Cooling Towers

Controlling the Critical Risk and Operational Programs

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1. STRATEGIES TO ADDRESS THE CRITICAL RISKS

There are numerous critical risks and associated strategies for managing these. Some relate to the improvement to the cooling tower system itself, others concern maintenance or operational aspects of the system.

The critical risks addressed include:

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

1.1 Stagnant Water Risk Control Strategies

1.1.1 Cooling Tower System Improvements

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

- Installation of a timer connected to a recirculating pump, set to operate at least once a day to circulate the biocide and other chemicals.

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

- Checking whether there are ‘dead legs’ and where they exist, removing or activating them.

  A visual examination for potential ‘dead legs’ is a vital part of the risk assessment. The entire pipe network needs to be followed and inspected to identify potential ‘dead legs’.

  On small simple systems, a visual inspection may be sufficient to identify potential ‘dead legs’.

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

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

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Once 'dead legs' have been identified, the associated risk will need to be controlled. This can be achieved by removal. The length of time taken to remove the pipe should be based on the overall risk assessment. Removing 'dead legs' can be a relatively straightforward task on small systems. On large complex systems, it may be appropriate to develop a program for the progressive removal of the pipes over a period of years, depending on the current performance of the tower system and the overall risk assessment.

In some cases, removal is not feasible and conversion of the pipe into active or live use may be an alternative. This process is called 'activation'. Activating a 'dead leg' may be achieved by:

- Installing a pipe connected to a pump, drawing water from the 'dead leg' and injecting it into another part of the system. This achieves circulation in the pipe and reduces sludge build up, allowing biocides to reach all parts of the system.
- Having a program to drain or flush the pipe at regular intervals, to remove the stagnant water.

Where 'dead legs' are located and cannot be removed or activated for a period of time:

- Pass this information on to the water treatment provider. It can then be considered in the development of an appropriate operational program.
- A higher level of maintenance and testing is used to compensate for the higher risk that the 'dead legs' represent.

1.2 Nutrient Growth Risk Control Strategies

1.2.1 Cooling Tower System Operation

Key strategies to minimise the risk of nutrient growth include:

- Identify sources of environmental contamination and attempt to reduce the amount.

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

- Use of a biodispersant.

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

- Control of corrosion.

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

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

- A more frequent cleaning program.

  The Regulations require cooling tower systems to be disinfected, cleaned and re-disinfected at least every six months. This needs to include the cleaning of all wetted surfaces in the system.

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1.2.2 Cooling Tower System Improvements

Key strategies to minimise the risk of nutrient growth include:

- Protecting the cooling tower basin from sunlight.

  The cooling tower basin (and the top deck of larger cooling towers) should be protected from sunlight. In many cooling towers the sides are open, allowing sunlight to reach the cooling tower basin and encouraging algae to form. The risk may be reduced by installing sides to the tower structure. The material used to protect the sides must be durable and easily cleaned. For example UV stabilised polypropylene or reinforced fiberglass.

- Reducing the water temperature of the system where possible.

  The temperature of the water in the system has a direct impact on the rate of bacterial growth. It may be possible, to lower the temperature, with little or no detriment to the operating efficiency of the overall cooling tower system.

1.3 Poor Water Quality Risk Control Strategies

1.3.1 Cooling Tower System Operation

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

- A comprehensive water treatment program.

  The Regulations require that the cooling tower system be continuously treated with:

  - One or more biocides to effectively control the growth of microorganisms, including Legionella
  - Chemicals or other agents to minimise scale formation, corrosion and fouling.
  - The water treatment program must involve the use of biodispersants, anti-corrosives and one or more biocides.

  The choice of biocides is important. They must be effective under local conditions in killing *Legionella* and other bacteria. Safety data sheets should be reviewed to ensure such evidence is available and what, if any, health and safety or environmental issues are associated with the product. Administer the biocide so as to maintain the recommended concentration at all times. This requires an accurate calculation of the total water volume and of the volume of the biocide required to reach the recommended concentration, taking into account water loss due to evaporation and bleed-off.

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

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

  - Oxidising
  - Non-oxidising.

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

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

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

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

- Regular monitoring of the chemical parameters as a measure of water quality.

