment 9

Routine Inspection of a Cooling Tower System

A routine inspection by a competent person as described in the Guide can include manual checks of:

- Power supply.
- Connection and integrity of chemical dosing lines.
- Water clarity.
- Levels of dosing chemicals within tanks.
- Observations and recording of control measures, such as chemical parameters.
- Obvious visible corrosion.
- Obvious physical defects or damage.
- Pump operation.

Attachment 10

Responsibilities of Stakeholders

Stakeholder	Responsibility
Landowner	To register all cooling tower systems on the land To take all practicable steps to ensure that a risk management plan is developed for all cooling tower systems To take all practicable steps to ensure that a risk management plan is developed for all cooling tower systems and reviewed annually To take all practicable steps to ensure that an audit of the risk management plan is performed annually for all cooling tower systems To 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 Health *(Legionella)* Regulations 2001 are complied with
System Manager	Ensure that the Health *(Legionella)* Regulations 2001 are complied with Management of contracts which relate to system Ensuring any reports from contractors requiring action are actioned promptly Reporting to senior management of any capital expenditure requirements To ensure that reasonable steps are being taken to minimise the risks
Property Manager	Management of contracts which relate to system Ensuring any reports from contractors requiring action are actioned promptly Reporting to client of any capital expenditure requirements and any significant public health or safety issues
Property Maintenance Contractor	Management of contracts which relate to system Ensuring any reports from contractors requiring action are actioned promptly Reporting to client of any capital expenditure requirements and any significant public health or safety issues
Mechanical Services Maintenance Contractor	Management of contracts which relate to system Ensuring any reports from contractors requiring action are actioned promptly Reporting to client of any capital expenditure requirements and any significant public health or safety issues
Water Treatment Provider	Comply with the Health *(Legionella)* Regulations 2001 Provide advice to clients on water treatment related issues Treat water to minimise risks of *Legionella* growth
Risk Management Plan Consultant	Perform comprehensive risk assessment that identifies risks to the client and recommends corrective actions to minimise those risks Drafts RMP to meet legal requirements for client acceptance
Cooling Tower Supplier	Confirms that tower meets AS/NZS 3666
Cooling Tower System Designer	Ensure system meets AS/NZS 3666 and reduces risks of 'dead legs' and *Legionella* growth in general wherever possible

Attachment 11

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 sewer, in accordance with any advice from the local water authority.
- Remove chemical dosing tanks.
- Disconnect power supply to the system.
- Disconnect water supply to the system.
- Remove the tower and preferably the other components of the system.

Ideally, the system including the tower should be removed, but where this is not practical, place a sign on the tower indicating that the system must not be re-activated.

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