

Legionella Control in Cooling Water Systems

NSW HEALTH GUIDELINES



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Section 1

Introduction

1.1 Purpose

Preventing the growth and transmission of *Legionella* bacteria, and subsequent outbreaks of Legionnaires' disease, is an essential goal in managing cooling water systems. The purpose of these guidelines is to explain the regulation of cooling water systems in NSW.

This document provides practical guidance on the legal requirements in the *Public Health Act 2010* (the Act) and the *Public Health Regulation 2012* (the Regulation). It assists stakeholders in understanding their roles and responsibilities (Section 2), understanding the impact of Legionnaires' disease (Section 3), provides an overview of cooling water systems (Section 4), explains the risk factors associated with cooling water systems (Section 5), the process for undertaking risk assessments (Section 6) and conducting audits (Section 7), and outlines the reporting, response and administrative requirements (Section 8).

Cooling water systems are devices that lower the temperature of water by evaporative cooling. Water is cooled in one or more cooling towers and delivered to an interface with an air-handling system, allowing the water to cool the air. The air handling system then delivers cold air towards, and hot air away from, the building interior.

Poorly managed cooling water systems can provide ideal conditions for the growth and transmission of *Legionella* bacteria. These systems can cause outbreaks of Legionnaires' disease, which have the potential to cause severe illnesses and deaths, and disproportionately affect vulnerable people. Hence the regulation of cooling water systems is an important health protection measure.

The regulatory approach in NSW is based on the 2011 edition of the Australian/New Zealand Standard (AS/NZS) 3666 Parts 1, 2, 3 and 4. The Guidelines should be read in conjunction with these industry standards, and legislated requirements. The Regulation requires the use of six approved forms, which are provided on the NSW Health website.

This document does not advise on the management of other regulated systems (air-handling systems, hot-water systems, humidifying systems, or warm water systems) referred to in the Act.

1.2 Regulatory approach

The regulatory approach to managing cooling water systems in NSW was previously based on a prescriptive approach which required all cooling water systems to be managed according to the same set of minimum criteria. This has been replaced with a performance based (or risk management) approach which requires the individual characteristics and unique risks of each cooling water system to be assessed and controlled.

This approach introduces six safeguards to minimise *Legionella* transmission, provide multiple levels of oversight, and ensure that problems are pre-empted, escalated and responded to in a timely manner. These six safeguards are summarised in Table 1.2-1.

Although the risk management approach requires cooling water systems to be maintained in accordance with AS/NZS 3666 Part 3 rather than Part 2, other parts of AS/NZS 3666 remain relevant for some aspects of managing cooling water systems. These include:

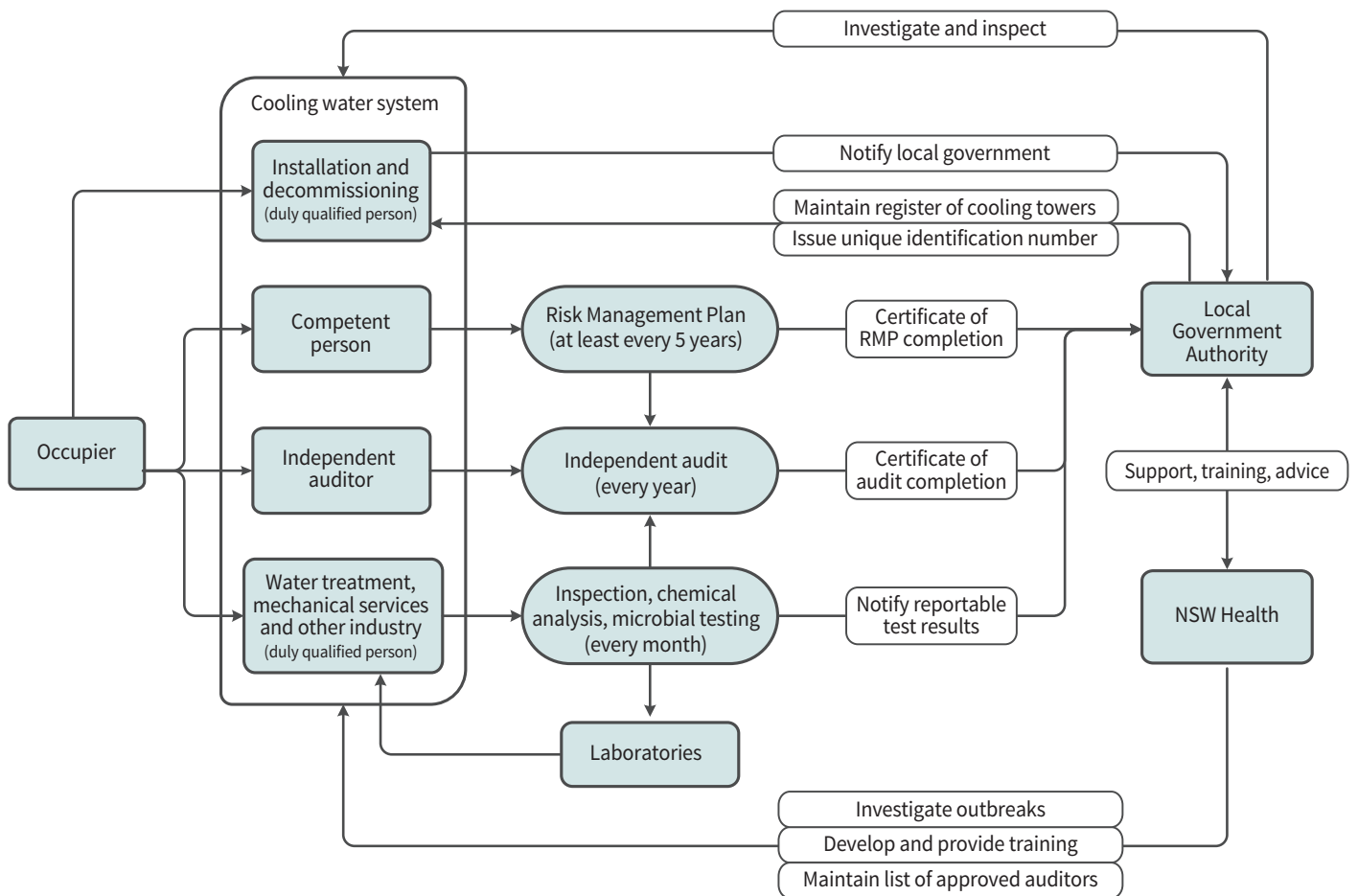
- Installation, design and commissioning in accordance with AS/NZS 3666 Part 1
- Operation (but not maintenance) in accordance with AS/NZS 3666 Part 2
- Maintenance in accordance with AS/NZS 3666 Part 3.

An overview of the regulatory approach in NSW is provided in Figure 1.2-1.

Table 1.2-1: Six regulatory safeguards for cooling water systems in NSW

Safeguard	Responsibility	Frequency	
1	Risk assessment, documented in a Risk Management Plan (RMP)	Developed by a competent person	Every five years (or more frequently if required)
2	Auditing	Conducted by an independent auditor	Every year
3	Certificates of RMP completion and audit completion	Provided by the occupier to the local government authority	As required
4	Sampling and testing for <i>Legionella</i> and heterotrophic colony count	Water sampled by a duly qualified person and tested by a laboratory	Every month
5	Notification of reportable laboratory test results (<i>Legionella</i> count $\geq 1,000$ cfu/mL or heterotrophic colony count $\geq 5,000,000$ cfu/mL)	Provided by the occupier to the local government authority	As required
6	Unique identification numbers for every cooling tower	Provided by the local government authority to the occupier	As required

Figure 1.2-1: Regulation of cooling water systems in NSW



1.3 Alternatives to cooling water systems

Cooling towers play an important role in refrigeration and air conditioning because they can effectively cool the ambient air temperature through evaporative cooling. Water is a practical and widely available cooling medium, and cooling towers are a cost-effective way of rejecting heat from refrigeration and air conditioning systems.

However, occupiers of cooling water systems should consider alternative technologies available to them which may be lower cost, easier to maintain, and do not pose a microbial risk. Alternative systems that do not provide the opportunity for *Legionella* bacteria to grow consequently remove the source of Legionnaires' disease. The competent person and duly qualified person should assist the occupier in understanding these costs and benefits. It can be useful to undertake a life cycle analysis, which can break down the:

- Costs to the occupier (including the short-term costs of installation, and long-term costs of operation and maintenance)
- Business impacts (for example, the cost savings from effective cooling, versus the risk to business from closures due to high *Legionella* counts)
- Environmental impacts (for example, use and disposal of chemical biocides into the environment, water usage, and the impacts of high energy consumption)
- Social impacts (for example, morbidity and mortality associated with outbreaks of Legionnaires' disease).

There are two broad categories of systems (or "chillers") that can be used to cool a building: air cooled chillers and water cooled chillers. In large commercial facilities, water cooled chillers are far more energy efficient than their air cooled counterparts for air conditioning. In air cooled chillers, fans blow air directly over coils to cool the water or refrigerant. Although the air cooled chillers do not require a cooling tower and eliminate the associated microbial management costs, the energy efficiency advantage of water cooled chillers typically compensates for the extra capital and water treatment costs. However, in smaller systems, the economics are different, and may favour the use of air cooled chillers.

There are alternatives and variations to the standard open circuit evaporative cooling tower which can reduce the risk of microbial contamination, and simplify the amount of maintenance and management required. Table 1.3-1 shows the different technologies and types of systems that can be used for heat rejection, and compares their relative cost and microbial risk.

The heat rejection technology used in a cooling water system can vary significantly based on the process that it is designed to support. For example, thermal power stations are served by large, hyperbolic cooling towers and the cooling water for these towers can be drawn from a nearby water body (such as a lake, river, or ocean). This water is circulated through the cooling tower as a once-through process, meaning that there is no aerosolisation or exposure of the cooling water to ambient air, as the cooling water is drawn and returned back to the water body.

Table 1.3-1: Alternative heat rejection technologies

Heat rejection technology	Microbial control risks	Costs		
		Capital	Maintenance	Energy
Open circuit water cooled	Higher	Medium	Higher	Lower
Closed circuit water cooled	Higher	Medium	Medium	Medium
Hybrid (wet/dry) cooled	Medium	Higher	Medium	Medium
Air cooled, adiabatic pre-cooling	Medium	Higher	Medium	Medium
Air cooled	Lower	Higher	Lower	Higher
Geothermal	Lower	Higher	Lower	Lower
Water body (lake, river, ocean)	Lower	Higher	Higher	Lower
Evaporative air cooled	Lower	Lower	Medium	Lower
Dew point cooling	Lower	Medium	Medium	Lower

This type of heat rejection technology therefore poses a lower risk of Legionnaires' disease, but has higher associated capital and maintenance costs.

Occupiers of premises with **small water cooled systems** can consider replacement of the water cooled system with a dry air cooled system. Many small water cooled systems with a heat rejection capacity of up to 300kW (about 20L/s recirculating water flow rate) may be good candidates for replacement. 300kW is considered the lowest level of heat rejection capacity for the effective use of water cooled systems because of the associated costs of microbial control. Microbial control in such small systems is often difficult to achieve due to:

- Rapid turnover of warmed water from evaporation, bleed off, wind, and other losses
- Relatively large wet surface area compared to small water volume (area-to-volume ratio)
- Tight arrangement of components making it difficult to obtain safe and easy access to regularly service the system.

These inherent deficiencies are difficult to control, and therefore smaller cooling water systems have been associated with many outbreaks of Legionnaires' disease both in Australia and overseas. These small water cooled systems can often be economically replaced with an air cooled system eliminating the risk.

Section 2

Roles and responsibilities

2.1 Introduction

This section outlines the roles and responsibilities of stakeholders involved in the management of cooling water systems in NSW. Each stakeholder has an important role in ensuring that a cooling water system is optimally managed, and that the safeguards put in place by the *Public Health Act 2010* (the Act) and *Public Health Regulation 2012* (the Regulation) are followed. Table 2.1-1 summarises these roles and responsibilities.

2.2 Occupier

Occupiers are ultimately responsible for ensuring that cooling water systems on their premises are managed (installed, operated and maintained) in accordance with the Act and Regulation. They may engage a duly qualified person (DQP) to manage the system on a routine basis on their behalf, and a competent person to undertake a risk assessment on their behalf.

The Regulation allows the occupier to carry out the role of both the DQP and competent person, if they meet the definition of those roles. However, the occupier cannot audit their own cooling water system.

The occupier must ensure that, for their cooling water system:

- A competent person undertakes a risk assessment every five years (or more frequently if required), with all identified risks and their control strategies documented in a Risk Management Plan (RMP) (see Section 6)
- An independent auditor performs an audit of compliance every year (see Section 7)
- A DQP performs inspection, maintenance (including servicing), chemical analysis, and laboratory testing for *Legionella* count and heterotrophic colony count (HCC) every month
- The local government authority is notified of reportable test results of *Legionella* count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL (see Section 8.6)

- A certificate of RMP completion (every five years, or more frequently if required) and certificate of audit completion (every year) is provided to the local government authority (see Section 8.3)
- The local government authority is notified of the installation of the system and any change in particulars, including decommissioning (see Section 8.3)
- A unique identification number is displayed on each cooling tower in their system (see Section 8.5)
- Required documents and information are readily available (see Section 8.1).

The term occupier can refer to different persons or organisations, depending on the circumstances. Examples of an occupier include:

- The owner of the land or premises on which the cooling water system is located
- The leaseholder or tenant who installed, operates or maintains the cooling water system
- The owners corporation where the cooling water system is part of the common property in a building that is subdivided into a strata scheme.

2.3 Duly qualified person

The duly qualified person (DQP) manages the cooling water system on a routine basis, and is typically employed by a water treatment company, mechanical services company or other organisation involved in the management of cooling water systems. The occupier may carry out this role, if they meet the definition of DQP (see Table 2.1-1). The roles of the DQP include:

- Performing inspections of the cooling water system (at least monthly)
- Conducting any maintenance (including servicing) required by the RMP and Regulation (at least monthly)
- Performing chemical analysis (at least monthly)
- Performing microbial testing for *Legionella* count and HCC (at least monthly)

Table 2.1-1 Stakeholder roles, definitions and qualifications

Stakeholder	Role	Definition and qualifications
Occupier	To ensure that their cooling water system is managed (installed, operated and maintained) in accordance with the Act and Regulation.	The Act defines the occupier as the owner of a premises (e.g. building) on which a cooling water system is located; the person entitled to occupy the premises (e.g. leaseholder or tenant); or the owners corporation of premises under a strata scheme.
Duly qualified person (DQP)	To manage the cooling water system on a routine basis including installing, operating and maintaining the system. The Regulation allows the occupier to carry out this role, if they meet the definition of DQP.	The Act defines the DQP as a person who installs, operates, or maintains a regulated system. The DQP is typically employed by a water treatment company, mechanical services company, or other industry organisation.
Competent person	To undertake a risk assessment of the cooling water system, and document this in a Risk Management Plan (RMP). The Regulation allows the occupier to carry out this role, if they meet the definition of competent person.	The Regulation defines the competent person as a person who has appropriate training or practical experience (or both) in the installation, operation or maintenance of cooling water systems, sufficient to provide safe and satisfactory performance of these systems.
Independent auditor	To conduct an annual audit of compliance with the RMP and Regulation to ensure that required actions have been carried out.	The Regulation requires the auditor to be approved by the NSW Health Secretary, and to be independent of the occupier, competent person, DQP, and laboratory. The auditor must undergo specified training in order to be approved to carry out this role.
Authorised officer	To investigate systems and enforce compliance with the Regulation by occupiers, DQPs, competent persons, and independent auditors.	The Act and Regulation provide an authorised officer with powers to inspect premises, inspect documents, take samples, and serve improvement notices, prohibition orders and penalty infringement notices. They can also direct the occupier to make required documents and information available, perform additional testing, perform disinfection, decontamination or full system clean, and undertake a new risk assessment.
Local government authority (LGA)	To regulate cooling water systems in their area together with NSW Health. This includes maintaining specific records of each system, investigating systems which may not be complying with the Act or Regulation, and taking enforcement action.	The Regulation outlines LGA roles in maintaining a register of cooling water systems, issuing unique identification numbers, receiving notification of installation or change in particulars (including decommissioning) receiving notification of reportable test results of <i>Legionella</i> count and heterotrophic colony count, receiving certificates of RMP completion and audit completion, and responding to audits demonstrating non-compliance.
Laboratory	To test water samples provided by DQPs for <i>Legionella</i> count and heterotrophic colony count, and provide results to the occupier.	The Regulation requires laboratories to be accredited by the National Association of Testing Authorities (NATA).
NSW Health	To regulate cooling water systems in NSW together with local government authorities. This includes developing the Regulation and policies for managing cooling water systems (Health Protection NSW), and monitoring and investigating cases and outbreaks of Legionnaires' disease (Public Health Units).	Health Protection NSW and Public Health Units are two parts of NSW Health responsible for the surveillance and public health response to infectious diseases and environmental health issues. Health Protection NSW is the central office, and there are 12 Public Health Units situated within Local Health Districts across metropolitan and regional NSW.

- Performing system cleaning (at a frequency specified in the RMP)
- Implementing control strategies specified in the RMP
- Completing the monthly report (Approved Form 3).

The occupier may choose to contract a DQP to fulfil other responsibilities on their behalf, including:

- Notifying a new installation or a change in particulars (including decommissioning) to the local government authority
- Displaying a unique identification number on each cooling tower
- Receiving microbial test results from the laboratory and notifying reportable test results to the local government authority
- Providing certificates of RMP completion and audit completion to the local government authority
- Ensuring required documents and information are readily available.

Different DQPs may perform different functions in the management of a cooling water system. For example, one DQP may be engaged to install and commission the system, while a second DQP may be engaged to perform monthly testing for *Legionella* count and HCC. A third DQP, such as the building manager or facilities manager, may be engaged to oversee the system and act as a central point of contact with the occupier. All DQPs should ensure that they follow the RMP when managing the cooling water system, and ensure that they comply with the Regulation. The DQPs and the occupier should have clear communication processes.

The reference to “competent personnel” in section 4.7 of AS/NZS 3666 Part 1 and section 2.2.1 of AS/NZS 3666 Part 2 refers to roles (commissioning a system and operating requirements) that are to be carried out by a DQP. The term “competent personnel” is different to the term “competent person” referred to in the Regulation and described in the next section.

2.4 Competent person

A core safeguard in the management of cooling water systems in NSW is the preparation of an effective risk assessment by a competent person. The risk assessment considers the risk of *Legionella* growth and transmission from a cooling water

system, and identifies actions and control strategies to reduce the risk.

The risk assessment must be undertaken by a competent person every five years (or more frequently if required), and documented in an RMP. The occupier may carry out this role, if they meet the definition of competent person (see Table 2.1-1). They may also engage a competent person to undertake a risk assessment on their behalf.

The Regulation requires the person who undertakes a risk assessment to be a competent person, that is, a person who has appropriate training or practical experience (or both) in the installation, operation or maintenance of cooling water systems, sufficient to provide safe and satisfactory performance of these systems. This definition is based on section 1.5.15 of AS/NZS 3666 Part 1, and it includes the reference in section 2.3 of AS/NZS 3666 Part 3 to a person competent to evaluate the condition of a cooling water system and undertake a risk assessment.

The Regulation also allows a person acting under the supervision of a competent person to prepare an RMP (such as a water treatment company technician or a person in a junior role), provided that the competent person ultimately confirms the effectiveness and takes responsibility for the risk assessment and resulting RMP.

The competent person who completes the risk assessment may be employed by the same water treatment company, mechanical services company or other organisation which is engaged to install, operate or maintain the cooling water system. There is no requirement for the occupier to engage the same competent person on a recurring basis.

Section 6 provides further information on the roles and responsibilities of the competent person, including further definition of appropriate training and experience. Competent persons are encouraged to complete the NSW Health course on *Legionella Control in Cooling Water Systems* in order to help demonstrate their competence in undertaking effective risk assessments of cooling water systems.

2.5 Independent auditor

Independent auditors provide another important safeguard in the management of cooling water systems, by ensuring that the occupier and DQP have complied with the requirements of the RMP and Regulation. Occupiers must engage an independent auditor to audit compliance with the

RMP and Regulation within each 12 month audit period. The audit must be completed within two months after the end of the audit period. The independent auditor provides a certificate of audit completion to the occupier, who must submit this certificate to the local government authority within 7 days.

The auditor must be independent of:

- The occupier of the premises containing the cooling water system
- The person who undertook the risk assessment
- The DQP who installed the cooling water system
- The DQP who operates or maintains the cooling water system, or who has done so in the previous 5 years
- The person who operates a laboratory that carried out any monthly testing of the cooling water system in the previous 5 years.

All auditors must be approved by NSW Health and, at a minimum, must successfully complete the NSW Health course on *Legionella Control in Cooling Water Systems* in order to be approved to carry out this role. There is no requirement for the occupier to engage the same independent auditor on a recurring basis. Section 7 provides further information on the roles and responsibilities of the independent auditor, including the criteria for approval to conduct audits of cooling water systems.

2.6 Laboratories

Laboratories test microbial samples (for *Legionella* count and HCC) collected from cooling water systems. They must be accredited by the National Association of Testing Authorities (NATA) to perform these tests. Laboratories provide reportable test results (*Legionella* count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL) to the occupier, who must provide them to the LGA within 24 hours of receipt, by completing the notification of reportable test results (Approved Form 4; see Section 8.6). Occupiers may also contract a DQP or laboratory to notify the local government authority of a reportable test result on their behalf.