Establishment and frequent monitoring of control measures is an important aspect of risk management. Once a control measure has been identified, a target range should be established beyond which corrective action is indicated.

Chemical parameters such as the concentration of biocides, pH, conductivity (to measure the build up of solids) and water temperature are good control measures. The table below describes the more commonly used parameters and the indicative ranges for each parameter. Note that they are only indicative ranges. More precise levels may be required for particular systems.

INDICATIVE WATER QUALITY TARGET RANGES	
Bacteria	
Legionella	Not detected (<10 CFU/mL)[1]
HCC	Less than 200,000 CFU/mL[2]
Solids	
Total dissolved solids	Less than 1000 ppm
Conductivity	Less than 1500 µS/cm
Suspended solids	Less than 150 ppm
Calcium hardness	Less than 180 ppm
pH	
pH (for bromine compounds)	7 – 9
pH (for chlorine based compounds)	7 – 8
Total alkalinity	80 – 300 ppm
Other additives	
Biodispersant	Follow the manufacturers' specifications
Corrosion inhibitor	Follow the manufacturers' specifications

Table 1: Indicative Water Quality Target Ranges

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

[1] The *Public Health and Wellbeing Regulations 2009* (Vic) prescribe a series of actions which must be taken following the detection of *Legionella* in a cooling tower system sample. See Section 4.4.2 *Adverse Test Results*.

[2] The *Public Health Regulations 2009* (Vic) prescribe a series of actions which must be taken where a cooling tower system sample is found to have a HCC of greater than 200,000 CFU/mL. See Section 4.4.2 *Adverse Test Results*.

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

- Testing frequently for Heterotrophic Colony Count Levels.

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

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

  Although there is no direct correlation between HCC levels and *Legionella* concentration a high HCC level (which is regarded as any count of greater than 200,000 CFU/mL) indicates that the system is moving out of control and may support *Legionella* growth, unless corrective action is taken.

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

  - Taken in containers as described in AS 2031.2 in terms of the selection of a suitable sampling container and preservation of the sample for later testing.
  - Collected as described in AS/NZS 3666.3. This involves the sample being stored at between 2 and 10°C prior to analysis. Analysis should be commenced within 24 hours of the sample being taken.
  - Analysed in accordance with the relevant method in AS 4276.3.1 using Plate Count Agar incubated at 37°C for 48 hours.

  The Regulations require monthly HCC testing. If the HCC level is above 200,000 CFU/mL, the Regulations require that specific actions must be undertaken. See Section 4.

  Testing should occur at least monthly, but the frequency should be proportionate to the risk posed by the system. See Section 3 Table 2 outlining recommended frequencies for testing HCC levels.

  As part of a risk assessment, it is important to look at past results for the testing of HCC. A graph can be charted to illustrate the levels over time, as compared to the action limit of 200,000 CFU/mL set in the Regulations.

- Testing for *Legionella*

  The Regulations requires action to be taken within 24 hours following detection of *Legionella* in any water sample taken from a cooling tower system. The method of laboratory testing for *Legionella* is such that an acceptable result is generally reported as 'less than 10 CFU/mL'.

  Testing for *Legionella* is:

  - Required by the Regulations, under certain circumstances described in Section 4.
  - Strongly recommended at a frequency based on the risk assessment for the system and the risks posed by the system. See Section 3 Table 2 outlining recommended frequencies for testing for *Legionella*.

  There can be delays after sampling before results become available and a potential for negative results. Therefore the absence of *Legionella* in an isolated test cannot be seen as proof that the system is operating well. In other words testing needs to be part of an overall testing program and compared to other results.

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Testing for *Legionella* requires samples to be:

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

For testing for *Legionella* the laboratory should:

- have National Association of Testing Authorities (NATA) accreditation; and
- use relevant Australian Standards in their testing processes.

Appropriate bleed-off rates suited to the system in use.

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

1.3.2 Cooling Tower System Improvements

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

- Installation of automated dosing devices.

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

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

There are several types of automated devices for chemical dosing:

- Timer controlled dosing pumps.
- Feedback controlled dosing using oxidation-reduction potential (ORP) probes.
- Feedback controlled dosing using direct measurement of chlorine and bromine concentrations.

