BETTER BUILDINGS PARTNERSHIP

# COOLING TOWER GUIDELINES

July 2018

# contents

# about the better buildings partnership

The BBP is a collaboration of leading property owners, managers and influencers that work to improve the performance and sustainability of existing buildings in the City of Sydney and across Australia.

The Partnership affects broad market transformation on issues difficult to champion by individual companies acting alone. Our work has seen significant progress on issues as diverse as best practice leasing, cooling tower management, operational waste and green infrastructure.

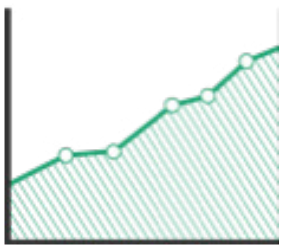
The BBP focuses its efforts on intractable and systemic industry issues and seeks to identify a high water mark of best practice capable of delivering a step-change in performance on a particular issue.

Whilst the exact delivery method is designed for each issue, projects are generally moved from identification to delivery using a series of maturation levels. This process is not always direct and linear, as different issues may require an iterative looping of key areas to achieve the long-term objectives.

## How the BBP works

### engaging industry and government

### scaling sustainability



### benchmarking progress

### transforming markets

## BBP delivery method

| | | |
|---|---|---|
| 1 | PROBLEM IDENTIFICATION | The Partnership defines the problem and the particular barriers to improved performance with a diverse cross-section of relevant stakeholders. |
| 2 | GAP ANALYSIS | The Partnership leverages its experience and current practices to collect and promote existing best practice and identify issues and missing links. |
| 3 | DEFINING BEST PRACTICE | The Partnership defines ideal industry best practice and where it currently exists, whether in its own practices, its supply chain, or others locally and globally. |
| 4 | ITERATIVE CO-CREATION | The Partnership works with its members and external stakeholders to co-create, fill the gaps and sense-check best practice guidelines and standards defined. |
| 5 | IMPLEMENTING BEST PRACTICE | The members of the Partnership pilot the best practice guidelines and standards in their own organisations, to embed best practice and identify minor modifications. |
| 6 | BENCHMARK PROGRESS | The Partnership creates systems for monitoring and benchmarking uptake of its best practice works in its membership and the industry. |
| 7 | TRANSITION TO STANDARD PRACTICE | The Partnership works with industry bodies, government and other appropriate organisations to embed its work into existing tools and systems for broader uptake and servicing. |

# executive summary

The Better Buildings Partnership (BBP) is committed to continuous improvement in the management of cooling tower systems with particular focus on water consumption and overall water efficiency. Drawing on extensive expertise in this area, the BBP has developed these guidelines to assist building owners and property managers in working towards a best practice process of managing water consumption within these systems.

This guideline document includes a number of water management tools and processes that can be used to effectively understand and better manage cooling tower systems. Using these tools will promote comparable data, clearly articulated accountabilities and transparent reporting processes.

The BBP hopes that by working together as an industry we can drive better standards, improve industry benchmarking and increase positive outcomes from cooling tower water management activities.

Robust cooling tower management programs require clear contracts and defined lines of responsibilities.

A number of model contract clauses have been developed to assist with this process. A range of related tools that collectively form a cooling tower water management plan are also described and documented in this guideline. The tools are available in Excel format so they can be used as a set or as enhancements to supplement your current water management systems.

This guideline does not assume that all buildings will operate in a similar manner. Instead, they are a framework. Each organisation will choose its priorities, level of service and reporting based upon internal needs and requirements. The guidelines simply seek to provide a common set of measures, a transparent method of comparing performance and a mechanism to iteratively improve performance over time.

# how to use this guide

The cooling tower water efficiency principles documented within this Guideline have been developed by the BBP to provide a standardised baseline of information that can be utilised by property managers, water efficiency teams, tenants and organisations to understand the concepts around cooling tower water efficiency. It outlines the main methods in which a cooling tower consumes water and outlines a number of options and/or recommendations to optimise or minimise the amount of water consumed with a cooling tower system.

It should be noted that this Guide should be used as a basis of information and is not necessarily a comprehensive guide to all matters relating to cooling tower water efficiency. If cooling tower water efficiency is unable to be optimised or water consumption minimised via the use of this Guideline then it is recommended that expert assistance be obtained from an outside technical source.

The Guideline has been divided into six sections to allow ease of use depending on individual and organisational requirements.