2.7 Authorised officer

Authorised officers are appointed by local government authorities and NSW Health to carry out regulatory oversight functions and ensure that occupiers, DQPs, competent persons and independent auditors comply with the Regulation.

Typically, environmental health officers are appointed as authorised officers.

The Act and Regulation provide an authorised officer with powers to:

- Enter and inspect premises
- Inspect documents and direct the occupier to make required documents and information available
- Take samples from the cooling water system
- Direct additional testing of the cooling water system
- Direct a disinfection, decontamination, or full system clean to be performed
- Direct a new risk assessment to be undertaken
- Serve improvement notices (requiring remedial actions to be taken) and prohibition orders (requiring the system to be shut down)
- Issue penalty infringement notices.

Authorised officers play an important role both during the normal management of cooling water systems, and in investigating single cases and suspected outbreaks of Legionnaires' disease.

2.8 Local government authority

Local government authorities (local councils) play an important role in controlling *Legionella* in NSW. The Regulation specifies the following roles for local government authorities:

- Maintaining a register of all cooling water systems in their local government area (see Section 8.4)
- Receiving notification of installation or a change in particulars (including decommissioning) of cooling water systems in their local government area (see Section 8.3)
- Issuing occupiers with a unique identification number for each cooling tower in their cooling water system (see Section 8.5)
- Receiving notification of reportable test results of *Legionella* count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL (see Section 8.6)
- Receiving certificates of RMP completion and audit completion (see Section 8.3).

Local government authorities should develop processes, based on local relationships and needs, in order to meet their responsibilities under section 4 of the *Public Health Act 2010* (that is, to take appropriate measures to ensure compliance with regulation of cooling water systems).

Local government authorities can choose to carry out an on-site **inspection program** of cooling water systems in their area. The frequency of inspection is at the discretion of the local government authority and can be conducted in accordance with their local business plans. Inspection programs are an effective way for local government authorities to meet their responsibilities under section 4 of the Act, and help to protect the health of their local population.

Additional activities that local government authorities can undertake in order to meet their responsibilities include:

- Regularly inspecting cooling water systems in their area to ensure compliance with the Regulation
- Responding to reportable test results of *Legionella* count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL following the recommendations in the Guidelines (see Section 8.6)
- Responding to audits demonstrating non-compliance with the RMP and Regulation (see Section 7.6)
- Following up systems with overdue certificates of RMP completion and audit completion
- Identifying unregistered cooling water systems
- Assisting Public Health Units during a Legionnaires' disease outbreak investigation
- Using authorised officers' powers to enforce compliance with the RMP and Regulation, where appropriate (see Section 2.7).

2.9 NSW Health

NSW Health is the regulator of cooling water systems in NSW together with local government authorities. Two parts of NSW Health are responsible for developing the policy framework for the management of cooling water systems, and for conducting outbreak investigations and surveillance activities. These two parts are Public Health Units and Health Protection NSW.

NSW Health has a network of 12 Public Health Units across metropolitan and regional NSW. Each Public Health Unit is geographically aligned to one or more Local Health Districts, and one or more local government authorities.

Public Health Units are the local offices responsible for:

- Following up single case notifications of Legionnaires' disease regarding possible exposures
- Investigating clusters or outbreaks of Legionnaires' disease, with assistance from local government authorities
- Providing support and advice to stakeholders, including industry and local government authorities in their area
- Appointing authorised officers to support enforcement activities and outbreak investigation
- Assisting in the application and enforcement of the Regulation.

Health Protection NSW is the central office responsible for:

- Setting out the regulatory approach and policy framework for the management of cooling water systems
- Developing the Regulation, Guidelines, approved forms and protocols to support stakeholders in carrying out their roles
- Approving and maintaining a list of independent auditors
- Coordinating the response to large or multi-jurisdictional Legionnaires' disease outbreaks, or when the capacity of individual Public Health Units to respond is exceeded
- Supporting Public Health Units through ongoing advice and training.

2.10 Penalties and offence provisions

The Act outlines penalties for individuals and corporations in relation to non-compliance with the installation (section 28), operation (section 29), and maintenance (section 30) requirements of cooling water systems; notification of installation or change in occupier (section 31); training directions (section 32); and improvement notices and prohibition orders. These penalties also apply to the corresponding clauses of the Regulation. For example, clauses 13I and 13J of the Regulation correspond to section 28 of the Act as they all refer to installation requirements. However, clause 13K (which is part of the installation requirements subdivision of the Regulation) does not have a corresponding reference in the Act, and therefore a separate penalty is stated in the Regulation for an offence under this clause.

Tables 2.10-1 and 2.10-2 summarise the types of non-compliance included in the Act and the Regulation which may result in an offence or penalty, the associated clauses, and penalty units. There are other offences or penalties for which the occupier, or a person engaged by the occupier, may be liable; these are specified in the Act and Regulation. One penalty unit is equal to \$110 in NSW (current as of July 2018).

A **penalty infringement notice (PIN)** is a fixed financial penalty for an offence prescribed by the Regulation. The PIN can be issued as a ticket on the spot, or sent by email or post, and contains information about the alleged offence and fine amount. The Regulation allows authorised officers to serve PINs when:

- The occupier has been issued a unique identification number and has not displayed the number on a sign on the cooling tower, in the required size and material, within 30 days of the local government authority providing the number (clause 13K)

- The occupier has been served with a prohibition order, and has not displayed a copy of the order in a conspicuous place at or near each entrance to the premises, for the period of time specified by the authorised officer (clause 13X).

2.11 Licensing of air-conditioning and refrigeration work in NSW

Persons involved in the installation, operation and maintenance of cooling water systems should ensure they comply with the requirements set out by NSW Fair Trading.

A licence from NSW Fair Trading may be required before any air-conditioning or refrigeration work can be undertaken in NSW, regardless of the cost of the work and regardless of whether the work is residential, commercial or industrial.

Further information can be obtained from NSW Fair Trading (http://www.fairtrading.nsw.gov.au/ftw/Tradespeople/Home_building_licensing/Licence_classes_and_qualifications/Air_conditioning_and_refrigeration.page).

Table 2.10-1: Offences or penalties in the Act

Section	Non-compliance resulting in an offence or penalty	Penalty units
28	Failure to install a system in accordance with the prescribed installation requirements under the Regulation	100 to 1,000 (see the Act)
29	Failure to operate a system in accordance with the prescribed operation requirements under the Regulation	100 to 1,000 (see the Act)
30	Failure to maintain a system in accordance with the prescribed maintenance requirements under the Regulation	100 to 1,000 (see the Act)
31	Failure to notify the installation of a system, within one month	10
31	Failure to notify the change of occupier of an installed system, within one month	10
32	Failure to undertake specified training required by the NSW Health Secretary	1,000 (see the Act)
47	Failure to comply with a prohibition order	See the Act

Table 2.10-2: Offences or penalties in the Regulation

Clause	Non-compliance resulting in an offence or penalty	Penalty units
13K	Failure to display a unique identification number on a cooling tower within 30 days	20
13R	Failure to provide reportable test results within 24 hours of receipt	20
13S	Failure to provide the required documents and information within 4 hours of request	20
13T	Failure to notify a change in the particulars of a cooling water system within 7 days	10
13V	Falsifying any test results in relation to a cooling water system	20
13W	Failure to comply with maintenance precautions	20
13X	Failure to display a prohibition order as required by the authorised officer	10

Section 3

Legionella bacteria and Legionnaires' disease

This section provides an introduction to *Legionella* bacteria and Legionnaires' disease, with a focus on cooling water systems. It is important for all stakeholders to understand the role of cooling water systems in the transmission of *Legionella* and the impacts of Legionnaires' disease on human health.

3.1 Legionnaires' disease

Legionnaires' disease is an infection of the lungs caused by *Legionella* bacteria. It usually presents as pneumonia that can vary from mild to severe illness. Legionnaires' disease has an incubation period of 2 to 10 days, meaning that symptoms usually appear 2 to 10 days after exposure to *Legionella* bacteria.

Legionnaires' disease has a 10% case fatality rate, meaning that one out of ten people that are infected by *Legionella* bacteria develop pneumonia and die from it. However, the risk of developing Legionnaires' disease is greater among people who are older (particularly above 50 years of age), smoke cigarettes, or have medical conditions that weaken the immune system (such as cancer, lung disease, diabetes, or being a transplant recipient).

Legionella bacteria can also cause less serious illnesses such as Pontiac fever. The group of illnesses caused by *Legionella* bacteria is called legionellosis.

3.2 Legionella bacteria

Different species of *Legionella* bacteria occur naturally in aquatic environments (*Legionella pneumophila*) and in soil (*Legionella longbeachae*). *Legionella* species are further divided into serogroups, not all of which cause human disease. *Legionella pneumophila* serogroup 1 is a common cause of Legionnaires' disease associated with cooling water systems.

The growth and multiplication of *Legionella* bacteria is promoted by:

- A wet and warm environment with a temperature range of 25 to 42°C (optimum temperature of 37°C)
- Stagnant water or low water turnover
- High concentration of other microorganisms, including algae, amoebae, slime and other bacteria
- Presence of biofilm, scale, sediment, sludge, corrosion products or other organic matter
- Degraded plumbing components, such as rubber fittings, which may provide nutrients to enhance bacterial growth.

Artificial water systems, such as cooling water systems and warm water systems, can produce these conditions and hence provide an ideal environment for *Legionella* bacteria to multiply to large numbers.

3.3 Transmission

People can become infected with *Legionella* bacteria by inhaling very fine water droplets (or aerosols) that contain the organism. Most commonly, people are infected by breathing in aerosols generated by artificial water systems, including cooling water systems and warm water systems.

The main risk factors for the transmission of *Legionella* bacteria from an environmental source are:

- Presence of *Legionella* bacteria
- Conditions suitable for the organism to multiply
- A mechanism for creating and spreading aerosols and
- Exposure of susceptible people to these aerosols.

Other artificial water systems that may transmit *Legionella* bacteria include spa pools, fountains, car washes, vegetable mister sprays, thermostatic mixing valves (used to mix hot and cold water), and ice machines.

3.4 Outbreak investigation

The *Public Health Act 2010* requires all cases of Legionnaires' disease to be notified to NSW Health. Public Health Units follow up and interview cases of Legionnaires' disease to investigate potential exposures. If more than one case reports a common exposure, the Public Health Unit may initiate an outbreak investigation or environmental assessment.

The environmental assessment involves searching for possible sources of aerosol generation in the geographical areas where the aerosol could have spread, and where the case could have been exposed. This process can involve the urgent inspection of cooling towers, and issuing improvement notices or prohibition orders to non-compliant cooling water systems. If required, occupiers should provide after-hours access to cooling water systems during outbreak investigations. Further information is provided in the *NSW Health Legionnaires' disease control guideline for Public Health Units* (<http://www.health.nsw.gov.au/Infectious/controlguideline/>).

3.5 Surveillance data

Legionnaires' disease notification data are published on the HealthStats NSW website (<http://www.healthstats.nsw.gov.au/>). Health Protection NSW is responsible for state-wide surveillance of Legionnaires' disease cases and outbreaks, and assisting Public Health Units when their capacities to respond are exceeded.

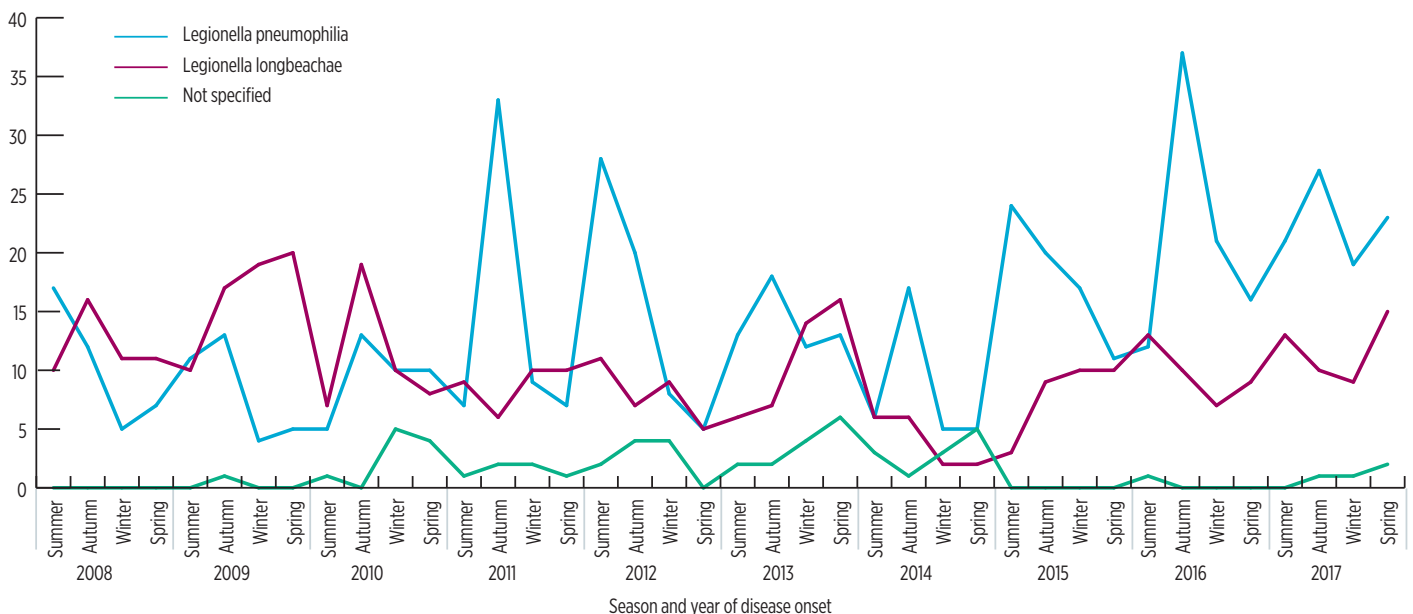
Over the ten years from 2008 to 2017, an average of 57 cases of *Legionella pneumophila* was notified per year. Figure 3.5-1 shows the notifications by season from 2008 to 2017. Peaks in *Legionella pneumophila* cases often occur in autumn. This seasonal trend may be explained by a prolonged period of cooling tower use over summer, followed by intermittent use during autumn due to ambient temperature fluctuations. Together, these factors may result in optimal water temperatures, water stagnation and higher nutrient levels which, in turn, promote the growth of *Legionella* bacteria and increase the risk of *Legionella* transmission.

3.6 Impacts on business

Outbreaks of Legionnaires' disease associated with cooling water systems can have significant implications for businesses. The *Public Health Regulation 2012* requires reportable test results (*Legionella* count $\geq 1,000$ cfu/mL or heterotrophic colony count $\geq 5,000,000$ cfu/mL) to be notified to local government authorities, who may inspect the premises and issue notices if necessary (see Section 8.6).

Depending on the circumstances, normal operations of a business may need to be suspended while a cooling water system is inspected and remedial action is carried out. This may involve disinfection, cleaning, and further testing to ensure the risk of Legionnaires' disease at that premises is controlled. Those who are responsible for the operation or maintenance of cooling water systems should therefore ensure that effective processes are in place to limit the public health and commercial impacts from outbreaks of Legionnaires' disease.

Figure 3.5-1: Notifications of Legionnaires' disease in NSW, by species and season of disease onset, 2008 to 2017



Section 4

Overview of cooling water systems

This section describes the different types and features of cooling water systems, and introduces the lifecycle approach for managing cooling water systems. It also introduces Australian/New Zealand Standard 3666 (AS/NZS 3666) Part 3. This section is important for stakeholders involved in the management of cooling water systems as it forms the basis of subsequent sections on risk assessment and auditing.

4.1 Introduction to cooling water systems

Cooling water systems are defined in the *Public Health Act 2010* as a device for lowering the temperature of water or other liquid by evaporative cooling, or an evaporative condenser that incorporates a device containing a refrigerant or heat exchanger, together with its associated equipment and pipe work. The *Public Health Regulation 2012* defines **cooling tower** as above, but without the “associated equipment and pipe work”.

In simple terms, a cooling water system contains one or more cooling towers. Cooling towers are mechanical devices that cool and recirculate water in order to reject the heat generated from refrigeration, air conditioning and industrial processes. The heat extracted from the cooling tower is rejected into the atmosphere by reducing temperature through evaporation. This allows thermal plants to be both mechanically and economically viable. Cooling water systems can range in size from systems servicing smaller establishments (such as retail stores, small manufacturers, and dry cleaners) to office blocks and large industrial processes.

However, the warm surfaces of a cooling water system can provide an ideal environment for bacteria such as *Legionella* to grow. The bacteria can then move through the water circulating in the system, and eventually exit the cooling tower and aerosolise. The bacteria can spread and potentially infect a large number of people over large distances.

Preventing the growth of bacteria is therefore a critical aspect of managing a cooling water system. This requires microbial control measures to be implemented at each stage in the life cycle of the system, from the design and installation to the operation and maintenance of cooling water systems.

Further information on cooling towers is covered in the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) *Design Application Manual DA 17: Cooling Towers (2009)*.

4.2 Types of cooling towers

Cooling water systems extract energy from the heat source, transfer the heat to the circulating cooling water, and reject that heat into the atmosphere through the cooling tower. Inside the tower, the heated cooling water is sprayed into the top of a large chamber containing packing (the “fill”) which increases the surface area over which the hot circulating water meets the cooling air stream. Ambient air flows over the wet fill which can be made of various materials and placed in different configurations.

Most modern **fill** is manufactured from a range of plastics, such as rigid, unplasticised polyvinyl chloride (uPVC) and ultraviolet-stabilised polypropylene sheets. These are oriented in a complex honeycomb arrangement to encourage the cooling water to spread over a thin layer across a larger surface area as it falls through. Older systems used a splash bar type of fill to break up the falling water droplets to facilitate water evaporation; these were sometimes made of wooden slats which resulted in a lower air flow compared to modern fill. Large industrial systems often use steel fill.

The amount of evaporation that takes place depends on design factors such as the surface area of the fill, and the temperature and humidity of the incoming cooling air. Evaporation rate is key to the heat rejection capacity. For every 5°C water temperature drop achieved by the system, the water loss by

evaporation is typically 1 per cent of the cooling water circulation rate. This can result in a highly efficient transfer of heat out of the system.

The water flow and air stream within the cooling tower are typically oriented to move in opposite directions (“**counter-flow**”). This allows the hot water entering the top of the fill to be in contact with the warmed air leaving the fill, and the cooler water leaving the bottom of the fill to be in contact with the cool air entering the system (see Figure 4.2-1). This arrangement maximises the evaporative process which takes place throughout the fill. In another arrangement known as “**cross-flow**”, the water flow is oriented to meet the air stream travelling horizontally across the heat exchange fill (see Figure 4.2-2).

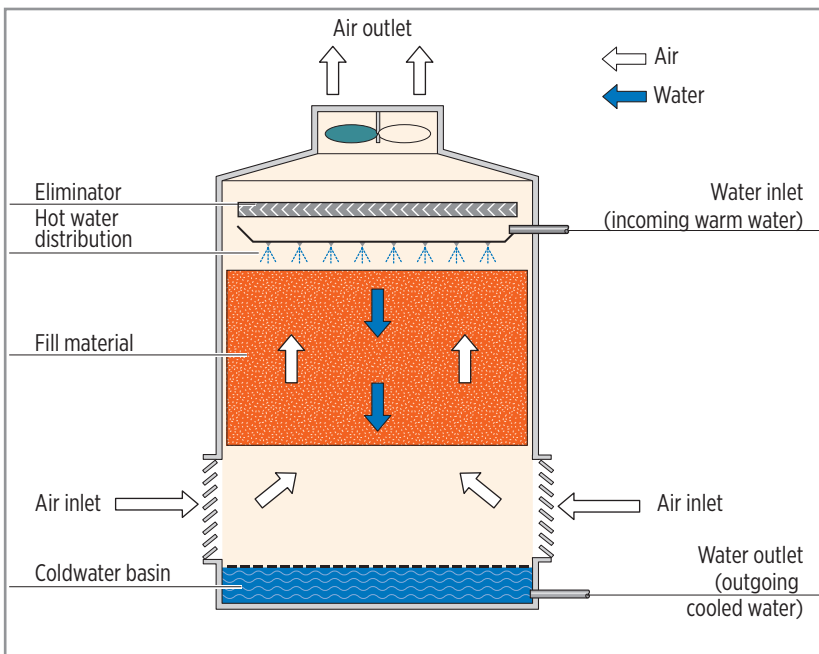
To increase the evaporation of the falling water droplets, a fan is used so that air is drawn (induced draught) or forced (forced draught) through the tower. Induced draught counter-flow cooling towers are very common (see Figure 4.2-1). They can be identified by the fan at the top of the system. The fan pulls air up through the cooling tower where the water is falling. The air usually enters the tower through inlet louvres on the sides. Drift eliminators are placed above the sprays to prevent loss of water through drift. This is also an important

control mechanism which prevents *Legionella* in the water droplets from escaping the system.

Induced draught cross-flow cooling towers also have a fan that is mounted on top. However, the fan draws the air stream horizontally across the water falling from the top of the tower to the basin, instead of vertically in an opposite direction to the water flow (see Figure 4.2-2). Forced draught counter-flow cooling towers have the fan located at the air inlet just above the water basin, so that air is forced through the tower from the bottom, rather than being drawn out at the top (see Figure 4.2-3).