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

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

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

In large installations where there are multiple cooling towers connected in series (cells), there may be a practice where some cells are shut down in rotation for lengthy periods of time. The automated dosing device may sometimes only be connected to one cell and it may be necessary to have multiple dosing points to cater for such situations.

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

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

- Selection of an appropriate point for chemical dosing.

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

Generally, unless there are clear reasons why the dosing happens at a different point, it is recommended that dosing of chemicals occur immediately or soon after the cooled water leaves the cooling tower. This means that a lower volume of chemicals would be lost due to splashing in the cooling tower.

- Provision of a dedicated water sampling point.

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

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

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

- Installation of side stream water filtration in dirty environments.

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

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1.4 Deficiencies in the Cooling Tower System Risk Control Strategies

1.4.1 Cooling Tower System Improvements

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

- A comprehensive review of the system design, to confirm that it complies with AS/NZ 3666 (series).

  This should be the first step in the RMP. It can be performed by contacting the original supplier or by full or partial comparison with AS/NZS 3666 (series).

- A comprehensive review of the current operation and performance of the system.

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

- Development of operating and maintenance manuals.

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

  - Physical details, including drawings, of the plant, equipment and systems.
  - Suppliers' recommendations on maintenance, including water treatment maintenance and management.
  - Recommended cleaning methods and dismantling instructions.
  - Start-up, operating and shut-down procedures.
  - Particulars of the maintenance management program.

  For older systems, much of this information may not be available, but some information may be collectable during the risk assessment process. It is critical to understand the basic design of the system, including the water flow. This may require discussion with maintenance or mechanical services contractors. Any information such as schematic or concept drawings should be included in an operational manual for these older systems. New systems should not be commissioned until such information is available. The recommended shut-down and start-up procedures in particular should be documented to minimise risks.

- Assessment of Useful System Life.

  Like all plant, cooling tower systems have a limited useful life. There is a point beyond which further maintenance is uneconomical and complete replacement of the tower should be considered. An assessment should be made of the useful life of the tower system and how well it is meeting business needs.

- Installation of an effective drift eliminator to AS/NZ 3666 (series).

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

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Where possible, check the drift eliminator is still in good condition and has not become dislodged from its installation position.

- Review and monitor tower safety.

  Tower safety (for example ladders, rails and platforms) is critical to those who work on the tower. The integrity and physical condition of all components must be reviewed and regularly monitored to prevent breakage or other failure.

- Using suitable materials for external components.

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

- Using suitable materials for internal components.

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

1.5 Location and Access Risk Control Strategies

1.5.1 Cooling Tower System Operation

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

- Restricting access to the tower and its surrounds to only those staff or contractors with a direct need to access the area.

  This is a way of reducing the number of people who may be exposed to aerosols and is best achieved in an operational sense through clarity about individual roles. Identifying those people who require access to the area and establishing a security system is one method of achieving this.

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

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

- More frequent cleaning for tower systems exposed to significant environmental contamination.

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

1.5.2 Cooling Tower System Improvements

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

- Display of warning signs to advise staff or contractors that the area has restricted access.

  All staff and contractors should be discouraged from gathering near the area. A sign should be placed advising of ‘Authorised Access Only.’

  Best practice is to clearly identify each cooling tower as a ‘Cooling Tower’.

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- Restricting access to the tower.

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

- Relocation of the tower to a more remote site or less contaminated environment (where possible).

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

- Ensuring there is a safe and stable area for maintenance workers to access the tower system.

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

- Installation of a side stream filter as discussed in 7.2.3.2

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

2. OPERATIONAL PROGRAMS

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

- Stagnant water
- Nutrient growth
- Poor water quality.

An operational program will include the following components:

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

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2.1 Training for Personnel

The operation and maintenance of a cooling tower is not a task that can be performed by personnel without appropriate skills and experience. People involved should have a skill level appropriate to the task they are required to perform. Skills can be obtained by practical instruction and/or formal training.

Competencies required to fulfill all of the necessary tasks described below would include:

- Health and safety.
- Handling of chemicals used in the process.
- Use of cleaning tools.
- Understanding of the components of a cooling tower system, including pumps.
- Use of water quality testing apparatus.
- Sample collection, storage and transport.