A brief explanation of the six sections is provided below:

**Section 1:** Introduction: Provides a brief conceptual overview of cooling tower water consumption.

**Section 2:** Water Balance: Provides an overview of the technical concepts encompassing a cooling tower water balance and a brief summary of relevant calculations.

**Section 3:** Cooling Tower Water Management Plan (CTWMP): Provides a set of evaluation tools that can be used to measure and evaluate cooling tower water consumption and efficiency.

**Section 4:** Contract Clauses: A set of standard contract clauses that can be inserted into the relevant internal management documents and relevant third-party contracts.

**Section 5:** Cooling Tower Rating Protocol: A BBP developed rating protocol tool that can be used to assess the current best practice program for cooling tower water efficiency at an individual site level or across a larger organisation.

**Section 6:** Definitions: A list of definitions relevant to cooling tower water consumption and efficiency.

# 10 steps to good practice

| | | |
|---|---|---|
| 1 | Specify your Corporate Outcomes | Define corporate policy statements that link water efficiency to the long term operating objective of the facility. |
| 2 | Allocate Roles and Responsibilities – Corporate Level | Define who has ultimate responsibility for driving the development and facilitation of cooling tower water management processes throughout the group (3a). |
| 3 | Develop a Cooling Tower Water Management Plan (CTWMP) | Develop the core document that details relevant cooling system information and fosters successful collaboration between all stakeholders to ensure targets are reached. |
| 4 | Allocate Roles and Responsibilities – Site Level | Define the roles and responsibilities from a site and contractor/subcontractor perspective to ensure a structured approach to improvement initiatives and fosters a collaborative approach between the stakeholders. |
| 5 | Undertake Water Balance and Efficiency Opportunities Evaluations | Based upon the information documented in the CTWMP, document current water consumption and estimate potential improvement opportunities that are worth investigating or implementing (5). |
| 6 | Evaluate Opportunity Cost | A detailed evaluation and analysis of the overall costs involved with implementing the opportunities evaluated. |
| 7 | Implement | Document and implement a formal action plan and project brief to ensure understanding and buy-in from all stakeholders. Where applicable, include the template clauses in the relevant cooling tower management documents and third-party contracts (4). |
| 8 | Measure and Verify | Document a process for formally evaluating the outcomes of the program. Development of defined success criteria against baseline data. |
| 9 | Monitor and Control | Undertake a routine and structured auditing process to monitor system performance and operation. Requires regular reporting of cooling tower water efficiency against set system benchmarks. |
| 10 | Update Cooling Tower Water Management Plan (CTWMP) | The CTWMP should be used as a living document with regular updating to ensure documentation of observations, improvement activities and outcomes. It should continually reflect the corporate objectives and any changes in industry standards. |

# 1. introduction

## 1a.The Scale of the Opportunity

Cooling tower systems are an integral part of many refrigeration and process cooling systems across all industries, in particular the commercial property industry. Cooling towers, and their associated system components, are commonly used to provide comfort cooling for large commercial buildings including office buildings, retail centres, airports, hospitals and hotels. Cooling towers are the point in the system where heat is dissipated to the atmosphere via the evaporative process and provide a vital function to the operation and performance of a property. Due to the inherent requirement to reject process heat via evaporation, cooling towers require significant quantities of fresh water to compensate for losses associated with evaporation, drift and blowdown (or bleed). Potentially up to half of a buildings water usage can be consumed in the cooling tower systems alone.

Sydney CBD commercial office buildings are estimated to consume in the order of 200 million litres of water per year – that's enough to fill up 80 Olympic swimming pools. Cooling towers are typically the most significant water consumer in a commercial office building, often consuming up to 50% of total building annual water use.[1]

The cost of reducing water consumption by focusing on cooling towers is low relative to other water saving opportunities (e.g. upgrading toilets, urinals, showers, taps or installing rainwater collection or water recycling equipment)

A foundation report by the BBP found that a commercial office building's cooling tower water use could be reduced by up to 9% by applying the best practice recommendations described in these guidelines.