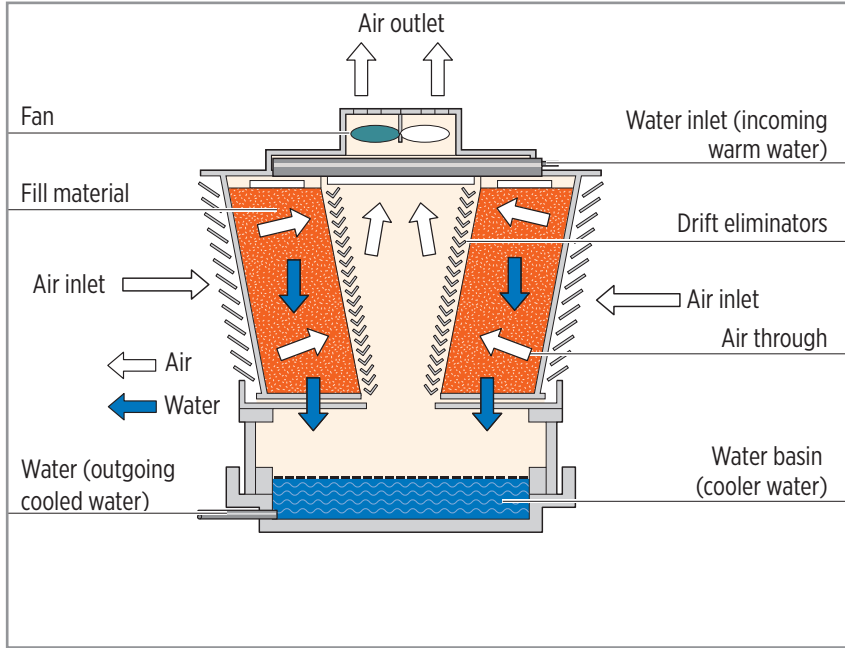
Evaporative condensers are typically used to reject heat in industrial processes. These devices work in a similar way to other types of cooling towers, but do not contain any fill material, and circulate refrigerant fluid instead of water. They carry a similar risk of *Legionella* transmission and are a regulated system under the Regulation. **Evaporative air coolers** or evaporative air-conditioners use water to cool the air, whereas cooling towers use air to cool the water (or other fluid). These devices cool air by moisture evaporation either directly into the airstream or indirectly around ducts carrying indoor air. Evaporative air coolers are not defined as a cooling water system, and are not a regulated system under the Regulation.

Figure 4.2-1: Induced draught counter-flow cooling tower



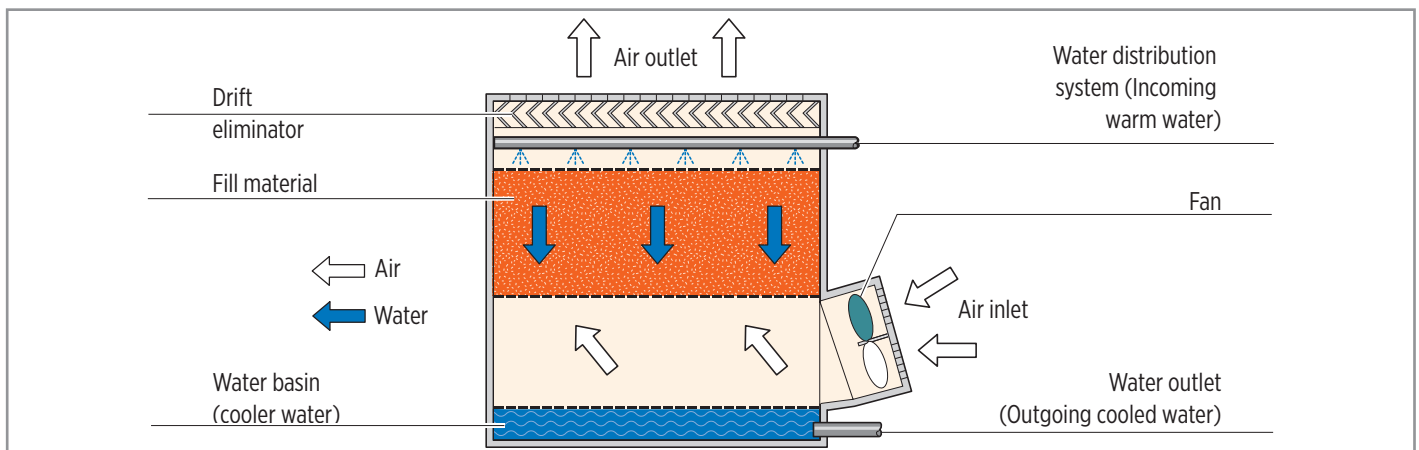
Obtained with permission from the Victorian Department of Health and Human Services

Figure 4.2-2: Induced draught cross-flow cooling tower



Obtained with permission from the Victorian Department of Health and Human Services

Figure 4.2-3: Forced draught counter-flow cooling tower



Obtained with permission from the Victorian Department of Health and Human Services

4.3 Life cycle approach to managing cooling water systems

Considering the different stages in the life cycle of a cooling water system can help the occupier and duly qualified person to reduce the risk of *Legionella* growth and transmission. The duly qualified person (who is engaged to install, operate or maintain a cooling water system) and the competent person should ensure they have considered all of the issues summarised in Table 4.3-1. Cooling water systems must be designed and installed in accordance with AS/NZS 3666 Part 1, operated in accordance with AS/NZS 3666 Part 2, and maintained in accordance with AS/NZS 3666 Part 3.

Table 4.3-1: Features to consider when managing cooling water systems

Category	Features to consider
Planning, location and siting	<ul style="list-style-type: none"> • Proximity to populations, such as pedestrian thoroughfares and occupied areas (Section 5.5.1) • Height of adjacent structures • Direction of prevailing winds and any localised wind patterns • Location of air inlets on nearby buildings, including windows that can be opened • Effect of enclosures around the cooling towers • Proximity to other thermal or polluted discharges, such as kitchen exhausts (Section 5.5.2) • Proximity to adjacent unsealed roads or areas which may cause dirt contamination to the cooling water system • Nutrient availability and exposure to direct sunlight (Section 5.2)
Design features	<ul style="list-style-type: none"> • Holistic approach to design and installation • Drift eliminators fabricated from corrosion resistant materials that meet AS/NZS 3666 Part 1 • Safe and easy access around the cooling water system for cleaning, maintenance, inspections, and water sampling (Section 5.5.3) • Components removable if practicable • Components not removable to be readily cleanable in situ • Internal corners at basin and sides that are rounded to facilitate cleaning • Basins that are graded to drain outlets at least 50mm diameter • Water supply and drainage facilities to comply with relevant authorities' requirements
Installation and start up features	<ul style="list-style-type: none"> • Water pipework and connections (Section 5.1.1) • Systems to be kept clean during installation • Water treatment to commence once system is filled • Fill, disinfect, drain system and flush pipework before start-up
Maintenance features	<ul style="list-style-type: none"> • Water quality and biofilm (Section 5.2.2) • Water treatment chemicals (Section 5.3.3.8) • Water quality monitoring (Section 5.3.4) • Microbial monitoring (Section 5.3.1) • System operational policies (Section 5.1.3) • Undertake a risk assessment, develop a Risk Management Plan (RMP), and audit the RMP (Section 6) • Maintenance workers to be trained, wear appropriate personal protective equipment (PPE), and follow safety procedures
Decommissioning	<ul style="list-style-type: none"> • Remove system components, water treatment chemicals and equipment, power supplies, and any hazardous waste

Section 5

Understanding risk factors associated with cooling water systems

This section provides guidance on managing key risk factors for *Legionella* growth and transmission in cooling water systems. It explains how to identify, assess and control the risks. An understanding of the risk of Legionnaires' disease should underpin all aspects of the management of cooling water systems, including installation, operation, maintenance, risk assessment and auditing.

This section should be read in conjunction with Section 6 on undertaking risk assessments and Section 4.3 on the life cycle approach to managing cooling water systems.

This section is based on the five risk categories and associated risk factors provided in Table 2.1 of Australian/New Zealand Standard (AS/NZS) 3666 Part 3, and set out in Table 5-1 below. Some risk factors are marked with an asterisk to indicate key performance indicators (KPIs). KPIs in relation to cooling water systems are risk factors that are testable, assessable and controllable for the performance, monitoring and verification of the system. Not all KPIs are important risk factors for *Legionella* growth and transmission; however, they are readily measurable and provide an overall assessment of the performance of the system.

Table 5-1: Risk categories and risk factors to be identified, assessed, and controlled

Risk category	Risk factor
Stagnant water	<ul style="list-style-type: none"> • Presence of water in dead legs • System not in use due to: <ul style="list-style-type: none"> – intermittent operation – seasonal usage
Nutrient availability and growth	<ul style="list-style-type: none"> • Presence of nutrients • Presence of biofilm • Water temperature* • Direct sunlight (which promotes algal growth)
Poor water quality	<ul style="list-style-type: none"> • Concentration of <i>Legionella</i> (all species are considered as potential pathogens)* • Concentration of other heterotrophic bacteria* • Presence of protozoa and algae • Water quality: <ul style="list-style-type: none"> – cleanliness* – pH* – presence of corrosion products* – presence of scale and fouling – conductivity/total dissolved solids* – control limits out of range* – suspended solids (e.g. from nearby construction work) – control of water treatment chemicals* – control of bleed* • Characteristics of make up water (physical, chemical, microbial) • Microbial control program

Risk category	Risk factor
Deficiencies in the cooling water system	<ul style="list-style-type: none"> • System size (surface area available for biofilm development compared with water volume) • Physical condition of system* • Aerosol generation and drift elimination
Location and access to cooling towers	<ul style="list-style-type: none"> • Aerosol dispersion and public access to system • System location and environment (environmental contamination, and burden on water treatment chemicals) • System access for inspection, maintenance, and cleaning

5.1 Stagnant water

Stagnant water increases the risk of microbial growth in cooling water systems. Inadequate circulation of cooling water and water treatment chemicals through the system can allow microorganisms to be left undisturbed for long periods of time, develop biofilm, and multiply at a rapid rate. A subsequent disruption to the stagnant water can seed the cooling water system with large numbers of microorganisms, including *Legionella* bacteria.

The risk of stagnant water can increase due to:

- The presence of water in dead legs
- The system not being in use, due to intermittent operation or seasonal usage.

5.1.1 Presence of water in dead legs

Dead legs are defined in AS/NZS 3666 Part 1 as a section of the system that does not permit the circulation of water. Dead legs prevent the circulation of both cooling water and water treatment chemicals in that part of the system; this results in stagnant water where microorganisms can be left undisturbed for long periods of time and multiply at a rapid rate. A subsequent disruption of the dead leg could seed the cooling water system with large numbers of microorganisms including *Legionella* bacteria. Dead legs often occur where there are disused or redundant pipes full of water. Automated valves may shut off parts of the system for lengthy periods of time.

Other components of a water cooling system can also become dead legs:

- A pumping plant is typically used to move cooling water around the system. These units can be operated in duty (active) and standby mode to extend plant life and provide flexibility in pumping. A pump in standby mode can become a dead leg.

- Installing a balance line to equalise the water depth between two cooling towers is considered good hydraulic practice because it promotes system efficiency; further guidance can be found in the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) *Design Application Manual DA 17: Cooling Towers (2009)*. However, the balance line can contain stagnant water.
- Cooling water systems can also contain loops and bends in pipes that do not drain when the system is shut down and hence develop stagnant water.

Figure 5.1-1 shows two dead legs (top left and bottom right) which have resulted from pipework that has been set up to allow a cooling tower to be installed in future. There is no flow through these pipe sections, allowing water to stagnate in these extremities of the system.

Figure 5.1-1: Two dead legs (top left and bottom right)



5.1.1.1 Identifying dead legs

The cooling water system should be visually inspected. It may also be helpful to review plans, detailed operational manuals and schematics of the water pipework and speak to staff and mechanical service contractors (including DQPs).

5.1.1.2 Treating dead legs

Disused or redundant pipe sections should be removed, or reduced to less than one pipe diameter in length from the main pipe. Alternatively, a small bore bypass should be fitted to connect the two dead legs which can then be flushed periodically or automatically. Both options will allow biocide-rich water to flow through the pipe and eliminate *Legionella* bacteria.

Figure 5.1-2 shows the addition of a small-bore bypass as a solution for managing a dead leg. The large blue central pipe (condenser water pump cross-connecting line) previously acted as a dead leg when the valve was closed. Adding a small-bore bypass which is opened once a week allows the line to be flushed, thereby eliminating the dead leg.

Figure 5.1-2: Solution for managing dead legs (small-bore bypass)



Strategies to prevent pumping units from becoming dead legs include:

- Rotating the use of duty and standby pumps on a daily basis, or as frequently as practicable, which can often be automated by using a building management system (BMS) or other system controller. This is also recommended where there is a third pump that is placed in standby mode for two duty pumps.
- Rotating the use of duty and standby pumps on a weekly basis, manually, if automated control is not available.
- Periodically opening the pipework at duty and standby pumps lines to allow water containing biocides to flow through the system.

Strategies to prevent balance lines from becoming dead legs include:

- Draining the system sumps periodically, ideally monthly if practical; the sump is located at the bottom of the cooling tower basin where the basin drains out, allowing dirt to collect in the process
- Installing a balance line above the sump drain valves, which would allow the line to drain and refill with biocide containing water
- Installing drain valves on the balance line if it is mounted below the sump drain arrangement
- Installing a permanent small-bore piping circuit with its own small in-line circulating pump to allow water to move through the balance line and prevent stagnation (this is a more expensive control strategy)
- Designing the water filtration equipment so that it is piped into and draws its suction from the balance line, and discharges into the cooling tower basin while still allowing the balance line to equalise the water depth between two or more cooling towers
- Installing side stream filtration equipment (the best option) which takes water from the balance line and ensures it is never a dead leg. Side stream filtration is typically designed to allow 5 to 10% of the total system cooling water flow rate to pass through the filter bed (see Figure 5.1-3).

Figure 5.1-3: Side stream filtration equipment at the balance line, connecting three cooling tower basins



5.1.2 System not in use due to seasonal or intermittent operation

Cooling water systems used with air-conditioning systems are often shut down over winter and may also be used intermittently when ambient temperatures fluctuate, for example, in spring or autumn. Systems may also need to be temporarily shut down for cleaning or repair. Intermittent use increases the risk of stagnant water and needs to be managed appropriately.

System start up after an idle period can cause biofilm to detach from surfaces and circulate through the system, seeding the water and leading to further microbial growth. Continuously operated cooling water systems can produce positive *Legionella* counts on monthly testing, but they are unlikely to be associated with disease since episodic shedding of biofilm is rare. In contrast, intermittently operating systems may experience shearing forces across biofilm at each start up operation. This can release (slough) a large section of biofilm into the circulating water, while biocide concentrations may have depleted. This can promote rapid microbial growth and an increased risk of disease.

Procedures for safe seasonal usage of cooling water systems are provided in section 2.5.4 in AS/ NZS 3666 Part 2, and the AIRAH *Design Application Manual DA 17: Cooling Towers (2009)*.

5.1.2.1 Managing shut down periods

Shut down refers to a process of suspending the use of a cooling water system using a defined shut down procedure. Cooling water systems that undergo intermittent or seasonal use are still considered to be in operation unless they have been decommissioned, and the local government authority has been notified. The RMP (Approved Form 1) should specify procedures to enable operation on an intermittent or seasonal basis.

Cooling water systems that have been shut down can be managed in one of two ways:

1. By being drained, cleaned, kept in a dry condition, with water treatment reinstated before start up
2. By leaving water treatment in continuous operation, with cooling water circulated through the entire system at least once every 48 hours.

During the months that the system has been drained, cleaned and kept in a dry condition (option 1), monthly inspections, maintenance (including servicing), chemical analysis, and microbial testing is not required. However, monthly reports should still be completed (stating that the system has been shut down), and included in the 12 month audit period. During the months that water treatment is in continuous operation (option 2), normal operation and maintenance procedures should be in place. This includes conducting monthly inspections, maintenance (including servicing), chemical analysis, and microbial testing, and documenting the findings in a monthly report.

Cooling water systems associated with emergency power generation plants are often dormant for extended periods and produce a dead leg effect. This can be addressed by running a parallel dosing circuit to the main piping array. This ensures that water containing chemical biocides can enter the main system before exiting back at the dosing pump.

5.1.2.2 System start up and shut down procedures

The start up phase of a building construction program presents special challenges for limiting microbial growth. Equipment may be starting and stopping, balancing valves may not have been set, water temperature may be less well regulated, and general water chemistry will not have reached equilibrium. Dust from the premises during construction may have settled in the fill passages of the cooling water system, resulting in uneven falling water flow. The basin area should be inspected to ensure that water flows are even (see Figure 5.1-4).

Figure 5.1-4: Even fall of water across basin area suggests fill passages are clear



System start up and shut down procedures should be documented and available on the premises, and documented as part of the RMP. Start up procedures are unique to each system and operators should consult the manufacturer's manual. A shut down procedure can be used during normal system operation or in an emergency. As an example, the following steps should be included in a shut down procedure:

1. Locate mechanical services switchboard
2. Select desired cooling water system
3. Switch off and tag system condenser water pump at control switch
4. Switch off and tag relevant cooling water system fan control switch
5. Switch off and tag other relevant motors (filter pump, other fans and auxiliaries).

5.2 Nutrient availability and growth

Nutrient availability can promote the rapid growth of bacteria such as *Legionella* in cooling water systems and must be managed appropriately. The risk of nutrient availability and growth can increase when:

- Nutrients are present
- Biofilm is present
- Water temperature is within a range that supports microbial growth
- Water is exposed to direct sunlight which promotes algal growth.

5.2.1 Presence of nutrients

Environmental contaminants can enter cooling water systems through the water supply and ambient air. The constant fall of water through the system "scrubs" the air and introduces large amounts of organic and inorganic particles into the system. Sources of nutrients include:

- Atmospheric dust, from building demolition, construction sites, heavy traffic, unsealed roads, and car parks
- Organic matter, from overhanging trees, other vegetation, birds, and other animals
- Exhaust from buildings, kitchen exhausts, other vents, and flue outlets.

The site should be inspected to identify all potential environmental contamination sources. Where feasible, action should be taken to remove or reduce these sources. Attention should be paid to housekeeping on the premises by trimming back any overhanging trees so that they are well clear of

cooling towers. Organic matter from leaf litter can provide a nutrient source that can also deplete chemical biocides and promote the growth of *Legionella* bacteria. Louvered air inlet screens should be installed to reduce the amount of air contaminants entering the system. Side-stream filtration can be applied to remove nutrients from the circulating water. Cooling towers should be located at least 8 metres from kitchen exhausts (which can provide nutrients for microbial growth), and at least 6 metres from an outdoor air intake or window (which can receive aerosol generated by the cooling tower). The quality of the make-up water should be monitored (see Section 5.3.4).

5.2.2 Presence of biofilm

Biofilm is an important risk factor for microbial growth. Biofilm is a physiologically coordinated community of microorganisms attached to a surface. The microorganisms involved are planktonic (that is, floating and dispersed in the water), with the ability to attach to surface such as pipework in the cooling water system. Biofilm can shield the underlying microorganisms from water treatment chemicals, and therefore allow unchecked growth of *Legionella* bacteria. Established biofilm can detach from surfaces and circulate through the system, seeding the water and leading to further microbial growth.

The presence of this phenomenon in cooling water systems highlights the importance of effective water treatment; the use of chemicals such as biocides breaks up and eliminates these microbial colonies, and exposes the underlying bacteria to circulating biocides.

5.2.3 Water temperature

Water temperature is a significant risk factor for the growth of *Legionella* bacteria, which favour water temperatures between 25 and 42°C. The growth of *Legionella* is limited by keeping the water temperature below this range in all parts of a cooling water system. Water temperature should be monitored and measured at the return line. Operating refrigeration systems (such as air conditioning chillers) below 25°C has the added benefit of minimising energy use. Many modern chillers are able to operate at very low temperatures for most of the year.

5.2.4 Direct sunlight and algal growth

Some species of blue-green algae are a risk factor because they produce and transfer nutrients to *Legionella* bacteria. Algae are commonly present in

water sources and in dust in the ambient air, but their growth requires warm water and sunlight. Hence, algae are usually found in the splash zones or wet surfaces of a system which are exposed to sunlight. These may include the cooling tower basin, and the wet top deck of some types of cooling towers.

This risk can be managed by inspecting and removing visible algae in cooling towers. Exposure to sunlight can be reduced by:

- Installing drift eliminators and louvered air inlet screens that shade wet areas from direct sunlight
- Ensuring that the water distribution deck at the top of the system is covered, for example, by adding hoods over the air intake to avoid exposure to direct sunlight (see Figures 5.2-1 and 5.2-2).

Figure 5.2-1: Water distribution deck with an open cover and clean water distribution nozzles



Figure 5.2-2: Cross-flow cooling towers with rectangular covers at the top of the towers (preventing entry of sunlight) and a walkway for safe and easy access



5.3 Poor water quality

Ensuring good circulating water quality is fundamental to preventing *Legionella* growth and transmission. The risk of poor water quality can increase due to:

- High concentration of *Legionella* bacteria (all species are considered as potential pathogens)
- High concentration of other heterotrophic bacteria
- Presence of protozoa and algae
- Poor water quality, including:
 - Cleanliness
 - pH
 - Presence of corrosion products
 - Presence of scale and fouling
 - Conductivity/total dissolved solids
 - Control limits out of range
 - Suspended solids (e.g. from nearby construction work)
 - Control of water treatment chemicals
 - Control of bleed
- Characteristics of make-up water (physical, chemical, microbial)
- Ineffective microbial control program.

5.3.1 Concentration of Legionella and other heterotrophic bacteria

Elevated *Legionella* count and heterotrophic colony count (HCC) are the main risk factors to be controlled in cooling water systems. High levels of these microorganisms indicate a loss of effective microbial control, and require urgent remedial action to be taken. HCC is a count of colonies of heterotrophic aerobic bacteria present in a cooling water system. HCC represents the total bacterial count, and is sometimes referred to as heterotrophic plate count (HPC), total plate count (TPC), or standard plate count (SPC).