2.2 Inspection

Inspection means a simple monitoring of a small number of key components such as:

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

2.3 Service

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

- A check of the water quality, including parameters such as pH, conductivity, biocide levels etc.
- Refilling of chemical dosing tanks.
- Removal of empty tanks.
- A check of all dosing and control equipment including timers, pumps and tubing. This should involve a calibration check on the pumps and resetting, if necessary, against desired parameters.
- Inspection of the wetted components and general integrity of the system.
- Corrosion checks.

Action should be taken to remedy any problems immediately.

2.4 HCC Test

This test is described in Section 1.3.

2.5 Testing for *Legionella*

This test is described in Section 1.3.

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2.6 Cleaning

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

2.7 Performance Measures

Another critical element of operational program is the use of performance measures such as those listed in Section 1.3.1. In the case of the outsourcing of operational programs, these should ideally be clarified before the program is defined in a contract.

2.8 Record-Keeping

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

As a minimum the following records should be kept:

- Date of service or inspection
- Identification of cooling tower system
- Identification of particular towers
- Name of person and organisation conducting the inspection and service
- Type/make/model of cooling tower
- Water storage volumes for dosing calculations
- Details of the inspections (for example what was the purpose/scope
- Details of any actions such as:
  - chemicals were added and volumes
  - bleed-off rate was checked
  - towers were cleaned
  - the cooling tower water was tested for chemical levels and the results (pH)
  - the cooling tower water was tested for bacteria levels and the results (name of laboratory)

3. SELECTING AN APPROPRIATE OPERATIONAL PROGRAM

3.1 Operational Program

The completed risk assessment will be used to classify the risks posed by the cooling tower system and to develop an operational or maintenance program that is proportionate to those risks.

The Department of Health and Human Services has recommended a series of standard operational programs for reasonable maintenance practices of cooling tower systems.

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

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It is important to note that each of these operational programs meets the ongoing maintenance requirements of the Regulations.

RECOMMENDED OPERATIONAL PROGRAMS BASED ON RISK CLASSIFICATION			
Program A for Risk Category A	**Program B for Risk Category B**	**Program C for Risk Category C**	**Program D for Risk Category D**
Weekly inspection	Monthly inspection (two weeks after service)	Monthly inspection (two weeks after service)	Monthly service
Fortnightly service	Monthly service	Monthly service	Monthly service
A minimum of monthly HCC tests	Monthly HCC test	Monthly HCC test	Monthly HCC test
Six-monthly cleaning, more frequently where environmental contamination is a problem.			
Note the system must also be cleaned prior to initial start up following commissioning.			
Recommended *Legionella* Testing Frequency as a Performance Measure			
At least every month	Every month	Every two months	Every three months

Table 2: Recommended Operational Programs Based on Risk Classification

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

3.2 Maintenance Contractors

Carefully consider the qualifications and experience of companies before engaging them. Contract management and supervision is critical to the success of such an arrangement. Regular reports, feedback between the parties and performance monitoring are essential components of contract management.

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

Some key selection criteria include:

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

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The records listed in Section 2.8 provide a guide detailing what is required at each service. Many contractors have developed their own service reports and you should check that the details provided in their reports meet or exceed the details in Section 2.8.

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

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

4. Summary of Legal Requirements

4.1 Public Health and Wellbeing Act

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

- Register each cooling tower system with the Department of Health and Human Services
- Develop a risk management plan (RMP) for every cooling tower system on the site that considers critical risk factors:
    - **Stagnant water**, including the lack of water recirculation in a cooling tower system and the presence of dead-end pipe work and other fittings in a system.
    - **Nutrient growth**, including the presence of biofilm, algae and protozoa in a cooling tower system, water temperature within a range that will support rapid growth of microorganisms in a system and the exposure of the water of a system to direct sunlight.
    - **Poor water quality**, including the presence of solids, *Legionella* and high levels of microorganisms in a cooling tower system.
    - **Deficiencies in the cooling tower**, including deficiencies in the physical design, condition and maintenance of the system.
    - **Location of and public access to a cooling tower or cooling tower system**, including the potential for environmental contamination of the system and potential for exposure of people to the aerosols of the system.
- Have the RMP audited by a certified auditor annually
- Review the RMP at least once every year
- Keep records of all repair, maintenance and testing work that is carried out on the system for at least seven years after the records were created
- Ensure that the RMP and the records referred to earlier are kept either at the building in which the system is housed or at a building on the land where the system is located.