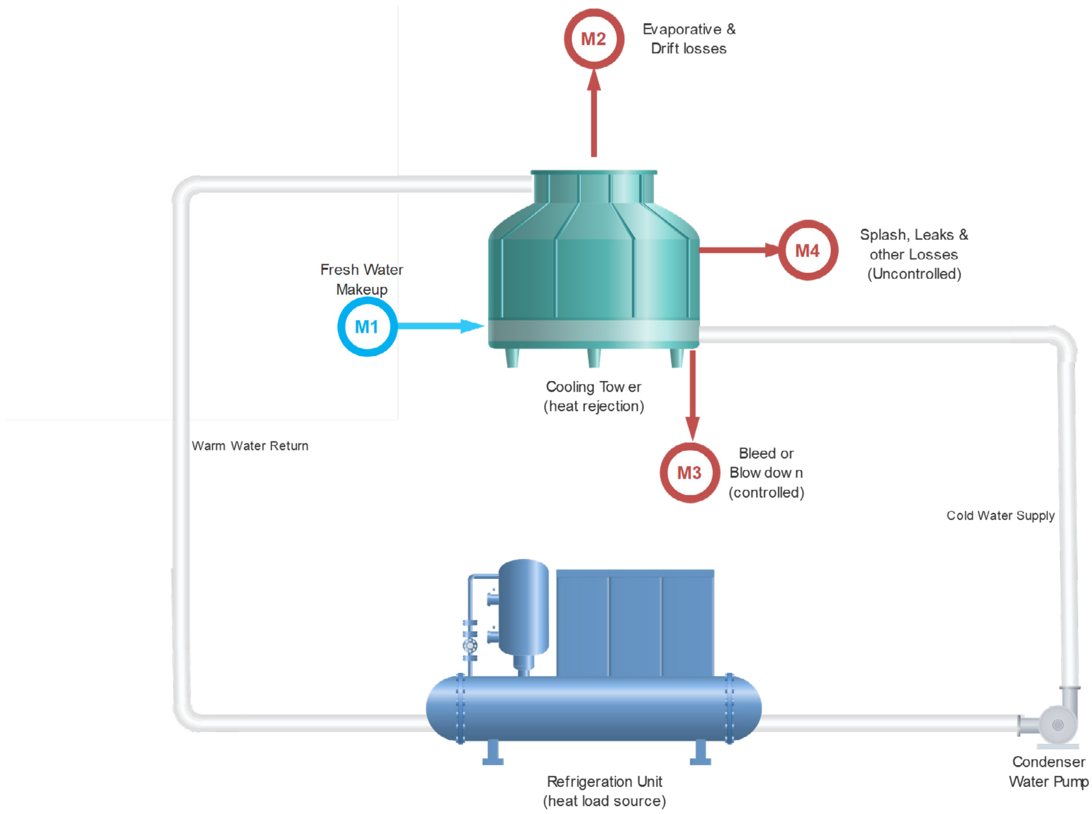
If we assume that the conditions observed in the foundation report visits are representative of all commercial building cooling towers in the city of Sydney, and we extrapolate the range of predicted savings (9%) associated with implementing the best practice initiatives recommended in this report to the entire city of Sydney, then city-wide water savings up to 4.5% may be possible. Cooling tower water savings could therefore make a significant contribution towards the City of Sydney's water reduction target of 10% by 2030 compared to 2006 baseline.

1 AIRAH, Best Practice Guidelines: Water conservation in cooling towers, Victoria State Government, 2009, p. 3.

# 2. water balance fundamentals

Within a conventional cooling tower system, water typically enters the cooling tower and is consumed in a number of areas. The diagram below provides a simplistic diagram of a cooling water system highlighting the water pathways or water balance details. Understanding where water is being consumed in a cooling tower system is one of many steps in implementing a best practice cooling tower water efficiency program.

**Drawing 1: Simplified Cooling Tower System Schematic**




The cooling tower water balance can be summarised in Equation 1 below:

| | |
|---|---|
| *Fresh Water Makeup* **(M1)** = *Evaporation and Drift* **(M2)** + *Bleed* **(M3)** + *Splash, Leaks and Losses* **(M4)** | *(1)* |

The following provides a basic overview of each of the main water balance areas:

### Fresh Water Makeup (M1)

Fresh water makeup is new water added to compensate for the volume of water lost through evaporation, drift, bleed and other losses. Fresh water makeup is generally direct from the properties potable water system but can also be supplemented from other sources such as rainwater tanks, bores or recycled water supply systems. The fresh water makeup supply volume is the total amount of water added to the cooling tower system.