5.3.1.1 Monthly microbial monitoring

The risk of *Legionella* growth is managed through a range of control strategies. Microbial monitoring provides one such important check that appropriate chemical biocides are being used, and that the risk to human health posed by the cooling water system remains low. The Regulation requires, at a minimum, monthly microbial monitoring of *Legionella* count and HCC, in accordance with AS/NZS 3666 Part 3. The results of the microbial testing determine the control strategies that should be adopted when specified levels are exceeded. The RMP can require more frequent microbial monitoring based on the risks posed by the system.

5.3.1.2 Microbial sampling

Samples to be tested for *Legionella* count and HCC should be representative of the circulating cooling water, and should be collected as described in Appendix A of AS/NZS 3666 Part 3. Sampling should be done at a dedicated sampling point, which should be situated on the return line to the system, and should be clearly labelled. The sampling procedure should include a first flush that discards a small amount of water, so that only the subsequent, circulating water is collected in the sample bottle.

Where the system does not have a dedicated sampling point, the technician (duly qualified person or DQP) can obtain a sample from any fitting that can be opened without being splashed by the system water, which presents a potential occupational health hazard to the technician. Water samples should be delivered to the testing laboratory within 24 hours, and kept between 2 to 8°C, in accordance with Appendix A of AS/NZS 3666 Part 3.

5.3.1.3 Microbial testing

The testing laboratory must be accredited by the National Association of Testing Authorities (NATA). Microbial testing involves a bacterial culture technique, in which the microorganism is grown on agar plates. While HCC results can be obtained within a few days, confirming the presence of *Legionella* can take up to 10 days. Both *Legionella* count and HCC are measured in colony forming units per millilitre (cfu/mL).

5.3.1.4 Responding to elevated counts

Appropriate control strategies must be implemented in response to an elevated *Legionella* count (≥ 10 cfu/mL) or HCC ($\geq 100\ 000$ cfu/mL). The RMP should provide an appropriate protocol consistent with the control strategies for disinfection and decontamination provided in Tables 3.1 and 3.2 and Figures 3.1 and 3.2 of AS/NZS 3666 Part 3, and these tables should be referenced in their entirety.

In some cases, it may be necessary to treat the risks which are unique to the premises, location, or method of operation of the cooling water system in a manner which is different to AS/NZS 3666 Part 3, but still consistent with its intent. For example, Table 3.1 of AS/NZS 3666 Part 3 requires immediate online disinfection when a *Legionella* count ≥ 10 cfu/mL is obtained during monthly testing. Due to the high cost of return calls in regional and rural areas, the DQP can establish a protocol whereby they take a monthly microbial sample, and perform a pre-emptive online disinfection before leaving the premises.

This can allow the *Legionella* risk to be controlled in a timely manner (in case a *Legionella* count ≥ 10 cfu/mL is obtained), and would be consistent with the intent of AS/NZS 3666 Part 3, which is to immediately control the microbial risk. The DQP would still need to return to the premises if a high *Legionella* count is obtained, in order to determine and treat the cause of the high microbial result and conduct a full system clean if required.

5.3.1.5 Reportable test results

The Regulation requires occupiers to notify the local government authority of reportable test results of *Legionella* count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL. These levels indicate that the system is performing poorly and may be exposing people to *Legionella* bacteria and hence warrants follow up by regulatory authorities. See Section 8.6 for guidance on how to notify reportable test results and how regulatory authorities can respond.

The requirement to notify the local government authority at these levels does not imply that no action should be taken until a reportable test result is reached; RMPs should specify the actions which should be taken at any level of *Legionella* count > 10 cfu/mL or HCC $> 100,000$ cfu/mL. These actions in the RMP should be consistent with Tables 3.1 and 3.2 and Figures 3.1 and 3.2 of AS/NZS 3666 Part 3.

5.3.2 Presence of protozoa and algae

Legionella bacteria can multiply within host organisms such as protozoa. These larger organisms are more resistant to biocides, and can thereby protect *Legionella* bacteria from water treatment chemicals. The use of biodispersants and routine cleaning can prevent growth of protozoa populations.

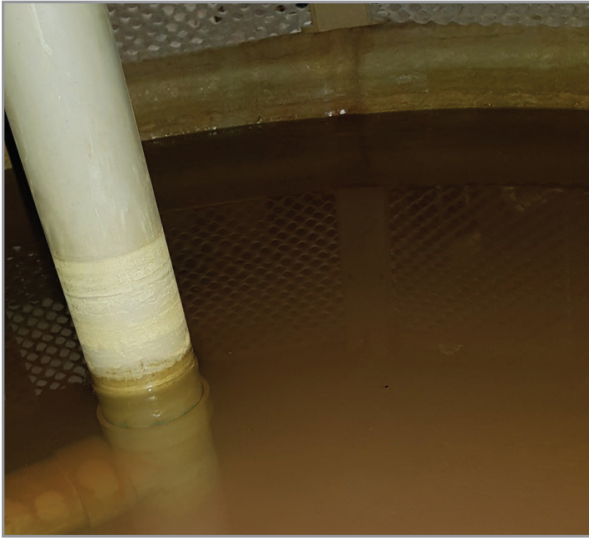
Algae are an important nutrient source for *Legionella* growth, and are usually found in warm water and the splash zones of a system exposed to sunlight. See Section 5.2.4 for further information on managing algae.

5.3.3 Water quality

5.3.3.1 Cleanliness

Cooling water systems can develop sludge, foam, biofilm or slime (including algae and fungi), rust, scale, dirt, dust (and any deposit or accumulation of impurities), or other foreign material. Poor cleanliness is an important risk factor for *Legionella* growth. Water that is cloudy or discoloured can indicate poor water cleanliness or insufficient cleaning and servicing (see Figure 5.3-1).

Figure 5.3-1: Cloudy or discoloured cooling water can indicate poor water cleanliness or insufficient cleaning and servicing



Cooling water systems should be cleaned on a regular basis. This involves draining and cleaning the cooling tower so that it is free from all visible foreign material, as listed above. AS/NZS 3666 Part 2 requires tower cleaning every six months. However, the Regulation requires compliance with AS/NZS 3666 Part 3, which allows cleaning to take place on a more or less frequent basis, as long as suitable offsets are put in place. For example, side stream filtration (see Figure 5.1-3) or full-flow centrifugal separators provide continuous cleaning and can allow the frequency of manual cleaning to be reduced. Conversely, a system exposed to high levels of environmental contamination may need to be cleaned more frequently. The competent person should determine the appropriate cleaning frequency, justify any variation to cleaning every six months, and document this in the RMP.

5.3.3.2 pH

Many biocides (both oxidising and non-oxidising) are deactivated or break down at high pH levels. High pH levels also increase the potential for scale build up and associated biofilm formation. The effectiveness of biocides can be improved by chemical treatment to lower the pH. DQPs should monitor pH and operate the system within control ranges specified in the RMP (see Section 5.3.3.6).

5.3.3.3 Presence of corrosion products

Corrosion increases the wet surface area for biofilm attachment and hence promotes *Legionella* growth. Corrosion can also release iron, which is a growth factor for *Legionella*. Corrosion should be controlled according to industry standards. Further guidance can be found in section 14-70 of the AIRAH *Design Application Manual DA 18: Water Treatment (1998)*.

Corrosion can be controlled during the design phase by selecting appropriate materials for the cooling water system. Corrosion can be controlled during the operational phase by using chemical inhibitors, and monitoring of the impact of circulating cooling water on metal surfaces of the cooling tower. Monitoring can be performed through visual inspection or regular (monthly or quarterly) testing using corrosion coupons. These are test plates made of identical metals to those used in the cooling tower. Chemical testing to measure the concentration of copper and iron in solution is sometimes used in addition to corrosion coupons. Corrosion inhibitors should be applied at a point where there is good water mixing, for example, at the suction side of the recirculating pump.

DQPs should monitor corrosion and operate the system within control ranges as specified in the RMP (see Section 5.3.3.6).

5.3.3.4 Presence of scale and fouling

Scale and fouling occur when compounds present in the circulating cooling water form deposits on wet surfaces of the system. Scale and fouling can reduce the effectiveness of water treatment chemicals, increase the wet surface area for biofilm attachment, and increase the water temperature at heat transfer surfaces. Figure 5.3-2 shows significant scale build up in the fill material.

Figure 5.3-2: Significant scale build up in the fill material



Scale and fouling should be controlled according to industry standards. Further guidance can be found in section 14-70 of the AIRAH *Design Application Manual DA 18: Water Treatment (1998)*. Scale and fouling can be controlled through water filtration to remove particulates, by continuously applying suitable chemical preparations such as dispersants and surfactants, and using bleed off procedures

(see Section 5.3.3.9). Chemicals should be applied at a point where there is good water mixing, for example, at the suction side of the recirculating pump.

5.3.3.5 Conductivity and total dissolved solids

Total dissolved solids (TDS) refers to all solids that are dissolved in the cooling water, which allow the water to conduct electricity. Therefore, conductivity can be used as an indicator of TDS, which is difficult to measure directly. Calibrated metres can be used to measure conductivity.

A high level of TDS (indicated by high conductivity) can be detrimental to some biocides, and can increase the potential for scale build up and associated biofilm formation. It should be controlled by means of an automated bleed system linked via sensor to measure the conductivity of the cooling water (this is required by AS/NZS 3666 Part 1).

A low level of TDS (indicated by low conductivity) can be associated with uncontrolled water losses in the system, or excessive use of make up water. Water losses can be due to backflow through the system when the pump stops, and an anti-backflow loop in the pipework can help overcome this defect. Backflow can also result from a faulty setting for the ball float valve in the system basin. Further guidance is provided in the AIRAH *Best Practice Guidelines: Water Conservation in Cooling Towers* (2009).

DQPs should monitor conductivity and TDS and operate the system within control ranges as specified in the RMP (see Section 5.3.3.6).

5.3.3.6 Control limits out of range

Setting and monitoring specific microbial and chemical risk factors is an important aspect of risk management. The competent person sets appropriate control ranges in the RMP by considering the recommended control ranges provided in the RMP template, local conditions, and the unique risks posed by the cooling water system.

The DQP must operate and maintain the cooling water system within these control ranges through an appropriate water treatment program that meets the requirements of AS/NZS 3666 Part 1 and Part 3. The DQP must monitor the risk factors (the Regulation requires monthly chemical analysis and microbial testing), and make changes to the water treatment program when water quality factors fall outside the specified control range.

5.3.3.7 Suspended solids

Suspended solids are physical particles suspended in the cooling water that can eventually settle on a surface and become sediment. They support microbial growth by increasing the surface area in the cooling water system, increasing corrosion rates when they settle on surfaces, and depleting biocides when they contain organic matter. Suspended solids may also contain nutrients that support microbial growth.

DQPs should monitor suspended solids and operate the system within control ranges specified in the RMP (see Section 5.3.3.6). Suspended solids can be controlled by limiting the nearby sources of airborne environmental contamination (such as overhanging trees), filtering make-up water for particulates, screening or filtering tower air intakes, and the use of bleed off procedures (see Section 5.3.3.9).

5.3.3.8 Control of water treatment chemicals

Water treatment chemicals are used in cooling water systems to control corrosion and scale formation (“chemical inhibitors”), break up biofilm (“biodispersants”), and prevent microbial growth (“biocides”) and fouling. These factors are interrelated, and failure to control one may lead to other factors occurring simultaneously, resulting in an environment that promotes the growth of *Legionella*. Different types of water treatment chemicals are sometimes combined in proprietary formulations to address these risk factors.

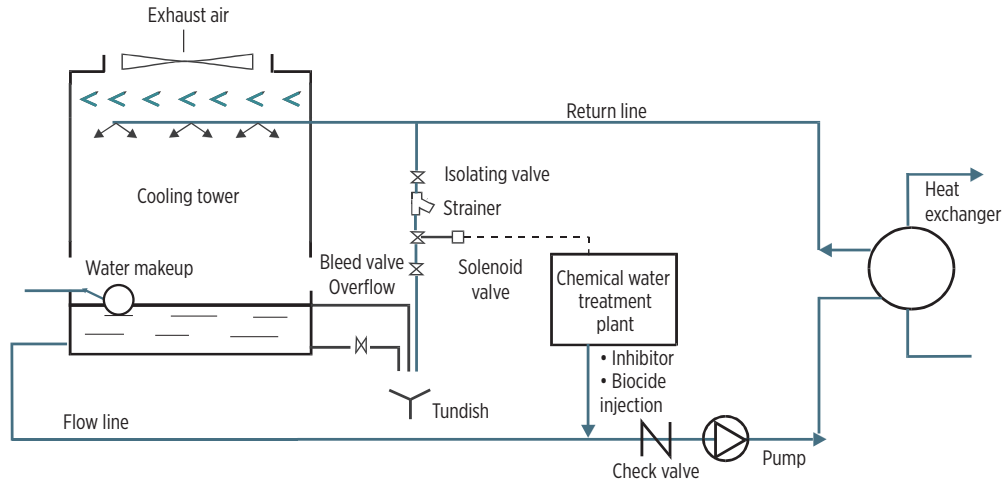
Figure 5.3-3 overleaf outlines a typical water treatment dosing arrangement.

Using an automated dosing system

Water treatment chemicals should be applied by an automated dosing system, which delivers the required dose of chemical at regular intervals, ensuring that the cooling water is being treated continuously. The system can also automatically control bleed-off (see Section 5.3.3.9).

Timer-controlled dosing systems deliver pre-set amounts of chemicals at pre-set frequencies, based on an operator’s calculation of the volume and time interval required to achieve the target concentration. Feedback-controlled dosing pumps monitor chemical parameters and add varying amounts of chemicals, depending on the water quality. This is often achieved by the use of dosing pumps activated by a signal from a water meter in the make up line or by the bleed off controller.

Figure 5.3-3: Water treatment dosing arrangement



The DQP should check the automatic controls for applying chemicals and system bleed off over their full operating ranges. They should ensure that the conductivity cell is calibrated, and the sensor is cleaned at least monthly. A delay timer should be installed to prevent the addition of water treatment chemicals during bleed off. Dosing systems have a limited lifespan and should be inspected regularly.

When using a feedback control system, a water meter should be installed in the system water supply pipeline. This allows the measurement of water make up rates, and proportional dosage of treatment chemicals.

Chemical containers should be properly labelled and banded (see Figure 5.3-4) to contain any spillage or leaks, prevent discharges to stormwater systems, and avoid a safety hazard to workers. Leaking containers should be replaced and unused containers should be removed from the premises. The storage of chemicals should not damage feed lines or prevent the flow of chemicals through dosing tubes. Chemical containers should not be stacked on dosing tubes. If chemicals are stored in a bund with a lid, the lid should not compress dosing tubes. Figure 5.3-5 shows a bund container where the dosing tubes would be compressed if a bund lid is replaced. Compression of tubes can be prevented by providing holes in the side or top of the bund through which the tubing can pass.

Selecting an appropriate point for chemical dosing

Dosing of the cooling water system should not take place at the point where the water quality is monitored by bacterial testing (the sampling point). It is important to ensure that sampling occurs at a point that is representative of the water circulating in the system.

Figure 5.3-4: Water treatment equipment



Figure 5.3-5: A bund container that may compress dosing tubes when the lid is replaced



5.3.3.9 Control of bleed

Bleed off (or blowdown) refers to the removal of water from a system and replacement with clean make up water to limit the concentration of total dissolved solids and suspended solids. An automated bleed system should be used to control bleed. The system should measure conductivity (which is an indicator of TDS levels in the water) with a sensor and initiate bleed off at appropriate times; this is required by AS/NZS 3666 Part 1. Additional manual bleed off can be undertaken to control scale or fouling.

Bleed off should only occur while chemical dosing is turned off. The water for bleed off should be taken from the return line of the cooling water system (to the cooling tower). Removal of warmed water at this point also helps to reduce system loading and conserve energy. As cooling water systems contain potent chemicals, approval from the sewerage authority may be required for systems to discharge into sewerage.

5.3.4 Characteristics of make up water

The quality of the make up water determines the composition of the cooling water. Make up water is the incoming water supply to the cooling water system which replaces the water lost by evaporation, bleed, drift, splash out, and leakage. It is often taken from a potable water supply and should be metered.

An effective water treatment program requires regular, monthly monitoring of the composition of the make up water and the cooling water, even when a potable water supply is being used. Monitoring the make up water allows identification of changes in water chemistry (for example, pH, dissolved and suspended solids, hardness and alkalinity) and allows necessary adjustments to be made to the water treatment program or system operating conditions. It is essential to measure impurities in make up water for systems that draw water from untreated sources (such as lakes, rivers, rainwater) or industrial processes (potentially containing oils and other contaminants).

The composition of the cooling water is also dependent on the cycles of concentration. This refers to the concentration of the cooling water divided by the concentration of the make up water; it is a useful indicator of the balance between excessive water losses and insufficient make up water being introduced into the system. Compounds that are normally present in the water can concentrate due to evaporation of water during the heat

exchange process. Further guidance is provided in the AIRAH *Best Practice Guidelines: Water Conservation in Cooling Towers* (2009).

5.3.5 Microbial control program

A well designed microbial control program involves water treatment control methods (using biocides) to support the (non-biocide) operational control methods detailed in the RMP.

Dual biocides should be used to control the growth of *Legionella* and other microorganisms. The RMP should advise on the most suitable choices for the primary and secondary biocides that match the characteristics of the cooling water system. There are two types of chemical biocides: oxidising (for example, chlorine and bromine) and non-oxidising (for example, isothiazolone). Best practice usually involves the simultaneous use of non-oxidising and oxidising biocides, and periodical rotation of biocides to prevent bacteria from developing tolerance to these chemicals. Very few systems use physical (non-chemical) biocides, such as devices that generate ultraviolet light, ozone or electromagnetic fields. Physical biocides should be used only as a secondary biocide in conjunction with conventional chemical biocides.

Chemical biocides should be applied using an automated dosing system (see Section 5.3.3.8). The frequency and quantity of biocide dosing should be based on the microbial activity of the system and the chemical parameters of the circulating water. Oxidising biocide concentrations can be readily automated and controlled, generally by measuring the oxidation-reduction potential (ORP). Determining the concentration of non-oxidising biocides on a regular basis may not be practical as it requires a laboratory test. Therefore, the amount of non-oxidising biocide to be added to a system is generally calculated from the metered volume of make up water.

Oxidising biocides can be applied either as a shot dose or continuously, while non-oxidising biocides should be added as a shot dose. Adequate quantities of oxidising biocides used in continuous dosing should be kept on the premises for use in emergency situations.

Chemical biocides should be applied at the suction side of the recirculating pump instead of the system basin, as this ensures that adequate concentrations of biocide are maintained in the water, resulting in more effective elimination of microorganisms. If additional biocides are manually applied to a cooling water system (for example, during servicing),

any standby equipment or pipework should be brought into circulation to avoid the creation of dead legs and subsequent microbial growth.

Biocide effectiveness is reduced if system residence time (holding time) is short. Holding time refers to the amount of time that the biocide is present in the cooling water system. Small systems with a high water turnover may have short holding times, meaning that the biocide does not have enough contact time in the water to eliminate microorganisms. For these cooling water systems, a fast-acting biocide is usually necessary as part of a dual biocide approach. To measure holding time, the total volume of the entire water circuit should be identified (including the system basin recirculation pipework and heat exchange equipment).

5.4 Deficiencies in the cooling water system

Mechanical deficiencies in cooling water systems can increase the risk of *Legionella* growth and transmission. These include:

- Smaller system size (surface area available for biofilm development compared with water volume)
- Poor physical condition of the system
- Aerosol generation and poor drift elimination.

5.4.1 System size

The ratio of surface area to water volume in the cooling water system is an important determinant of biofilm formation. Cooling water systems which have a lower volume of water relative to the submerged surface area are at higher risk of biofilm formation. When biofilm sloughs off an internal surface, it can transport *Legionella* bacteria within the system. Systems with lower water volumes also experience more rapid water turnover; this results in a short holding time, meaning that the biocide chemical and bacteria do not interact for an adequate amount of time to eliminate the bacteria.

This risk can be assessed by estimating the ratio of submerged surface area to water volume, which should be less than 10 for large plant (typically over 1,000kW heat rejection), between 10 and 20 for medium plant (less than 1,000kW), and above 20 for small plant (less than 300kW). Note that it is the submerged surface area, not the total internal surface area, that provides the substrate for biofilm formation. This ratio is an approximate calculation, but provides an indication of whether the chemicals selected and frequency of cleaning is suitable for the cooling water system.

5.4.2 Physical condition of system

Over time, the physical condition of a cooling water system deteriorates, reducing its thermal performance and creating an environment that promotes the growth and transmission of *Legionella* bacteria.

The competent person should identify physical defects when conducting the risk assessment, and document control strategies and required timeframes for their implementation in the RMP. The DQP should identify any defects and appropriate control strategies when undertaking monthly inspections of the cooling water system. The DQP may be the first person to become aware of deficiencies, and should inform the occupier when deficiencies are identified. An authorised officer may identify defects when inspecting or investigating a system and require the occupier to correct them.

The DQP should implement required control strategies as soon as possible and within the required timeframe. Table 5.4-1 shows some common physical defects and their control strategies.