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- Advise the Department of Health and Human Services within 30 days of:
    - Change in the ownership of the land
    - Change in mailing address or contact details
    - Change in number of cooling towers in a cooling tower system
    - Addition or removal of a cooling tower to or from the system. o Removal or permanent decommissioning of the system.
    - Relocation of the system on the lot of land on which it stands.

4.2 Public Health and Wellbeing Regulations

4.2.1 Sampling and Maintenance

The *Public Health and Wellbeing Regulations* *(Vic)* ~~*2009* (Vic)~~ requires the person who owns, manages or controls a cooling tower system:

- To ensure that the water in the system is continuously treated with:
    - one or more biocides to effectively control the growth of microorganisms including *Legionella*;
    - chemical or other agents to minimise scale formation, corrosion and fouling;
    - a biodispersant;
- To ensure that:
    - A chlorine-compatible biodispersant is added to the recirculating water of the system; and
    - that the system is disinfected, cleaned and re-disinfected:
    - immediately prior to initial start up following commissioning or any shut down period of greater than one month
    - at least every six months.
- To ensure that the system is serviced at least once each month;
- To ensure that a water sample is taken from the cooling tower system at least once a month and sent to a laboratory for a Heterotrophic Colony Count (HCC);
- To ensure that a water sample is taken from the cooling tower system at least once every three months and sent to a laboratory for a *Legionella* Test;

4.2.2 Adverse Test Results

Standard HCC Sampling and Response

- Within 24 hours of receiving a report that a sample was found to have a HCC of greater than 200,000 CFU/mL, the water in the system must be manually dosed with additional quantities of biocide or with an alternative biocide. The water treatment program, tower operation and maintenance program must be reviewed and any faults corrected to prevent a re-occurrence of the faults. Between two and seven days after the manual dosing a second sample must be taken and tested for HCC.

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- Within 24 hours of receiving a report that the result of the re-sampling described above was an HCC greater than 200,000 CFU/mL, the cooling tower system must be disinfected, cleaned and re-disinfected. Between two and seven days after the disinfection process, a further sample must be taken and tested for HCC.
- If after taking the previous steps the HCC result is still above 200,000 CFU/mL, then the process in the second point must be repeated until the HCC result is less than 200,000 CFU/mL in two consecutive water samples taken approximately one week apart, or the cooling tower system is closed until the problem has been remedied.

***Legionella* Sampling and Response**

- Within 24 hours of receiving a report that *Legionella* has been detected in the water of the system, the system must be disinfected, and a review performed of the water treatment program, tower operation and maintenance program. Any faults must be corrected. Between two and seven days after the disinfection a second sample must be taken and tested for *Legionella*.
- Within 24 hours of receiving that advice that *Legionella* was detected in the second sample, the system must be disinfected, cleaned and re-disinfected. Between two and seven days later another sample must be taken and tested for *Legionella*.
- If, after following the previous steps *Legionella* is still present then the process in the above point must be repeated until no *Legionella* is detected in two consecutive water samples taken approximately one week apart or the cooling tower system is closed until the problem has been remedied.
- If, while following the procedure described in these Regulations *Legionella* is detected in three consecutive water samples taken from the same system, the responsible person must notify the Department of Health and Human Services of the detection immediately by telephone, followed by a written notification within three days of the third detection of the organism.
- Decontaminated in the event that the system is implicated as the source of infection in a case or an outbreak of *Legionnaires*' disease.

5. REFERENCES

Public Health and Wellbeing Act 2008 (Vic)

Public Health and Wellbeing Regulations ~~2009~~ 2019 (Vic)

AS/NZS 2031: Selection of containers and preservation of water samples for microbiological analysis

AS/NZS 3666 (Series): Air-handling and water systems of buildings

AS/NZS 3666.2: Air-handling and water systems of buildings - Microbial control - Operation and maintenance

AS/NZS 3666.3: Air-handling and water systems of buildings - Microbial control - Performance-based maintenance of cooling water systems

AS/NZS 4276.3.1: Water microbiology - Heterotrophic colony count methods - Pour plate method using yeast extract agar

AS/NZS 3896: Waters - Examination for *Legionella* spp. including *Legionella* pneumophila

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