### Evaporation and Drift Losses (M2)

***"Evaporation"*** is an integral part of the operation of a cooling tower system and is generally the largest water consumer in the system when operating correctly. In wet cooling towers, water has direct contact with ambient air and cooling is achieved mainly by the evaporation process in which some of the water leaves with the air. Evaporative loss is empirically estimated at 0.85% of the circulating water flow per 10ºF of cooling range. The following empirical equation is normally used to estimate cooling tower system evaporation rates[1]:

$$\text{Evaporation} = 0.00085 \times \frac{9}{5} \times M \times (T1 - T2) \qquad (2)$$

Where:

T1–T2 = Temperature differential between inlet and outlet condenser water

Cooling tower evaporation rates will vary depending on system operation, performance and ambient conditions. Therefore, understanding and evaluating system operation including water recirculation rates and temperatures will ensure the system operator has a better overall picture of the system and subsequent evaporation rates.

Reducing system heat load will generally have the most impact on cooling tower water evaporation rates. However, alterations to system operation and/or a system redesign can also impact on system heat load and overall evaporation rates.

Water, in the form of small droplets, is often lost in the airflow leaving the cooling towers, and is called ***"Drift"***. Depending on the design of the cooling tower drift eliminators, water losses through drift should be maintained below 0.002% of the maximum design water circulation rate through the tower as per AS/NZS 3666:2011. However, poorly installed and/or poorly performing drift eliminators may cause drift levels to be well above the recommended level. Drift levels can also be impacted by system operation including poor water to air flow (L/G) ratios. A well installed modern, high efficient drift eliminator, along with a hydraulically balanced system should ensure drift levels are maintained well below the recommended level of 0.002% of the water circulation rate.

### Splash, Leaks and Other Losses (M4)

Splash, leaks and other system water losses can have an impact on overall system water efficiency. Usually in a well operated and maintained cooling system, these uncontrolled water losses are generally insignificant. However, if leaks are substantial, the water balance in Equation 1 needs to include these uncontrolled losses. Uncontrolled water losses may result from mechanical leaks from condenser water pumps, system valves and pipework or even from the cooling tower structure (e.g. loss of water on system shutdown or cooling tower cleaning). A well maintained and operated system that is regularly inspected should result in a negligible level of uncontrolled water losses.

1 Perry's Chemical Engineers Handbook

### Bleed/Blowdown (M3)

Bleed is the portion of concentrated cooling tower water intentionally discharged from the cooling tower to maintain acceptable water quality conditions. Because water evaporated in the cooling tower consists of pure water, the concentration of salts or other impurities will increase in the recirculating water. Bleed, or blowdown, reduces the level of solids, both dissolved and suspended, in the cooling tower by removing a portion of concentrated solids. Bleed is a controlled water loss from the system and is generally automatically controlled via a conductivity controller on the water treatment monitoring and control equipment and subsequent bleed control valve. The water being bled from the system is directed to sewer for discharge from the property. The bleed rate from a cooling tower can be calculated as per equation 3 below.

$$\text{Bleed Rate} = \frac{\text{Evaporation Rate}}{\text{Cycles of Concentration} - 1} \qquad (3)$$

Where:

$$\text{Cycles of Concentration} = \frac{\text{cooling water conductivity}}{\text{makeup water conductivity}} \qquad (4)$$

**Note:** A simplified calculation of cycles of concentration is based on water electrical conductivity levels. Other more complex calculations are possible however electrical conductivity has been used for simplicity purposes. Electrical conductivity is typically measured by the water treatment service provider during routine service visits and is also typically displayed on the water treatment control equipment.