Figure 5.4-1: Broken fanbelt where the motor functions but the fan does not



Figure 5.4-2: Collapsed fill can affect thermal performance and block access for maintenance



Table 5.4-1: Common physical defects in cooling water systems and recommended control strategies

System component	Common defects	Recommended control strategies
Fan drive	<ul style="list-style-type: none"> Broken fanbelt where the motor functions but the fan does not, resulting in no air flow (see Figure 5.4-1) 	<ul style="list-style-type: none"> Repair fan drive belt
Fill	<ul style="list-style-type: none"> Blocked fill passages due to buildup of mud and debris which is difficult to clean under regular water pressure Collapsed fill that can affect thermal performance and block access for maintenance (see Figure 5.4-2) 	<ul style="list-style-type: none"> Clean fill, dismantle if necessary Repair or replace fill
Drift eliminator	<ul style="list-style-type: none"> Drift eliminator is in poor condition or does not conform with AS/NZS 4180 or AS/NZS 3666 Part 1 (see Section 5.4.3) Air is bypassing the drift eliminator 	<ul style="list-style-type: none"> Replace with a modern high performance drift eliminator Seal around the drift eliminator or replace
Construction materials	<ul style="list-style-type: none"> Inappropriate materials used (such as wood), which can deteriorate in warm and wet conditions, and provide porous surfaces that inhibit cleaning and provide anchor points for microorganisms 	<ul style="list-style-type: none"> Replace inappropriate materials with modern durable materials, such as ultraviolet-stabilised polypropylene Maintain more frequently the materials which cannot be replaced
Components prone to uncontrolled water losses	<ul style="list-style-type: none"> Splash out at air intakes Leaks from casing joints and fittings Wind causing splash out Overflows from tower basin 	<ul style="list-style-type: none"> Review air volumes and intakes Seal joints and fittings Shield from prevailing winds Correct make up water settings
Components that are prone to deterioration and need frequent replacement	<ul style="list-style-type: none"> Dosing tubes may harden over time and crack, leak and become ineffective Plastic foot valves (or check valves) at the end of each suction tube and within the chemical container can become clogged over time Plastic degradation 	<ul style="list-style-type: none"> Replace degraded dosing tubes Clean or replace valves Monitor, provide new surface coatings, or replace
Components prone to bacterial build up and need careful cleaning	<ul style="list-style-type: none"> Pump section strainers include a basket to collect debris which can promote bacterial growth or become clogged 	<ul style="list-style-type: none"> Install a drain valve and a drain line which allows debris to discharge to a floor drain at each monthly servicing Alternatively, clean the strainer and basket at least annually
Wet surfaces often exposed direct sunlight	<ul style="list-style-type: none"> Cooling tower basin Water distribution deck of some types of cooling towers 	<ul style="list-style-type: none"> Install drift eliminators and louvered air inlet screens to shade wet areas Cover water distribution deck, for example, by adding hoods over the air intake (see Figures 5.2-1 and 5.2-2)
Components prone to corrosion	<ul style="list-style-type: none"> Metal corrosion 	<ul style="list-style-type: none"> Monitor, provide new surface coatings, or replace

5.4.3 Aerosol generation and drift elimination

It is important to limit the amount of aerosol produced by a cooling tower as this reduces the chances of *Legionella* leaving the system and affecting nearby populations.

There are two types of aerosol discharges from a cooling tower: plume and drift. The plume is a cloud of air containing extremely fine water particles which are produced when the ambient air outside the system is of lower temperature than the water leaving the system. This causes moisture leaving the system to condense and form a plume which does not contain *Legionella* bacteria. The drift from a cooling tower refers to water particles or droplets which have not evaporated, and are carried in the air stream leaving the system. This drift can contain both water treatment chemicals and any microbial contamination that may be present in the circulating water. Thus, it is important to reduce drift as it can spread *Legionella* bacteria.

A drift eliminator should be used to minimise the amount of droplets (or drift) leaving a cooling tower. This device can be made of plastic or metal and is oriented in zig zag passageways to allow air to move through while trapping water droplets (see Figure 5.4-3). The shape of the drift eliminator causes a sudden change in the direction of the air flow, which catches water droplets before they leave the system.

Drift eliminators should be of proven performance (tested in accordance with AS/NZS 4180). The performance of drift eliminators has improved greatly in recent years, and these high-performance modules can be retrofitted to older systems. Modern drift eliminators are generally constructed of materials such as propylene. The drift eliminator must be fitted and installed in compliance with AS/NZS 3666 Part 1. When installing drift eliminators, care should be taken to ensure that air does not bypass the eliminators and thus defeat their purpose.

Drift eliminators should be maintained in good condition, and replaced if defective or non-compliant (see Figure 5.4-3). AS/NZS 3666 Part 1 establishes a performance standard for drift eliminators, requiring the drift loss of a cooling water system to be no more than 0.002% of the water circulating rate. However, there is no simple field test that can verify this performance requirement, so an assessment needs to be made of the drift eliminator's condition. For example, the supplier can be asked to confirm that the drift eliminator met the standard at the time of

installation. Where possible, the drift eliminator should be checked to ensure that it is still in good condition (not damaged) and has not become dislodged from its installation position.

Figure 5.4-3: Damaged drift eliminator sections with algal build up



5.5 Location and access to cooling towers

The following location and access issues can increase the risk of *Legionella* growth and transmission:

- Aerosol dispersion and public access to the cooling water system
- System location and environment (environmental contamination, and burden on water treatment chemicals)
- Lack of system access for inspection, maintenance and cleaning.

5.5.1 Aerosol dispersion and public access

Outbreaks of Legionnaires' disease occur when *Legionella* bacteria is aerosolised out of cooling towers and into the environment, leading to community exposure to the bacteria. It is important to consider the extent to which people may be exposed to aerosols when designing and installing a system, and when assessing the risks posed by a system. Drift eliminators are an essential component of the cooling water system, and should be well designed and maintained in order to minimise aerosol dispersion.

Consideration should be given to nearby fresh air intakes and building openings which may introduce aerosols into buildings. Prevailing winds can also influence the direction and distance of aerosol dispersion. The risk profile of a cooling water system increases when it is close proximity to occupied areas, pedestrian thoroughfares, gathering points,

and other heavily trafficked areas, which increase the number of people exposed to aerosol. Cooling towers should be located and installed such that they do not discharge directly into a pedestrian thoroughfare; these requirements are specified in section 4.3 of AS/NZS 3666 Part 1 and AS 1668 Part 2. Proximity of the cooling water system to populations that are highly susceptible to Legionnaires' disease (such as hospitals and aged care facilities) should also be considered in the risk assessment, and appropriate control strategies put in place. It is particularly important to ensure effective maintenance of these systems at all times.

The occupier should ensure that access to the tower and its surrounds is restricted to essential staff and contractors; this reduces the number of people potentially exposed to aerosols. Access to the tower can be restricted through security systems, locked entrances, and displaying clear signs to indicate "authorised access only" and inform people of any risks that may be present. Figure 5.5-1 shows a sign which is displayed when the cooling water system undergoes routine cleaning.

Figure 5.5-1: Signage provided at a cooling water system premises



5.5.2 System location and environment

A range of environmental contaminants can be introduced to cooling water systems from the air or the make up water which directly or indirectly increase the risk of *Legionella* growth. Section 5.3.4 provides guidance on monitoring the quality of make-up water, and Section 5.2.1 provides guidance on limiting the introduction of nutrients from airborne dust. Other cooling towers located nearby should also be considered as these may be sources of aerosols containing *Legionella* bacteria that can enter nearby systems.

The design, installation, risk assessment and water treatment program should be tailored to the risk of environmental contamination of the cooling water system being assessed, and the likely exposure of

vulnerable populations. More frequent cleaning is one control strategy that can be used to address environmental contamination resulting from soil and dust from demolition or construction sites, in order to reduce the level of solids in the system that can encourage bacterial growth.

5.5.3 System access for inspection, maintenance and cleaning

The Regulation requires safe and easy access to cooling water systems and their components during commissioning, installation, operation and maintenance. The plant, equipment and other components which require safe and easy access are outlined in Section 2 of AS/NZS 3666 Part 1. This includes compliance with the requirements of AS 1470, AS 1657, and AS/NZS 2865.

Safe and easy access to the cooling tower can be achieved through the use of ladders, ramps, platforms, and walkways. Walkways should be large enough to allow routine maintenance, major works, and removal and cleaning of components to be carried out. Figure 4.2-1 and Figure 5.2-2 provide examples of good practice with accessible ladders and safe walkways. Figure 5.5-2 provides an example of poor practice where there is no walkway or platform to allow removal of access panels for inspection and maintenance.

Figure 5.5-2: A cooling tower with no walkway or platform to allow removal of access panels for inspection and maintenance



DQPs should ensure that safety procedures are specified for the site in accordance with AS/NZS 3666 Part 3, the recommendations contained in these Guidelines, and the requirements of work health and safety legislation.

Section 6

Undertaking risk assessments

This section outlines the process of undertaking a risk assessment, and documenting it in a Risk Management Plan (RMP). A risk assessment involves the identification, assessment, and control of risk factors in cooling water systems. It is a cornerstone of Legionnaires' disease prevention, and the basis of managing cooling water systems in NSW.

An overview of the risk assessment approach is provided in Figure 6-1 opposite.

6.1 Roles and responsibilities for risk assessment

6.1.1 Occupier

The *Public Health Regulation 2012* (the Regulation) requires occupiers to ensure that:

- A competent person undertakes a risk assessment of the cooling water system every five years (or more frequently if required)
- A competent person documents the risk assessment in an RMP and prepares a certificate of RMP completion
- The certificate of RMP completion is provided to the local government authority within 7 days of completing the risk assessment.

6.1.2 Competent person

A competent person must complete the risk assessment, document it in an RMP and prepare a certificate of RMP completion to be provided to the occupier.

Competent person is defined in the Regulation in accordance with AS/NZS 3666 Part 1 as a person who has appropriate training or practical experience (or both) in the installation, operation or maintenance of cooling water systems, sufficient to provide safe and satisfactory performance of these systems.

The occupier may carry out this role, if they meet the definition of competent person. They may also engage a competent person, typically employed by a water treatment company, mechanical services company or other organisation, to undertake a risk assessment.

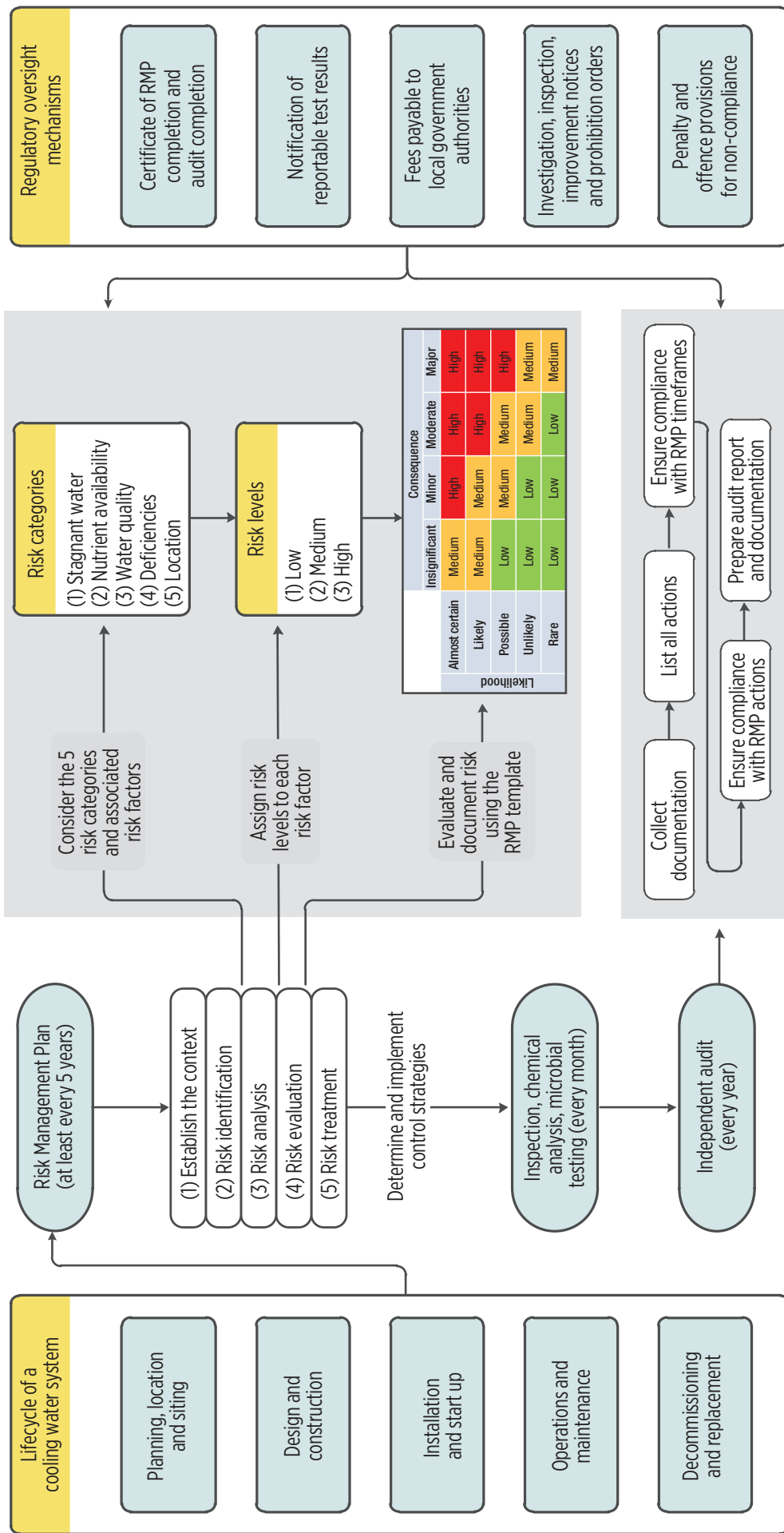
Appropriate training for undertaking a risk assessment can include (but is not limited to) a tertiary qualification in engineering, microbiology, chemistry, air conditioning and refrigeration; completion of the NSW Health course on *Legionella Control in Cooling Water Systems*; or completion of additional industry-based courses relevant to risk assessment of cooling water systems.

Appropriate experience for undertaking a risk assessment can include (but is not limited to) at least three years' experience in water treatment or heating, ventilation, and air conditioning (HVAC). This could describe the career of a person who has initially worked in a junior role as a water treatment technician (or duly qualified person), then progressed on to higher duties, and potentially worked under the supervision of a competent person to understand the risks and control strategies associated with cooling water systems.

The competence of the person undertaking the risk assessment is not formally assessed; instead, the **onus is on the competent person** to demonstrate their competence through appropriate training and experience; establishing an RMP which results in a highly functioning cooling water system; and the absence of repeated reportable test results. A new risk assessment can be undertaken if the existing risk assessment is considered no longer valid due to a change in risk, or if required by an authorised officer.

The Regulation allows a person **working under the supervision** of a competent person to undertake a risk assessment, provided that the competent person ultimately confirms the effectiveness and takes responsibility for the risk assessment and resulting RMP. For example, a water treatment technician may conduct a site inspection, collect the data required for the assessment of risk in a cooling water system, make recommendations, and complete the RMP. However, the competent person in their organisation must review the technician's work and sign off on the RMP.

Figure 6-1: Overview of the risk assessment process



6.1.3 Independent auditor

Occupiers must also engage an independent auditor to conduct an audit of compliance with the RMP every year, and prepare a certificate of audit completion. The occupier is responsible for ensuring that a certificate of audit completion is provided to the local government authority within 7 days.

6.1.4 Duly qualified person

The duly qualified person (DQP) manages the cooling water system on a routine basis and should ensure that the system is operated and maintained in accordance with the RMP. The DQP should notify the occupier and the competent person if they notice any change level of risk posed by the cooling water system. A new risk assessment and RMP may be required to reduce the likelihood of a Legionnaires' disease outbreak, and allow the system to operate at optimal capacity.

6.1.5 Local government authority

Local government authorities receive certificates of RMP completion from the occupier. The local government authority should record the due date of future RMPs in their register of cooling water systems and follow-up with the occupier if these items become overdue.

6.1.6 Authorised officer

The Regulation provides authorised officers with powers to require the occupier to provide the existing RMP, and to complete a new risk assessment and RMP. Authorised officers have a range of powers to inspect premises and enforce compliance with the Act and Regulation to protect the health of the local population.

6.2 Undertaking a risk assessment

The Regulation requires a risk assessment to be undertaken every five years (or more frequently if required), and documented in an RMP. The **Risk Management Plan (Approved Form 1)** has been developed by NSW Health to assist this process; the Regulation requires all risk assessments to be documented using this approved form. The approved form includes a **certificate of RMP completion**, which must be provided to the local government authority when the risk assessment is undertaken.

6.2.1 Frequency of risk assessment

A risk assessment must be completed before a newly installed system starts operating.

The Regulation requires a **new risk assessment** to be undertaken at least every five years (60 months). More frequent risk assessments are required if:

- The system was found to be high risk in the previous risk assessment. If so, risk assessments must be carried out every year. Section 6.3.3 explains how risk levels are determined
- The risk of the system has changed and the previous risk assessment is no longer valid. If so, a new risk assessment must be completed within 30 days of identifying the change in risk
- An authorised officer notifies the occupier to complete a new risk assessment. If so, a new risk assessment must be completed within 30 days of the notice being given.

The frequency of risk assessment for systems found to be low or medium risk can range from one and five years, as determined by the competent person and documented in the RMP.

A range of changes to the internal or external context of a system may indicate increased risk and the need for a new risk assessment. These include:

- Major construction on or near the premises, or other activity contributing to increased contamination of the cooling water system (for example, from high dust levels)
- A vulnerable population is identified to be in close proximity to the cooling water system (for example, if a new hospital, nursing home, or childcare centre is built close to the premises)
- A new facility is built adjacent to the premises, resulting in increased local population numbers and foot traffic in proximity to the cooling water system (for example, a tourist attraction, convention centre, or other venue where people may congregate)
- A significant change to the operating hours of the cooling water system
- An obvious degradation of equipment and components that occurs naturally over time or due to poor maintenance
- Consistently elevated microbial test results for counts of *Legionella* or heterotrophic colony count (HCC), necessitating preventative or corrective action.

An authorised officer may investigate, inspect, and require an occupier to complete a new risk assessment if:

- Reportable test results are repeatedly notified for the water cooling system, or
- The authorised officer considers that the existing risk assessment is not sufficient to protect public health.

6.2.2 Evidence to consider in the risk assessment

It is important to base the risk assessment on data gathered on- and off-site. A risk assessment should involve:

- Site visits to the cooling water system being assessed, including inspection of cooling towers
- Interviews with personnel involved in the operation or maintenance of the cooling water system
- Reviews of existing documentation, including monthly reports of inspection, maintenance (including servicing), chemical analysis and microbial testing; and operating and maintenance manuals
- Other activities that help determine the risk factors that are unique to the cooling water system being assessed.

6.2.3 Using the Risk Management Plan approved form

The RMP (Approved Form 1) should be completed by a competent person, with reference to Section 5 of these Guidelines and AS/NZS 3666 Part 3.

The competent person must complete the RMP; assign a risk level (low, medium or high) for each of the five risk categories; and specify control strategies to reduce the risk of *Legionella* growth and transmission from the cooling water system. Any additional observations from data gathered on and off site should be documented in the RMP.

The RMP must also attach the operating and maintenance manuals, which must be completed in accordance with section 2.6 of AS/NZS 3666 Part 2. These are important documents which outline the safe and effective use of all plant and equipment associated with the cooling water system. The Regulation requires these documents to be readily available (either kept on the premises and made available on request, or kept electronically and made available within 4 hours of request by an authorised officer).

6.3 Risk assessment methodology

Performing a risk assessment involves monitoring and identification of risk factors; determining control strategies for the identified risk factors; consistent recording and auditing; and supporting more effective decision making. It is a cornerstone of Legionnaires' disease prevention, and the basis of managing cooling water systems in NSW.

The purpose of the RMP is to apply and document best practices to effectively control the growth and transmission of microorganisms (such as *Legionella*) while considering the risks that are unique to the cooling water system being assessed. Australian/New Zealand Standard (AS/NZS) ISO 31000 sets out the principles and guidelines of risk management.

The risk assessment must comply with the requirements of the Regulation, and must be developed in accordance with AS/NZS 3666 Part 3. The installation and operation requirements in AS/NZS 3666 Part 1 and Part 2 continue to apply. However, the maintenance requirements in AS/NZS 3666 Part 2 are now superseded by Part 3. This standard outlines the risk assessment requirements, as well as the monthly chemical and microbial sampling program.

The risk assessment framework described by AS/NZS ISO 31000 consists of five main steps:

1. Establishing the context
2. Risk identification
3. Risk analysis
4. Risk evaluation
5. Risk treatment.

6.3.1 Establishing the context

The overall **objective** of the risk assessment and RMP is to identify and put in place control strategies to limit the growth and transmission of *Legionella* bacteria. This can be achieved by considering external and internal parameters, and by considering actions that can be taken to reduce the risks.

The **external context** for the management of risks in cooling water systems is largely set by the Regulation and its supporting structures, such as local government authorities and Public Health Units. For example, the requirement of monthly testing for *Legionella* is mandated by the Regulation; it is one of the external parameters with which the risk assessment must comply.

The competent person should also consider the technological, financial and environmental best practice available at the time of developing the risk assessment. For example, air cooled systems can be an effective alternative to cooling water systems, but occupiers who commission these systems should understand the cost of installation as well as the long term maintenance, noise implications, physical footprint of the plant, running costs, and energy consumption. The competent person can help occupiers to navigate these alternatives by understanding the external context.

The **internal context** refers to the operating practices of the DQP, water treatment companies, mechanical services companies, laboratories, and others who contribute to the routine management of the cooling water system. The competent person should consider the needs and capacity of these persons, the occupier, and the end users of the cooling water system when undertaking the risk assessment and specifying control strategies in the RMP.

6.3.2 Risk identification

Legionella bacteria are the main **hazard** that is controlled through the risk assessment process. Section 3 describes the characteristics of *Legionella* and the factors that promote its growth and transmission from cooling water systems. Although the RMP addresses this single hazard, there are multiple risks associated with its presence in cooling water systems.

The aim of this step of the risk assessment is to comprehensively identify these risks, in relation to the specific cooling water system for which the RMP is being developed. It is helpful to identify the risks within the five categories described in Table 2.1 in AS/NZS 3666 Part 3. Table 5-1 sets out these five risk categories and the associated risk factors which should be identified in this step of the risk assessment process.

The RMP includes a section for each risk category and the associated risk factors, in order to assist the competent person in completing the RMP.

6.3.3 Risk analysis

The risk analysis can be performed in a quantitative manner (using numerical data where available) or qualitative manner (using observations and expert judgement). An effective qualitative risk analysis for cooling water systems can be performed by assigning a low, medium or high **risk level** to the five risk categories outlined in the previous step. Table 6.3-1 describes the risk levels and explains their meaning.

The risk assessment should provide control strategies which reduce the risk posed by the cooling water system. However, a risk factor can move from “high” inherent (or initial) risk to “medium” or “low” residual (or remaining) risk. If the control strategy or mitigation measure is permanent, the risk no longer exists and can be marked as “low” inherent risk in future RMPs. If the control strategy is

Table 6.3-1: Risk levels and their meaning

Risk level	Explanation and actions required	RMP frequency
Low	This level indicates a low risk of <i>Legionella</i> transmission from this cooling water system. Continue to manage the cooling water system using the existing maintenance and monitoring procedures. Continue using the existing water treatment system.	Five years
Medium	This level indicates a medium risk of <i>Legionella</i> transmission from this cooling water system. This level suggests that the ability of the system to inherently discourage bacterial growths is reduced. Urgently review the effectiveness of the maintenance procedures and water treatment system. Review the results of monitoring (including monthly chemical analysis and microbial testing), deterioration of equipment, and safe access for maintenance. Determine the actions to be taken and allocate priority.	One to five years
High	This level indicates a high risk of <i>Legionella</i> transmission from this cooling water system. This level suggests that the system may be actively encouraging growth and transmission of microorganisms. Immediately review the effectiveness of the maintenance procedures and water treatment system. Correct any deficiencies and implement remedial actions. Consider whether the cooling water system is at the end of its useful life and whether it needs to be replaced.	Every year

temporary, ongoing, or incomplete, then it may only be possible to reduce a “high” inherent risk to a “medium” residual risk. If there is no control strategy to address a “high” residual risk, then the occupier should consider removing or replacing the water cooling system in the longer term.

The overall risk of *Legionella* growth and transmission from a cooling water system is calculated by considering the residual (or remaining) risk for each risk factor, and within each risk category, to determine the overall risk evaluation for the system. This overall residual risk determines how often a risk assessment of the cooling water system is required.

The competent person must assign the overall risk level for the cooling water system based on their judgement and technical understanding of the system; in some cases, one risk category with a “high” residual risk level may result in an overall “high” risk evaluation for the cooling water system. There is no simple formula to add the risk level for the five risk categories to arrive at an overall risk level for the system; the purpose of the risk assessment is to understand the risks that are unique to the particular cooling water system being assessed.

Another way to analyse the risk posed by any particular risk factor identified in the previous step is to consider the **consequence and likelihood** of these risk factors occurring in the cooling water system being assessed. Table 6.3-2 provides an easy to follow matrix which can be used when assigning a risk level to each risk factor. The competent person should clearly justify and document their decision making process for assigning the chosen risk level in the RMP.

6.3.4 Risk evaluation

The risk evaluation is the decision making process which allows the risk level allocated during the risk analysis step to be translated into actions in the following risk treatment step. Making an effective risk evaluation requires the competent person to have appropriate training or practical experience in the installation, operation and maintenance of cooling water systems. Section 5 provides further information to guide the competent person in evaluating the risk factors associated with *Legionella* growth and transmission.

6.3.5 Risk treatment

The risk treatment involves selecting one or more options to address (or “treat”) the risks identified, analysed and evaluated in the previous steps of the risk assessment. These options are also known as **control strategies**, and they should be documented in the RMP. Section 5 provides further information to guide the competent person in developing control strategies for their cooling water system.

Table 6.3-2: Consequence versus likelihood

		Consequence			
		Insignificant	Minor	Moderate	Major
Likelihood	Almost certain	Medium	High	High	High
	Likely	Medium	Medium	High	High
	Possible	Low	Medium	Medium	High
	Unlikely	Low	Low	Medium	Medium
	Rare	Low	Low	Low	Medium

Section 7

Conducting independent audits

This section describes the audit process, roles and responsibilities of the independent auditor, criteria for non-compliance with the Risk Management Plan (RMP) and the *Public Health Regulation 2012* (the Regulation), and response by local government authorities to non-compliance.

Independent auditing of the RMP every year is a requirement under the Regulation. It provides an important safeguard in the management of cooling water systems, and ensures that changes to the risk posed by the system are captured on a regular basis. The audit must be conducted by an independent auditor using the audit report (Approved Form 2).

7.1 Purpose of independent audit

The purpose of the audit is to ensure that the occupier and duly qualified person (DQP) manage the cooling water system in accordance with the Regulation, and that any actions, control strategies and monitoring required by the RMP are implemented within the required timeframe.

The scope of the audit is to assess the management of the cooling water system, but only in terms of compliance with the RMP and Regulation.

Independent auditors are required to:

- **Assess** compliance with the **actions, control strategies and monitoring** required by the RMP (including inspection, sampling, testing, maintenance and issue rectification)
- **Assess** compliance with the **timeframes** for the above actions, control strategies and monitoring required by the RMP
- **Not assess** compliance with any **optional recommendations**, suggestions, or advisory notes that do not affect microbial control or the risk assessment in the RMP (for example, an advisory note from the competent person stating that updated fan controls would save energy)
- **Not assess** the **effectiveness or accuracy of the risk assessment**.

7.2 Roles and responsibilities of the auditor

The Regulation requires the **occupier** of premises containing a cooling water system to engage, every year, an **independent auditor** to conduct an audit of compliance with the RMP and Regulation. The auditor should provide the certificate of audit completion to the occupier, who is responsible for ensuring that the certificate is provided to the local government authority within 7 days.

Occupiers are ultimately responsible for the cooling water system under the *Public Health Act 2010*; they may engage a **DQP** to install, operate or maintain a cooling water system on their behalf. Occupiers may also put in place contractual agreements allowing the independent auditor or the DQP to provide documentation directly to the local government authority.

The independent auditor must fulfil the following **criteria for approval to conduct audits** of cooling water systems:

- Must be on a list of persons approved by NSW Health
- Must successfully complete the NSW Health course on *Legionella Control in Cooling Water Systems* (including relevant units of competency)
- Must demonstrate appropriate qualifications and experience (assessed on an individual basis).

The auditor must apply to NSW Health for approval by completing the **application for approval to audit cooling water systems (Approved Form 5)**.

Appropriate qualifications to obtain approval as an independent auditor can include (but is not limited to) qualifications obtained through TAFE NSW, or to be licensed by NSW Fair Trading, such as Certificate III in Air-conditioning and Refrigeration (which requires completion of the TAFE NSW electrotechnology training package). **Appropriate experience** to obtain approval as an independent auditor in NSW can include (but is not limited to)

experience in conducting audits for another government agency or commercial organisation. For example, this can be demonstrated by having a role:

- As an approved auditor of a cooling tower system risk management plan under legislation managed by the Victorian Department of Health and Human Services
- Under the site auditor scheme administered by the NSW Environment Protection Authority (EPA)
- Under the Regulatory Food Safety Auditor System administered by the NSW Food Authority
- As a drinking water quality auditor on the Technical Services and Water Licensing Audit Panel administered by the NSW Independent Pricing and Regulatory Tribunal (IPART).

The **auditor must be independent** of:

- The occupier of the premises containing the cooling water system
- The person who undertook the risk assessment
- The DQP who installed the cooling water system
- The DQP who operates or maintains the cooling water system, or who has done so in the previous 5 years
- The person who operates a laboratory that carried out any monthly testing of the cooling water system in the previous 5 years.

The above persons cannot audit the cooling water system that they are involved in managing, and penalties for non-compliance apply. Independent auditors can be removed from the list of approved persons by NSW Health if they fail to act in an appropriate manner. This includes:

- Issuing a certificate of audit completion fraudulently or by concealing the facts
- Conducting audits incorrectly
- Failing to adhere to the independence requirements stated above
- Failing to comply with the requirements of the Regulation.

Independent auditors should maintain any necessary insurance, public liability, and professional indemnity cover in accordance with usual business practice. There is no requirement for the occupier to engage the same independent auditor on a recurring basis.

7.3 The audit process

7.3.1 Overview

The annual audit is a document-based review of compliance with the RMP and Regulation. It is not mandatory for the auditor to conduct an on-site inspection of the premises where the cooling water system is located.

In conducting an audit, the independent auditor should inspect all documents generated within the 12 month audit period, and obtain evidence that the occupier has complied with all actions and timelines required by the RMP and Regulation. The auditor may follow up and request further documentation from the occupier or DQP in order to complete the audit. Unique identification numbers should be used on all documentation relating to cooling water systems and cooling towers.

The independent auditor must document the audit using the audit report (Approved Form 2), and provide it to the occupier. The occupier (or the DQP they have engaged to manage the system) must then submit the certificate of audit completion to the local government authority within 7 days.

7.3.2 Documentation to be audited

The occupier must provide the independent auditor with documentation covering the 12 month period since the last audit. This information should be provided using the monthly report (Approved Form 3) which is prepared by the DQP. The following documents should be reviewed by the independent auditor:

- Current valid RMP for the cooling water system
- Monthly report covering the following items:
 - Inspection
 - Maintenance (including servicing)
 - Chemical analysis
 - Microbial testing (for *Legionella* count and heterotrophic colony count)
- Records of actions required to be completed by the RMP during this audit period (for example, removal of a dead leg or replacement of a drift eliminator)
- Records of actions taken to address non-compliance identified by previous audit (including photographs and receipts as evidence of compliance)
- Records of any notifications made to the local government authority (for example, notification of a reportable test result).

7.3.3 Frequency of audit

The Regulation requires audits to be conducted every 12 months. This is separate to the requirement for a new risk assessment to be undertaken every five years (or more frequently if required). Local government authorities and NSW Health may carry out inspections of cooling water systems at their discretion, as a separate process to annual auditing.

An audit must be conducted within two months after the end of the 12 month audit period. The audit period commences on the first day of the month following the month in which the risk assessment was undertaken. For example, if the RMP was completed on 15 January, the audit period would commence on 1 February and end on 31 January the following year. The audit for this period would need to be completed by 31 March, using the last 12 months of data and documentation to determine whether the system was compliant with the RMP and Regulation.

Figure 7.3-1 describes the frequency and timing of the audit in two scenarios. Scenario 1 describes the frequency of audit for a low risk cooling water system, for which a new RMP is prepared every five years and an audit is conducted every year. Note that the RMP for the second five year period is prepared at the start of the sixth year (in this case, January 2025), and the audit which is conducted in the sixth year actually assesses compliance with the final (fifth) year of the previous RMP. The first audit for any given RMP is conducted in the second year of that RMP period.

Scenario 2 describes a situation where an audit demonstrates significant non-compliance with the RMP or Regulation, and a new RMP has been required (for example, by an authorised officer). This may result in a lag period between a non-compliant audit notification to the local government authority and a new RMP being prepared (in this case, between February and April 2023). The next audit period commences in the month after the second RMP was prepared. Thus, the first audit for the second RMP period is conducted in May 2024 (as it would assess 12 months of data from the time the second RMP was prepared in April 2023) and not February 2024. This means that the system is not audited during the lag period between notification of the non-compliant audit and preparation of the new RMP (between February and April 2023). However, there is significant regulatory oversight provided by local government or Public Health Unit authorised officers during this time.

Small variations in the timing of the audit may arise. For example, although the first RMP in Scenario 1 expires in December 2024, the occupier may choose to undertake the second RMP one month earlier. In this case, if the RMP was completed in November 2024, the audit period would commence on 1 December 2024 instead of the expected commencement on 1 February 2025 (if the second RMP was undertaken in January 2025). This example results in an acceptable change to the audit period; however, it is not acceptable for the risk assessment to be undertaken later than its expiry date. That is, the second RMP should commence on the day after the first RMP expires. The audit period is always calculated based on the month when the risk assessment was undertaken.

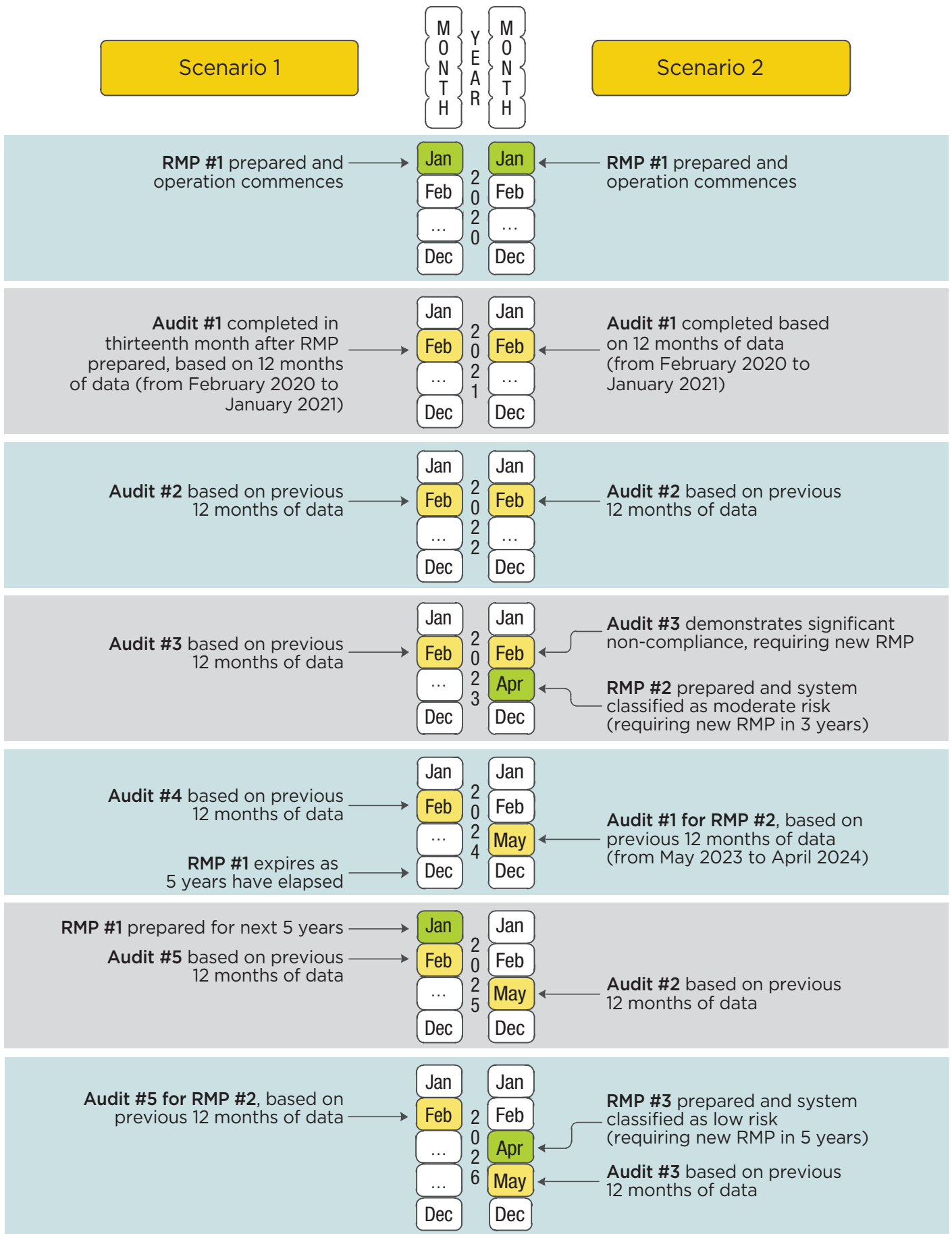
7.3.4 Time tolerance for completion of actions required by the RMP

There may be legitimate reasons for short delays in completing the actions required by the RMP (for example, long weekend periods, or equipment and vehicle breakdowns). Table 7.3-1 defines acceptable time tolerance periods which the independent auditor can use when assessing compliance of delayed actions against the RMP. The competent person should state the timeframe for actions in the RMP using these terms, to make the requirements clear to all stakeholders involved. Note that these time tolerances do not apply to actions required by the Regulation (such as monthly microbial testing), for which there are no acceptable delays.

Table 7.3-1: Acceptable time tolerance for completion of actions required by the RMP

Interval	Acceptable time tolerance
Six months	Delay of ≤ 1 month
Three months (quarterly)	Delay of ≤ 2 weeks
Two months	Delay of ≤ 10 days
One month (monthly)	Delay of ≤ 7 days
Two weeks (fortnightly)	Delay of ≤ 3 days (or the first working day following a long weekend)
Seven days (weekly)	Delay of ≤ 2 days (or the first working day following a long weekend)
One day (24 hours)	Delay of ≤ 1 day

Figure 7.3-1: Frequency of audit in two different scenarios



For example, if the RMP requires an action to be completed quarterly, the occupier has three months, plus two weeks into the following month, to complete that action. Similarly, a monthly action should be completed within the following month, plus 7 days. If an action is not completed within the acceptable delay period, it will be considered by the independent auditor to be non-compliant with the RMP.

When a cooling water system undergoes intermittent or seasonal use it is still necessary to comply with the requirements of the RMP, prepare monthly reports, and conduct annual auditing. A cooling water system that has been shut down is still considered to be in operation unless it has been decommissioned, and the local government authority has been notified.

7.3.5 Steps in the audit process

An annual audit should be conducted in the following steps, and documented using the audit report (Approved Form 2).

Step 1: Collect all documentation

Collect all required documentation from the occupier or DQP (see Section 7.3.2). The auditor is expected to request any missing documentation at this point. If an occupier is unable to provide the documentation, this may automatically lead to a non-compliance. Confirm that all relevant documentation including inspection reports, maintenance (including servicing) reports, chemical analysis, and microbial testing reports (monthly laboratory test results) have been completed.

The auditor is not required to contact the local government authority to confirm whether enforcement actions (through improvement notices and prohibition orders) have been completed. Instead, local government authorities can use the findings of the audit to prompt further internal checks of their register and completion of any pending enforcement actions.

Step 2: List all actions

List all the actions, control strategies and monitoring required by the RMP in order to assess whether they have been carried out. Table 7.3-2 provides some examples of actions that may be required by the RMP.

Table 7.3-2: Example of actions required by RMP

Actions required by RMP	Number of actions
Monthly inspections	12 actions
Monthly maintenance (including servicing)	12 actions
Two system cleans per year	2 actions
Monthly heterotrophic colony count testing	12 actions
Monthly <i>Legionella</i> testing	12 actions
Removal of two dead legs	2 actions
Upgrade of auto dosing equipment	1 action
Installation of a new drift eliminator	1 action
Use of alternate biocides each month	12 actions

Step 3: Assess compliance with RMP actions

The documentation should demonstrate that the cooling water system has complied completely with each action required by the RMP and Regulation. The required actions are indicated in The Risk Management Plan (Approved Form 1) and the audit report (Approved Form 2), and the Regulation.

Step 4: Assess compliance with RMP timeframes

Ensure that timeframes for actions specified in the RMP have been followed. If the RMP does not include a timeline for a particular action or repair, auditors should treat this action as if the work should have been completed within the 12 month audit period. Section 7.3.4 lists the acceptable time tolerance for undertaking actions required by the RMP.

Step 5: Determine compliance with the RMP and Regulation

Determine whether the cooling water system has been compliant with the RMP and Regulation during the 12 month audit period, based on findings from the previous steps. Provide an itemised summary of non-compliance demonstrated by the audit in the audit report (Approved Form 2). Outline the actions needed to achieve compliance where possible (for example, missing documentation). This is designed to assist authorised officers in local government authorities to follow up and address non-compliance.

Step 6: Prepare audit report and documentation

Complete the audit report (Approved Form 2) which documents the findings of the audit. Provide the certificate of audit completion to the occupier (depending on contractual agreements) and the relevant local government authority.

Step 7: Local government authority assessment and response

Local government authorities should use the results of the audit to prompt further follow up investigation, if necessary (see Section 7.6). The local government authority should also check the list of approved auditors published on the NSW Health website to ensure that each audit was completed by an approved auditor. Each approved auditor is issued with an identification number to be included on the certificate of audit completion.

7.4 Triggers for non-compliance

An independent auditor may state on a certificate of audit completion that the cooling water system has failed to comply with the RMP or Regulation within the 12 month audit period. The audit report (Approved Form 2) specifies the following triggers for an audit demonstrating non-compliance, which would prompt further follow up by an authorised officer from the local government authority. These triggers should only refer to the 12 month period that is being audited.