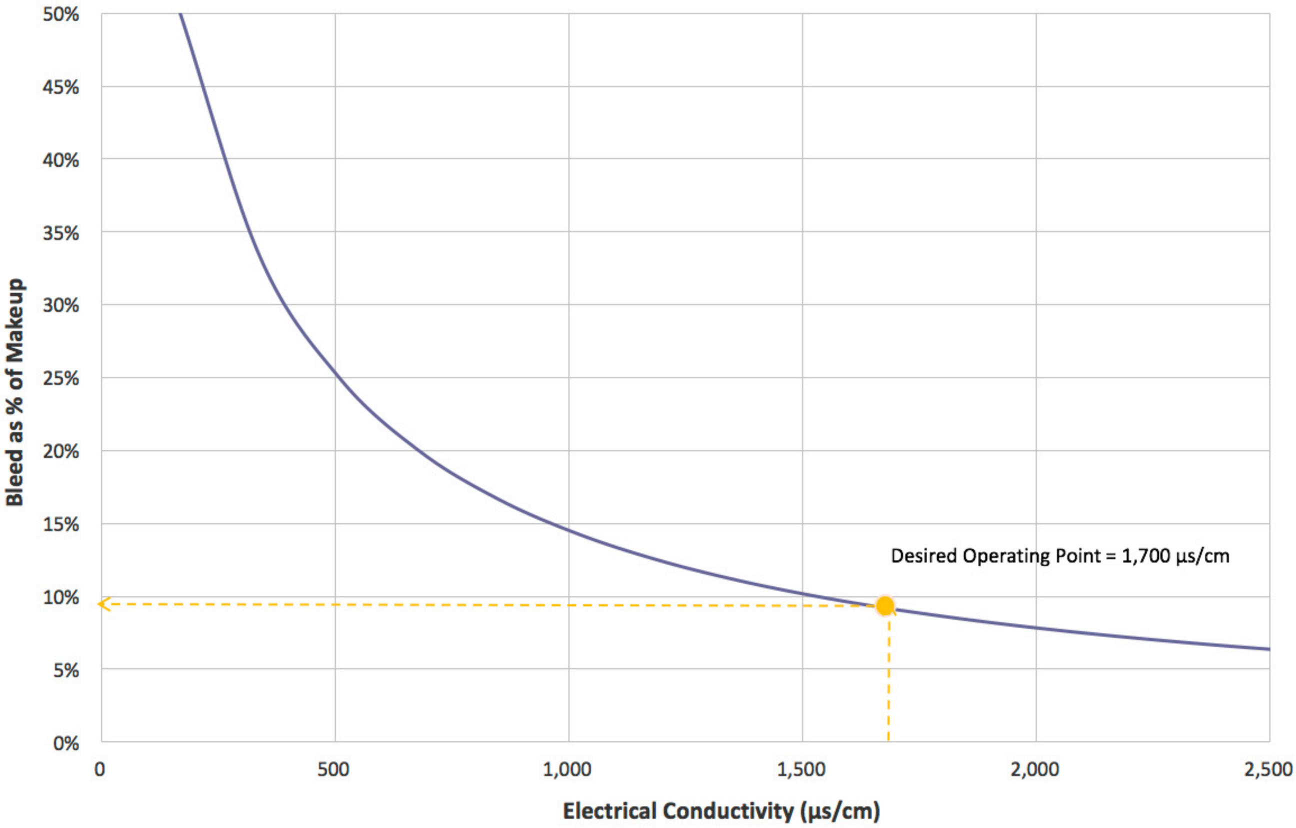
A cooling tower system's cycles of concentration, as measured by electrical conductivity, is considered the most practical method of understanding the overall water efficiency of the system at a basic level.

The selection of an appropriate level of cycles of concentration or electrical conductivity for a cooling tower system is a complex process that takes into account more than just water efficiency. The makeup water chemistry largely determines the maximum cycles of concentration possible as certain salts (i.e. magnesium and calcium) have limited solubility at high cycles of concentration. Exceeding solubility levels for these salts results in the formation of scale in high temperature areas such as chiller condenser tubes thereby reducing overall heat transfer and overall system performance. The desired cycles of concentration level is a balance between cooling tower water efficiency and control of scale, fouling and corrosion in the system.

Rather than nominate a desired cycles of concentration level, this guideline recommends that all BBP cooling tower systems be optimised at an electrical conductivity level of 1,700 µs/cm or its corresponding Total Dissolved Solids (TDS) level. This electrical conductivity level has been selected to ensure a high level of overall water efficiency without compromising water quality or overall system performance.

BBP Cooling Tower Electrical Conductivity Setpoint
= **1,700 µs/cm**

The chart below provides a graphical representation of the relationship between bleed, makeup and electrical conductivity for a typical cooling tower system. The chart shows that the system bleed rate – shown as a percentage of overall system makeup – is high at low electrical conductivity levels but flattens off as the electrical conductivity increases.




The chart also reveals that the desired operating electrical conductivity of 1,700 µs/cm is located at a very efficient point on the operating curve ensuring the bleed rate as a percentage of overall makeup is optimised.