- Not completing actions, control strategies and monitoring required by the RMP
- Not completing actions, control strategies and monitoring required by the RMP, within the timeframe required by the RMP
- Not completing actions required by the Regulation:
 - Sampling and testing the cooling water system for *Legionella* count and heterotrophic colony count, every month
 - Notifying the local government authority of a reportable test result, within 24 hours of receiving the result (these dates are recorded on the approved forms)
 - Providing the local government authority with a certificate of RMP completion and certificate of audit completion, within 7 days after the RMP or audit was completed (these dates are recorded on the approved forms)
 - Preparing a monthly report of inspection, maintenance (including servicing), microbial testing, and chemical analysis, every month.

7.5 Reporting requirements

Local government authorities are encouraged to put in place arrangements to respond to late submissions of certificates of audit completion. This may involve off-site or desk-based follow up in the first instance, with an escalation process involving an on-site inspection of repeatedly non-compliant systems. This inspection may involve issuing an improvement notice or prohibition order where appropriate. The authorised officer may also refer a poorly performing auditor to NSW Health (Health Protection NSW) for further investigation.

The Regulation requires local government authorities to maintain a register of cooling water systems in their area. This register must include a record of notifications received, inspections carried out, and improvement notices or prohibition orders issued by the local government authority (see Section 8.4). This information should be shared with NSW Health (Public Health Units) when necessary to assist outbreak investigations. Similarly, NSW Health (Health Protection NSW) should inform local government authorities of updates relating to systems in their area (for example, an auditor being removed from the list of approved auditors).

7.6 Responding to an audit demonstrating non-compliance

The **independent auditor** is responsible for determining compliance with the RMP and Regulation, and should indicate on the audit report (Approved Form 2):

- Whether the audit demonstrated compliance with the RMP and Regulation, based on the triggers in Section 7.4
- An itemised summary of non-compliance demonstrated by this audit and the actions needed to achieve compliance
- The date when the next audit is required.

Local government authorities should develop processes to address an audit demonstrating non-compliance based on local relationships and needs, in order to fulfil their obligations under section 4 of the *Public Health Act 2010* (that is, to take appropriate measures to ensure compliance with regulation of cooling water systems). Local government authorities may respond to non-compliance by:

1. Contacting the occupier or DQP to follow up on the elements of non-compliance noted by the auditor
2. Determining whether the matter can be resolved by off-site follow up, or whether an on-site inspection is required
3. Using the authorised officer's powers to inspect and enforce compliance with the Act and Regulation (see Section 2.7 for a full list of the authorised officer's powers)
4. Updating the register of cooling water systems with the response to the audit demonstrating non-compliance, and remedial actions that need to be taken.

Some non-compliance may be effectively followed up with a telephone discussion or off-site review of documents that may be provided electronically by the occupier or DQP. Other non-compliance may require an authorised officer to use their powers to inspect and enforce compliance with the Act and Regulation. This includes the option for the authorised officer to issue an improvement notice requiring the RMP to be reviewed, and a new risk assessment to be prepared by a competent person.

If it is clear that the RMP no longer accurately reflects the circumstances of the cooling water system, and that the system poses a threat to public health, an authorised officer can require that the system undergo immediate improvements (by issuing an improvement notice) or cease operations (by issuing a prohibition order). Penalties for non-compliance apply, as specified in the Regulation and the Act.

Section 8

Administration of cooling water systems

This section outlines procedures and protocols to assist the routine management and administration of cooling water systems, including the format for unique identification numbers and the response to reportable test results.

8.1 Required documents and information

The *Public Health Regulation 2012* (the Regulation) requires certain documents and information relating to cooling water systems to be readily available for inspection by an authorised officer. An authorised officer should request records in writing. The required documents and information must be either:

- Kept on the premises in hard copy, and made available for inspection on request by an authorised officer
- Kept electronically, and made available for inspection within 4 hours of request by an authorised officer.

Required documents include:

- The current Risk Management Plan (RMP) and certificate of RMP completion
- Audit reports and certificates of audit completion for the past 5 years
- Monthly reports (documenting the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing) for the past 5 years
- The operating and maintenance manuals for the system
- All records of the maintenance and service of the system.

Required information includes the name and contact details of each duly qualified person (DQP) who installed, operated or maintained the cooling water system in the last 5 years, and the name and contact details of any competent person who has

provided services in relation to the cooling water system in the last 5 years. The required information may be contained within the required documents, and does not need to be recorded separately.

The requirements for **operating and maintenance manuals** are specified AS/NZS 3666 Part 2. Maintenance manuals should include:

- Physical details of the plant, equipment and systems and pre-treatment carried out
- Recommendations on maintenance including water treatment maintenance and management
- The manufacturer's recommendation for checking, calibrating and maintaining all probes and sensors
- Recommended cleaning, disinfection and emergency decontamination procedures
- Start-up, operating and shut-down procedures
- Particulars of the maintenance management program including plant servicing, cleaning schedules, and replacement periods for equipment items, such as chemical dosing lines.

The requirements for **maintenance records** are also specified AS/NZS 3666 Part 2. Up-to-date maintenance reports and service reports should be provided for all plant, equipment and systems that are the subject of AS/NZS 3666 Part 2.

Maintenance records should include:

- Date, item of plant, equipment or system and nature of service performed
- Results of periodic testing carried out
- Details of defects found and rectification procedure undertaken
- The name of the person and company performing the service.

8.2 Approved forms

The Regulation requires approved forms to be used for documenting and reporting on certain aspects of cooling water system management. The use of approved forms ensures consistent documentation across NSW, helps to reduce errors, and allows more streamlined regulatory oversight. The six approved forms are outlined in Table 8.2-1. While the occupier is ultimately responsible for ensuring that the approved forms are filled out correctly and within the required timeframe, this role may be delegated to other stakeholders. These stakeholders are outlined in the table below.

Table 8.2-1: Approved forms

	Approved form	Responsibility
1	Risk Management Plan and certificate of completion	Competent person
2	Audit report and certificate of completion	Independent auditor
3	Monthly report (documenting the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing)	Duly qualified person
4	Notification of reportable test results	Duly qualified person
5	Application for approval to audit cooling water systems	Independent auditor
6	Notification of installation or change in particulars	Duly qualified person

Stakeholders are encouraged to use the approved forms available in an interactive electronic format on the NSW Health website. These forms allow for additional information to be attached to the documents to suit the needs of different users. Stakeholders are able to incorporate the content of these approved forms into their own forms and record keeping process; however, if they choose to do so then all components of the approved forms issued by NSW Health must be included in order to comply with the Regulation.

Cooling water systems that undergo intermittent or seasonal use are still considered to be in operation unless they have been decommissioned, and the local government authority has been notified (see Section 5.1.2). The RMP (Approved Form 1) should specify procedures to enable operation on an intermittent or seasonal basis, and it remains necessary to conduct annual audits (Approved Form 2) including the time of **shut down** within the normal 12 month audit period. Monthly inspection,

maintenance (including servicing), chemical analysis, and microbial testing should be documented in a monthly report (Approved Form 3) when it is undertaken (for example, when water treatment is left in continuous operation, with cooling water circulated through the entire system at least once every 48 hours). When monthly activities are not required (for example, when the system is drained, cleaned, and kept in a dry condition), it should be noted on the monthly report (Approved Form 3), which should still be presented for audit.

The **monthly report (Approved Form 3)** should be completed by the DQP. This form allows the occupier to demonstrate compliance with the Regulation by documenting the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing. One monthly report is required for each calendar month. The different sections of this form may need to be completed by different persons or organisations, and sometimes more than one DQP.

For example, on-site inspections and water treatment may be provided by one DQP, while another may carry out microbial sampling and testing (for *Legionella* bacteria). The occupier is ultimately responsible for ensuring the approved form is completed every month, and that 12 monthly reports are provided to the auditor at the end of the 12 month audit period. Cooling water systems which operate for less than 12 months of the year (when they are completely shut down) can provide the auditor with the number of monthly reports equivalent to the number of months in operation. Some cooling water systems may undergo more than one microbial sampling or inspection per month; this can be indicated on the approved form by stating the dates of inspection or sampling carried out in that month, and attaching further documentation if required.

The monthly report form can also be used by the DQP to inform the occupier about changes in the local environment, when these are noted during the inspection. It may not be possible for the DQP to be aware of all changes that occur, and the DQP is not required to conduct a risk assessment every month. However, it is good practice to consider whether any local changes have taken place which may increase the risk of *Legionella* growth and transmission, as part of the monthly inspection. Examples include major earthworks, building demolition or construction, and relocation of air intakes or exhausts in the vicinity of the cooling water system. Section 5 provides further information on the changes which can be assessed and remediated.

8.3 Timeframes for notification and actions

Compliance with timeframes set in the Act and the Regulation is necessary for the effective administration of cooling water systems, and for reducing the risk of Legionnaires' disease outbreaks. Table 8.3-1 sets out these timeframes within which the occupier must provide notification to the local government authority or authorised officer, and complete certain actions.

Penalties for non-compliance apply, as specified in the Regulation and the Act. Occupiers may also have to comply with other approvals and timeframes required by the local government authority, such as development approvals (DA) during the installation or decommissioning process.

Table 8.3-1: Timeframes for notification and actions

Action relating to the cooling water system	Timeframe
Provision of required documents and information to an authorised officer	4 hours
Notification of reportable test results to local government authority (upon receiving notice from the laboratory)	24 hours
Notification of a change in particulars (for example, a change in the contact details of the occupier)	7 days
Notification of certification of RMP completion to local government authority (upon completion of the risk assessment)	7 days
Notification of certification of audit completion to local government authority (upon completion of the independent audit)	7 days
Displaying the unique identification numbers (upon receiving notice from the local government authority)	30 days
Undertaking a new risk assessment (after the latest risk assessment is found to be no longer valid)	30 days
Notification of installation of the cooling water system	1 month
Notification of change of occupier of an installed system	1 month

8.4 Register of cooling water systems

The Regulation requires local government authorities to maintain a register of cooling water systems in their area. The register must include the following information for each cooling water system:

- Details of the premises on which the cooling water system is installed, including address and telephone number
- Details of the occupier of the premises, including residential address, e-mail address and home, business and mobile telephone numbers, and Australian Business Number (ABN) or Australian Company Number (ACN)
- Type of regulated system
- Unique identification number for each cooling tower in the system
- Date that each certificate of RMP completion was provided
- Date that each certificate of audit completion was provided
- Date and results of each reportable test result that was notified to the local government authority
- Details of any inspections carried out by the local government authority.

Local government authorities should review their registers on a regular basis to ensure that information is as accurate as possible. The register is an important tool for effectively managing Legionnaires' disease outbreaks, and for following up and reducing of the risk posed by poorly managed cooling water systems.

8.5 Unique identification numbers

The Regulation requires unique identification numbers to be displayed on every cooling tower in NSW. The ability to readily and accurately identify cooling towers is critical during outbreaks of Legionnaires' disease. However, even during the routine management of cooling water systems, all stakeholders should refer to cooling towers by their unique identification number.

Unique identification numbers should be used whenever the cooling water system is being described on official documentation. This includes RMPs, audits, certificates, monthly reports, sample collection labels, laboratory test results, local government registers, and any documents that are required to be audited (see Section 7.3.2).

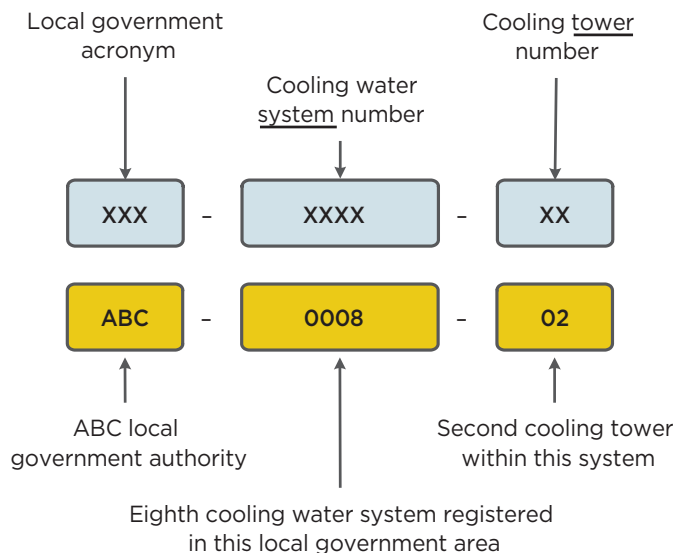
Unique identification numbers are issued by local government authorities when they are notified of a new installation by the occupier. A uniform and consistent approach to generating unique identification numbers is described below. It is strongly recommended that local government authorities across NSW adopt the following convention:

- Three letters indicating the local government area
- Four digits indicating the cooling water system number
- Two digits for the cooling tower number within that cooling water system.

Using three letter acronyms is a common standard across industries and disciplines, and three letters can be used to uniquely describe each local government area in NSW. Using four digits to describe cooling water systems allows up to 9,999 systems to be registered in each local government area across NSW. Using two digits to describe cooling towers allows up to 99 towers to be registered for each cooling water system.

Figure 8.5-1 describes the format of the unique identification numbers. A list of acronyms for each local government authority is provided on the NSW Health website.

Figure 8.5-1: Format of unique identification numbers



The Regulation requires a unique identification number to be displayed on a sign affixed to all cooling towers. The sign must be:

- Minimum size of 148 mm by 210 mm (A5 size)
- Clearly visible to a person examining or inspecting the cooling water system
- Made of a durable material.

The following tables explain how to interpret and apply unique identification numbers. When referring to the cooling water system in its entirety and not an individual cooling tower, the final two digits of the unique identification number should be “00”. This can be used to refer to deficiencies in common pipework, or when reporting on chemical and microbial results obtained from a sampling point shared between several cooling towers. The number ending in “00” can also be used to more accurately refer to a specific cooling water system when a premises contains multiple systems; this would allow authorised officers from a local government authority and a Public Health Unit to accurately refer to the correct system which they may be investigating together (for example, as part of an outbreak investigation).

Figure 8.5-2 provides a schematic representation a premises containing two cooling water systems.

Figure 8.5-2: Unique identification numbers for two cooling water systems on one premises

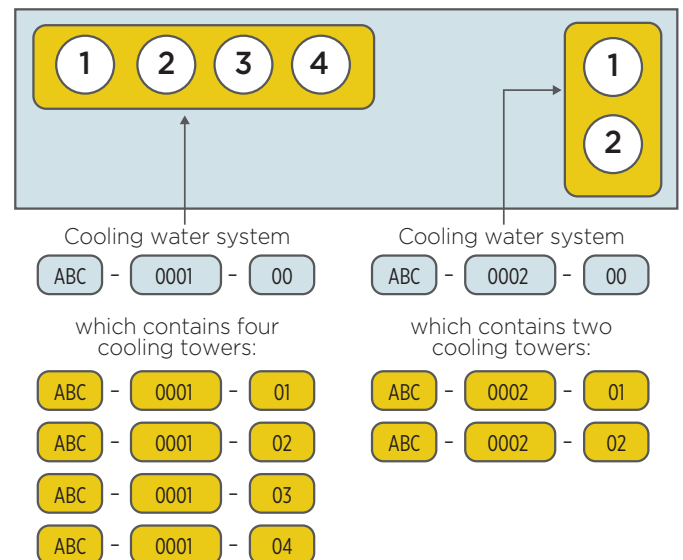


Table 8.5-1 provides the interpretation of unique identification numbers for a cooling water system containing four cooling towers.

Table 8.5-1: Interpretation of unique identification numbers, example 1

Unique identification no.	Interpretation
ABC - 0001 - 00	Cooling water system, located in ABC Council, registered as system number 1
ABC - 0001 - 01	The first cooling tower, located within cooling water system number 1, within ABC Council
ABC - 0001 - 02	The second cooling tower, located within cooling water system number 1, within ABC Council
ABC - 0001 - 03	The third cooling tower, located within cooling water system number 1, within ABC Council
ABC - 0001 - 04	The fourth cooling tower, located within cooling water system number 1, within ABC Council

Table 8.5-2 provides the interpretation of unique identification numbers for a second cooling water system containing two cooling towers, located on the same premises as the previous system.

Table 8.5-2: Interpretation of unique identification numbers, example 2

Unique identification no.	Interpretation
ABC - 0002 - 00	Cooling water system, located in ABC Council, registered as system number 2
ABC - 0002 - 01	The first cooling tower, located within cooling water system number 2, within ABC Council
ABC - 0002 - 02	The second cooling tower, located within cooling water system number 2, within ABC Council

When a cooling water system or cooling tower is **decommissioned**, the same unique identification number should not be reallocated to another system or tower, in order to avoid confusion in tracking numbers over time.

When a **new cooling water system** is installed on a premises with an existing system, a completely new, non-chronological number may need to be generated. For example, a premises containing an existing system “ABC - 0008 - 00” may have a second system installed which may be named

“ABC - 0135 - 00”. This number indicates that the new cooling water system was the 135th installation or notification in the ABC Council.

When a **new cooling tower** is added to an existing cooling water system, the new unique identification number can simply include the next chronological digit at the end of the unique identification number. For example, a cooling water system (“ABC - 0061 - 00”) with six existing cooling towers may have a seventh cooling tower added; this would be named “ABC - 0061 - 07”.

8.6 Reportable test results

The Regulation requires all cooling water systems to be sampled and tested monthly, at a minimum, to determine the *Legionella* count and heterotrophic colony count (HCC). Regular laboratory testing is a rigorous way to assess whether an RMP is effectively controlling the growth of microorganisms in the cooling water system.

Occupiers are responsible for ensuring that monthly testing takes place, and that the local government authority is notified if a **reportable test result** of *Legionella* count $\geq 1,000$ colony forming units per millilitre (cfu/mL) or HCC $\geq 5,000,000$ cfu/mL is obtained. Such high counts are associated with likely exposure of local populations to *Legionella*, and require urgent follow up.

Occupiers may also put in place contractual agreements allowing the DQP or laboratory to notify the local government authority of a reportable test result on their behalf.

8.6.1 Process of notification

Occupiers must notify the appropriate local government authority of a reportable test result within 24 hours of receiving the result. Penalties for non-compliance apply, as specified in the Regulation and the Act. The Regulation also includes penalties for any person who provides a false or misleading test result.

Laboratories can notify the occupier over the phone for presumptive results, but final results must be provided by completing the notification of reportable test results (Approved Form 4; see Section 8.6) and should contain the following:

- Details of the cooling water system, including unique identification number and site address
- Date and time of sample collection
- Date and time of testing

- Date and time of result receipt to the occupier
- Description of sampling point
- Test result
- Name and contact details of the occupier, laboratory, and DQP
- Confirmation of National Association of Testing Authorities (NATA) accreditation.

Local government authorities should develop effective processes for receiving reportable test results. One approach is to provide a publicly available telephone number and a regularly monitored email address, with local notification processes that are clearly outlined on the local government authority's website. This approach allows clear expectations to be set with stakeholders (such as occupiers and industry), and ensures that reportable test results (which are associated with likely exposure of local populations to *Legionella*) are not missed. In this way, local government authorities can meet their responsibilities under section 4 of the Act, and help to protect the health of their local population.

8.6.2 Responding to elevated microbial levels

The RMP should outline control strategies for managing any detection of *Legionella* count >10 cfu/mL or HCC >100,000 cfu/mL. These control strategies and actions should be in accordance with Tables 3.1 and 3.2 and Figures 3.1 and 3.2 of AS/NZS 3666 Part 3. As the risk management approach allows timely and dynamic management of elevated microbial levels, a much higher level has been set for reportable test results which must be notified to local government authorities.

Local government authorities can respond to reportable test results by:

1. Contacting the occupier or DQP to confirm that control strategies have been put in place
2. Reviewing the RMP for that cooling water system to ensure that control strategies are being put in place in accordance with AS/NZS 3666 Part 3
3. Contacting the occupier or DQP to follow up on the second and third tests which are required to demonstrate absence of microorganisms
4. Investigating the premises when poor practice is suspected, when there is a high risk of *Legionella* transmission, or when there is a history of repeated non-compliance with the Regulation

5. Using the authorised officer's powers to inspect and enforce compliance with the Act and Regulation (see Section 2.7 for a full list of the authorised officer's powers)
6. Charging fees for carrying out the above activities, according to local government authority processes
7. Updating the register of cooling water systems with the response to the reportable test result, and remedial actions that need to be taken.

Local government authorities should work closely with their local Public Health Unit, and may seek advice on responding to elevated *Legionella* count and HCC. It is important to develop local relationships between the two organisations, as Public Health Units will be aware of active human cases of Legionnaires' disease, while local government authorities will be aware of the management of cooling water systems in their shared area.

Section 9

Training

It is important for all stakeholders involved in the management of cooling water systems to have a proper understanding of the science relating to Legionnaires' disease outbreaks, cooling water system management, their roles and responsibilities, and requirements under the *Public Health Regulation 2012*.

NSW Health has developed a course on *Legionella Control in Cooling Water Systems* which provides an overview of these areas. Completion of this course is a requirement for approval to conduct audits of cooling water systems. Key stakeholders who would benefit from completing this training course include:

- Occupiers and building managers
- Water treatment, mechanical services, and industry technicians (duly qualified person)

- Competent person
- Independent auditors (must complete the training course in order to be approved to carry out this role)
- Authorised officers (environmental health officers in local government authorities and Public Health Units)
- Laboratory officers.

The training course is based on new and existing nationally-recognised units of competency, and is delivered over three modules. The delivery of training both online and face to face allows different levels of competency to be developed, as relevant to the person's role in managing cooling water systems.

Section 10

Additional resources

The Guidelines and other NSW Health publications on *Legionella* control can be found at: <http://www.health.nsw.gov.au/environment/legionellacontrol/>

The *NSW Health Legionnaires' disease control guideline for Public Health Units* provides information and protocols on the management of Legionnaires' disease outbreaks in NSW (<http://www.health.nsw.gov.au/Infectious/controlguideline/Pages/legion.aspx>).

Standards Australia convenes technical committees to develop internationally-aligned standards for various industries in Australia (<http://www.standards.org.au/Pages/default.aspx>).

- AS/NZS 3666.1:2011 Air-handling and water systems of buildings - Microbial control - Design, installation and commissioning
- AS/NZS 3666.2:2011 Air-handling and water systems of buildings - Microbial control - Operation and maintenance
- AS/NZS 3666.3:2011 Air-handling and water systems of buildings - Microbial control - Performance-based maintenance of cooling water systems
- AS/NZS 1336:2014 Eye and face protection - Guidelines
- AS/NZS 1337.1:2010/Amdt 1:2012 Personal eye protection - Eye and face protectors for occupational applications
- AS/NZS 1715:2009 Selection, use and maintenance of respiratory protective equipment
- AS/NZS 1716:2012 Respiratory protective devices
- AS/NZS 3500:2013 Plumbing and drainage Set
- AS/NZS 3896:2017 Waters - examination for *Legionella* spp. including *Legionella pneumophila*
- AS/NZS ISO 31000:2009 Risk assessment - Principles and guidelines
- AS 1668.2:2002 The use of ventilation and airconditioning in buildings - Ventilation design for indoor air contaminant control
- AS 1668.2:2012 The use of ventilation and airconditioning in buildings - Mechanical ventilation in buildings

- AS 2031-2012 Water quality - Sampling for microbiological analysis
- AS 4180:2008 Measurement of drift loss from cooling towers
- AS 4276.3.1:2007 Water microbiology - HCC methods - Pour plate method using yeast extract agar
- AS 5059:2006 Power station cooling tower water systems - Management of Legionnaires' disease health risk
- ISO 11731.2 Water quality - Detection and enumeration of *Legionella* - Direct membrane filtration method for waters with low bacterial counts

Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) provides further educational resources on the management of cooling water systems (http://www.airah.org.au/Web/Resources/Technical_Resources/DA_Manuals/AIRAH/Navigation/Publications/DA_Manuals/DA_Manuals.aspx).

- Design Application Manual DA 17: Cooling Towers, 2009
- Design Application Manual DA 18: Water Treatment, 1998
- Best Practice Guidelines: Water Conservation in Cooling Towers, 2009 (http://www.airah.org.au/Content_Files/BestPracticeGuides/BPG_Cooling_Towers.pdf)

Section 11

Glossary

This section defines terms associated with cooling water systems to assist stakeholders when reading and interpreting this document. This section should be read in conjunction with the *Public Health Act 2010*, the *Public Health Regulation 2012*, and the 2011 edition of the Australian/New Zealand Standard (AS/NZS) 3666 Parts 1, 2, 3 and 4.

Action plan	The section of the Risk Management Plan (RMP) that documents the control strategies that can be used to manage or treat the risks of <i>Legionella</i> growth and transmission.
Air-handling system	A system designed for the purpose of directing air in a positive and controlled manner to and from specific enclosures by means of air-handling plant, ducts, plenums, air-distribution devices and automatic controls.
Approved forms	Six forms required to be used by the Regulation in order to document certain aspects of managing a cooling water system. The use of approved forms helps to improve the consistency and accuracy of documentation across NSW. <ol style="list-style-type: none"> 1. Risk Management Plan and certificate of completion 2. Audit report and certificate of completion 3. Monthly report (documenting the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing) 4. Notification of reportable test results 5. Application for approval to audit cooling water systems 6. Notification of installation or change in particulars
Audit	An assessment of the compliance of a cooling water system with the actions and timeframes required by the RMP, and mandatory actions required by the Regulation. The audit must be conducted every year (based on 12 months of data and documentation), by an independent auditor.
Auditor	A person engaged by the occupier to conduct an annual audit of compliance of the cooling water system with the RMP and Regulation. The auditor must be approved by the NSW Health Secretary, have appropriate qualifications and experience, undergo specified training, and be independent of the occupier, competent person, duly qualified person, and laboratory.
Australian/New Zealand Standard (AS/NZS) 3666	Documents developed by a joint technical committee of Standards Australia and Standards New Zealand. The regulatory approach in NSW is based on the 2011 edition of the AS/NZS 3666 <i>Air Handling and Water Systems of Buildings</i> Parts 1, 2, 3, and 4.
Authorised officer	A person appointed by a local government authority or NSW Health to carry out regulatory oversight functions and ensure that occupiers, duly qualified persons, competent persons, and independent auditors comply with the Regulation. Typically, environmental health officers are appointed as authorised officers.
Automated dosing pump	A device that automatically discharges a measured amount of water treatment chemicals into the cooling water system. Use of this device minimises health and safety risks, and ensures that levels of water treatment chemicals are maintained at appropriate levels.
Biocide	A chemical or physical agent used to eliminate microorganisms (such as <i>Legionella</i> bacteria) in cooling water systems.
Biodispersant	A chemical used to break down biofilm, remove dead organisms and other settled solids, and enhance the effectiveness of biocides used in cooling water systems.

Biofilm	A physiologically coordinated community of microorganisms including bacteria, algae and protozoa that attaches to wetted surfaces in cooling water systems. Biofilm can protect the underlying microorganisms from water treatment chemicals, and therefore allow unchecked growth of <i>Legionella</i> bacteria.
Bleed off	The removal of water from a system to limit the concentration of total dissolved solids and suspended solids.
Certificate of audit completion	The last section of the audit report (Approved Form 2) which is completed by the independent auditor, and documents the outcome of the audit (that is, whether the cooling water system was compliant with the RMP and Regulation). The occupier must provide the certificate to the local government authority within 7 days.
Certificate of RMP completion	The last section of the Risk Management Plan (Approved Form 1) which is completed by the competent person, and documents the outcome of the risk assessment (that is, whether the system was deemed low, medium or high risk). The occupier must provide the certificate to the local government authority within 7 days.
Chemical analysis	Testing a water sample for conductivity, pH, and other criteria necessary for effective management of corrosion, scaling, fouling and microbial growth (for example, concentration of hardness, chloride, biocide, corrosion inhibitor, and dispersant). Chemical analysis must be carried out monthly in accordance with section 3.4 of AS/NZS 3666 Part 3, and documented using the monthly report (Approved Form 3).
Cleaning	A maintenance requirement for cooling water systems which results in equipment and plant that is free from visible sludge, foam, slime (including algae and fungi), rust, scale, dirt, dust and any deposit or accumulation of impurities, or any other foreign material. The minimum frequency for cleaning is determined by the competent person and documented in the RMP. AS/NZS 3666 Part 2 requires cleaning every six months; however, AS/NZS 3666 Part 3 allows cleaning to take place on a more or less frequent basis, as long as suitable offsets are put in place.
Commissioning	A systematic and progressive process of putting the components of a system into operation, calibrating instruments and controls, and then making adjustments and checks to ensure that the total system is providing satisfactory operation and performance.
Competent person	A person who undertakes a risk assessment of the cooling water system, and documents this in an RMP. The Regulation allows the occupier to carry out this role, if they meet the definition of competent person. They may also engage a competent person to undertake a risk assessment on their behalf. A competent person must have appropriate training or practical experience (or both) in the installation, operation or maintenance of cooling water systems, sufficient to provide safe and satisfactory performance of these systems.
Control strategies	Options that are developed to manage or treat the risks identified, analysed and evaluated in the risk assessment. The main risk for which control strategies should be developed is the <i>Legionella</i> growth and transmission. Control strategies should be documented in the RMP.
Cooling tower	A device for lowering the temperature of water or other liquid by evaporative cooling, or an evaporative condenser that incorporates a device containing a refrigerant or heat exchanger. One or more cooling towers can be connected with associated equipment and pipe work to form a cooling water system.
Cooling water	The water which circulates through the cooling water system, and transfers heat from the heat source into the atmosphere. Cooling water can provide optimal nutrients and temperature conditions to allow <i>Legionella</i> bacteria to grow. Cooling water is dosed with water treatment chemicals in order to eliminate microorganisms.
Cooling water system	A device for lowering the temperature of water or other liquid by evaporative cooling, or an evaporative condenser that incorporates a device containing a refrigerant or heat exchanger, together with its associated equipment and pipe work.

Counter-flow	A type of cooling tower where the air stream moves in the opposite direction to the water flow. That is, the air stream moves upwards through the downward water flow.
Cross-flow	A type of cooling tower where the air stream moves perpendicularly to the water flow. That is, the air stream moves horizontally across the downward water flow.
Cycles of concentration	The concentration of the cooling water divided by the concentration of the make up water. This concept is a useful indicator of the balance between excessive water losses and insufficient make up water being introduced into the system.
Dead leg	A section of the system that does not permit the circulation of water, and therefore prevents water treatment chemicals from reaching that part of the system. Dead legs prevent the circulation of both cooling water and water treatment chemicals in that part of the system; this results in stagnant water where microorganisms can be left undisturbed for long periods of time and multiply at a rapid rate. A subsequent disruption of the dead leg could seed the cooling water system with large numbers of microorganisms including <i>Legionella</i> bacteria.
Decommissioning	The removal of system components, water treatment chemicals and equipment, power supplies, and any hazardous waste. The local government authority must be notified of decommissioning within 7 days by completing the notification of installation or change in particulars (Approved Form 6).
Decontamination	<p>A procedure for reducing the amount of <i>Legionella</i> and other bacteria present in a cooling water system. Disinfection and decontamination procedures are important control strategies that should be included in all RMPs. There are three levels of response to high <i>Legionella</i> count or heterotrophic colony count (HCC):</p> <ul style="list-style-type: none"> • Online disinfection for <i>Legionella</i> count >10 colony forming units per millilitre (cfu/mL) or HCC >100,000 cfu/mL • Online decontamination for <i>Legionella</i> count \geq1,000 cfu/mL or HCC \geq5,000,000 cfu/mL • System decontamination for a further <i>Legionella</i> count \geq1,000 cfu/mL or HCC \geq5,000,000 cfu/mL. <p>The three levels of response use of different biodispersants and biocides. Online disinfection and online decontamination is undertaken while the system is in operation, while system decontamination requires the system to be temporarily shut down.</p>
Disinfection	A procedure for reducing the amount of <i>Legionella</i> and other bacteria present in a cooling water system. Online disinfection is the first of three levels of response to high <i>Legionella</i> count or HCC.
Drift	Water droplets that are carried in the air stream leaving a cooling water system. These droplets can contain both water treatment chemicals and microbial contamination that may be present in the water circulating in the system. Reducing drift is an important way to prevent the spread of <i>Legionella</i> bacteria.
Drift eliminator	A component of the cooling tower which traps water droplets before they leave through the air outlet. Drift eliminators are made of plastic or metal oriented in zig zag passageways to allow air to move through while trapping water droplets.
Duly qualified person (DQP)	A person who installs, operates, or maintains the cooling water system on a routine basis. This person is typically employed by a water treatment company, mechanical services company, or other industry organisation. The Regulation allows the occupier to carry out this role, if they meet the definition of DQP.
Fill	A component of the cooling tower that cools the circulating water. The fill is normally made of plastic and oriented in a complex honeycomb arrangement to encourage the cooling water to spread over a thin layer across a larger surface area as it falls through. This hot circulating water meets the cooling air stream and results in heat rejection. Also referred to as packing.
Forced draught	A type of cooling tower in which a fan is used at the air inlet to force the air through the tower.

Heterotrophic colony count (HCC)	The count of colonies of heterotrophic aerobic bacteria present in a water sample taken from a cooling water system. Also known as total bacterial count, heterotrophic plate count (HPC), total plate count (TPC), and standard plate count (SPC).
Holding time	The amount of time that the biocide is present in the cooling water system. Small systems with a high water turnover may have short holding times, meaning that the biocide does not have enough contact time in the water to eliminate microorganisms. Fast-acting biocides can be used as a control strategy in this case.
Improvement notice	The improvement notice requires the system to comply with a specified enforceable requirement within a period of 72 hours (or a longer period as specified in the notice). An authorised officer may serve an improvement notice to the occupier if the officer believes on reasonable grounds that the cooling water system does not comply with a prescribed installation, maintenance or operating requirement.
Induced draught	A type of cooling tower in which a fan is used at the air outlet to draw the air through the tower.
Inspection	A thorough check of the physical components of a cooling water system. Inspection must be carried out at least every month, or more frequently if required by the competent person.
Installation	Mounting plant, equipment and controls, securing in position, connecting up to components of a system for subsequent commissioning of the plant and the associated system. The local government authority must be notified of newly installed systems within one month by completing the notification of installation or change in particulars (Approved Form 6).
Key performance indicators (KPIs)	A risk factor that is testable, assessable and controllable for the performance, monitoring and verification of the system. Not all KPIs are important risk factors for <i>Legionella</i> growth and transmission; however, they are readily measurable and provide an overall assessment of the performance of the system.
<i>Legionella</i> bacteria	<i>Legionella</i> are gram negative bacilli which cause Legionnaires' disease'. Different species of <i>Legionella</i> bacteria occur naturally in aquatic environments (<i>Legionella pneumophila</i>) and in soil (<i>Legionella longbeachae</i>). <i>Legionella</i> species are further divided into serogroups, not all of which cause human disease. <i>Legionella pneumophila</i> serogroup 1 is a common cause of Legionnaires' disease associated with cooling water systems.
Legionellosis	The group of illnesses caused by <i>Legionella</i> bacteria.
Legionnaires' disease	A potentially fatal illness characterised by pneumonia and caused by infection with <i>Legionella</i> bacteria species, commonly <i>Legionella pneumophila</i> . The incubation period of the disease is from 2 to 10 days, and the attack rate is low. Symptoms include an abrupt onset of high fever, non-productive cough, chills, headache and muscle pain.
Legionnaires' disease outbreak	Two or more cases of Legionnaires' disease who report a common exposure. Also referred to as a cluster. Public Health Units may initiate an outbreak investigation, with assistance from the local government authority.
Local government authority (LGA)	The regulator of cooling water systems in their area together with NSW Health. LGAs (also known as local councils) have roles in maintaining a register of cooling water systems, issuing unique identification numbers, receiving notification of installation or a change in particulars of a cooling water system, receiving notification of reportable test results of <i>Legionella</i> count and HCC, receiving certificates of RMP completion and audit completion, and responding to audits demonstrating non-compliance.
Maintenance	The regular routine activity aimed at preserving the operational standard and cleanliness of equipment, which includes inspection, repair, replacement, preventive service and cleaning.
Make up water	The incoming water supply to the cooling water system which replaces water lost by evaporation, bleed, drift, splash-out, and leakage. Make up water is often taken from a potable water supply and should be metered. It "makes up" and forms the cooling water which is circulated throughout the system to achieve evaporative cooling.

Microbial testing	The testing of a water sample for <i>Legionella</i> count and HCC, which must be carried out by a laboratory accredited by the National Association of Testing Authorities (NATA). Microbial testing must be carried out at least monthly, documented using the monthly report (Approved Form 3), and is considered a reportable test result if <i>Legionella</i> count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL.
Monthly report	The monthly report documents the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing. The monthly report (Approved Form 3) must be completed by the duly qualified person to demonstrate compliance with activities required by the RMP and Regulation.
Must	Indicates that an action is mandatory and required by law.
NSW Health	The regulator of cooling water systems in NSW together with local government authorities. Two parts of NSW Health are responsible for developing the policy framework for the management of cooling water systems (Health Protection NSW), and outbreak investigation and surveillance (Public Health Units).
Occupier	The owner of a premises (e.g. building) on which a cooling water system is located; the person entitled to occupy the premises (e.g. leaseholder or tenant); or the owners corporation of premises under a strata scheme. The occupier is responsible for ensuring that their cooling water system is managed (installed, operated and maintained) in accordance with the Act and Regulation.
Operation	The use of a system from commissioning to decommissioning.
Performance based management	An approach to managing cooling water systems which requires the individual characteristics and unique risks of each cooling water system to be assessed and controlled. Also referred to as a risk management approach.
Prohibition order	<p>A prohibition order requires that the system must not be operated until the occupier has been given a clearance certificate by the authorised officer.</p> <p>An authorised officer may serve a prohibition order to the occupier if they believe on reasonable grounds that:</p> <ul style="list-style-type: none"> • The occupier has not complied with an improvement notice within the time required under the notice, and the prohibition order is necessary to prevent or mitigate a serious risk to public health, or • The system does not comply with a prescribed installation, maintenance or operating requirement and a prohibition order (rather than an improvement notice) is urgently necessary to prevent or mitigate a serious risk to public health.
Register of cooling water systems	<p>Local government authorities must maintain a register of cooling water systems in their area. The register must include details of the: premises on which the cooling water system is installed, occupier, unique identification number of each cooling tower, notification of certificate of RMP completion and audit completion, notification of reportable test results, and inspections carried out by the local government authority.</p> <p>The register is an important tool for effectively managing Legionnaires' disease outbreaks, and for following up and reducing of the risk posed by poorly managed cooling water systems.</p>
Required documents	<p>Documents which must be either kept on the premises and made available on request, or kept electronically and made available within 4 hours of request by an authorised officer. These documents include the:</p> <ul style="list-style-type: none"> • RMP and certificate of RMP completion • Audit report and certificates of audit completion, for the past five years • Monthly reports (documenting the results of monthly inspection, maintenance (including servicing), chemical analysis, and microbial testing) for the past 5 years • The operating and maintenance manuals for the system • All records of the maintenance and service of the system.

Required information	Information which must be provided (in either electronic or paper form) on request by an authorised officer within 4 hours of the request. This information includes the name and contact details of each DQP who installed, operated or maintained the cooling water system in the last 5 years, and the name and contact details of any competent person who has provided services in relation to the cooling water system in the last 5 years.
Reportable test results	The results of a laboratory test of a cooling water system that show a <i>Legionella</i> count $\geq 1,000$ cfu/mL or HCC $\geq 5,000,000$ cfu/mL. Reportable test results must be notified to the local government authority for that area.
Risk assessment	A process of assessing the risk of <i>Legionella</i> growth and transmission from a cooling water system, and identifying actions and control strategies to reduce the risk. The risk assessment must be undertaken by a competent person every five years (or more frequently if required), and documented in an RMP.
Risk factors	A variable or characteristic associated with an increased risk of <i>Legionella</i> growth and transmission from a cooling water system. These variables and characteristics are assessed by the competent person when undertaking a risk assessment. Actions and control strategies specified in the RMP are designed to address the risk factors.
Risk Management Plan (RMP)	The RMP documents the risk assessment, actions, and control strategies to reduce the risk of <i>Legionella</i> growth and transmission from a cooling water system. The RMP is a core safeguard in preventing Legionnaires' disease outbreaks, and must be documented using the Risk Management Plan (Approved Form 1).
Servicing	A thorough check of a cooling water system by a duly qualified person. It can include an inspection of physical components, repairs to physical components, chemical analysis, microbial testing and cleaning.
Should	Indicates that an action is recommended as best practice.
Shut down (including temporary, intermittent, and seasonal use)	<p>A process of suspending the use of a cooling water system using a defined shut down procedure. Cooling water systems can be shut down temporarily (for example, for cleaning or repair) or can undergo intermittent or seasonal use (operated only during some parts of the year).</p> <p>Cooling water systems that undergo intermittent or seasonal use are still considered to be in operation unless they have been decommissioned, and the local government authority has been notified. The RMP (Approved Form 1) should specify procedures to enable operation on an intermittent or seasonal basis.</p> <p>Cooling water systems that have been shut down can be managed in one of two ways:</p> <ul style="list-style-type: none"> • By being drained, cleaned, kept in a dry condition, with water treatment reinstated before start up • By leaving water treatment in continuous operation, with cooling water circulated through the entire system at least once every 48 hours.
Start up	A process of starting the use of a cooling water system using a defined start up procedure.
Sump	A component of the cooling tower located at the bottom of the basin where water drains out and dirt can collect. It is necessary to drain the system sumps periodically, ideally monthly if practical.
Suspended solids	Physical particles that are suspended in cooling water and increase corrosion rates when they settle on a surface within the cooling water system. Suspended solids also support microbial growth by reducing the effectiveness of the water treatment chemicals (as sediment may contain organic matter which depletes chemicals intended to treat <i>Legionella</i> bacteria), and by increasing the surface area in the cooling water system (which may lead to biofilm and microbial attachment).
The Act	The <i>Public Health Act 2010</i> which is primary legislation passed by Parliament to set out the legal principles in relation to the management of cooling water systems.

The Guidelines	The <i>NSW Guidelines for Legionella Control in Cooling Water Systems</i> which provide an interpretation of the Regulation, and further advice for managing cooling water systems in NSW.
The Regulation	The <i>Public Health Regulation 2012</i> which is subsidiary legislation created or amended by the Minister to dictate how the provisions of the Act are implemented.
Total dissolved solids	The total weight of dissolved solids in water, which would remain if all the water were evaporated.
Unique identification number	A number that must be displayed on all cooling towers in NSW and used on all documentation and test results relating to cooling towers and cooling water systems. The unique identification number is issued by the local government authority when they are notified of a new installation by the occupier. The ability to readily and accurately identify cooling towers is critical during Legionnaires' disease outbreaks, and also during the routine management of cooling water systems.
Water quality management	An important strategy for reducing the risk of <i>Legionella</i> growth and transmission from a cooling water system, which should include a water management program (which focuses on chemical analysis of the system, and sets out the performance criteria and operating control ranges) and a water treatment program (which focuses on microbial control).
Water treatment chemicals	Chemicals used in cooling water systems to control corrosion and scale formation ("chemical inhibitors"), break up biofilm ("biodispersants"), prevent microbial growth ("biocides"), and fouling.



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