Increasing electrical conductivity above 1,700µs/cm will yield only small incremental reductions in overall bleed rates and ultimately cooling tower water consumption. However, water quality control can become an issue if electrical conductivity levels above 1,700 µs/cm are maintained for periods of time. A low electrical conductivity will result in a steep increase in bleed volumes, a reduced level of system water efficiency and an increase in consumption of water treatment chemicals.

Operating a cooling tower system at an electrical conductivity level of 1,700 µs/cm, or its corresponding total dissolved solids level, will result in system bleed rates be optimised at approximately 10% of the overall system water makeup. The remaining 90% of the makeup water to the system will be lost due to evaporation, excluding any other losses.

It is very important to ensure a cooling tower system operates near the recommended electrical conductivity set point. At lower electrical conductivity, the difference in water usage varies much more dramatically than at higher electrical conductivity levels.

The implementation of adequate water treatment controls in combination with an understanding of the optimum achievable electrical conductivity based upon actual makeup water quality should result in maximisation of the electrical conductivity of any given cooling tower system.

The optimum electrical conductivity for any cooling tower system is dependent upon makeup water quality. Historical makeup water quality within the Sydney Water and BBP operating area was found to have low variability indicating a benchmark electrical conductivity level of 1,700 µs/cm is both practical and achievable whilst minimizing any negative impacts on overall system performance.

Important Note:
The electrical conductivity level of 1,700 µs/cm has been selected based upon water analyses of typical Sydney CBD potable water. If alternate sources or recycled water is used in the cooling tower system then additional advice should be sought from an experienced water treatment expert to recommend an alternate electrical conductivity or cycles of concentration level. It should also be clearly stated operating at this conductivity setpoint will not guarantee that the system is adequately protected from scale, corrosion or fouling issues. The type, control and performance of the water treatment program will have a vital impact on the overall performance of the system and must be well controlled. Operation at this level will allow for optimum discharge factor ratio calculation for charges associated with wastewater disposal from the property.

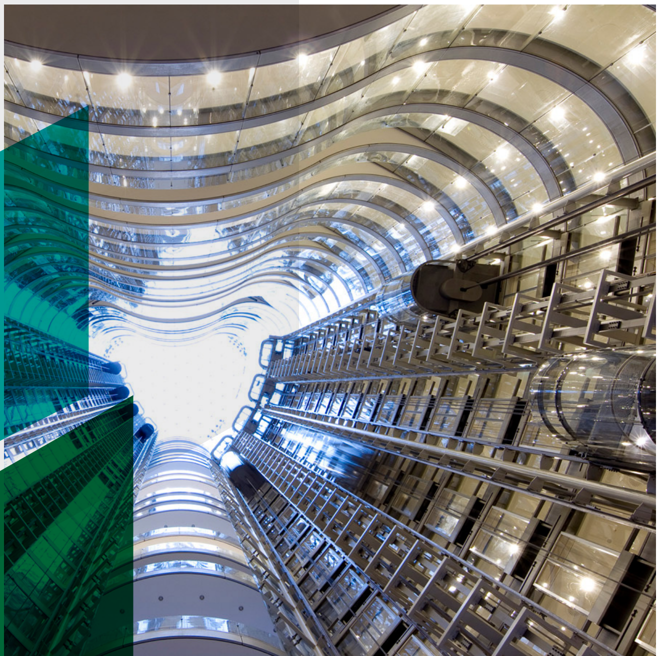
# 3. cooling tower water management plan (CTWMP) template

The Cooling Tower Water Management Plan (CTWMP) template will assist you to document and detail all information regarding the cooling tower systems at your property and provide a basis for evaluating and implementing cooling water saving opportunities.

The CTWMP is to be compiled in conjunction with all relevant stakeholders including, but not limited to, the sustainability manager, technical managers, property managers, mechanical services contractor and water treatment contractor.

Frequency of reporting and updating details of the CTWMP should be undertaken at a frequency that best suits the organisation and corresponds with other internal processes.

The Cooling Tower Water Management Plan (CTWMP) has been split up into 6 sections to to allow ease of use depending on individual and organisational requirements.



A brief explanation of the six sections is provided below:

- **Section 3a: Property and Contractor Details:** Provides a summary of property, key contractors and water management plan team members;
- **Section 3b: Water Charge Details:** Provides an overview of water charge rates applicable to the property and the cooling tower system;
- **Section 3c: Cooling Tower System Technical Information:** Provides a tabulated summary of the technical aspects of the cooling tower system;
- **Section 3d: Cooling Tower System Water Consumption Tracking:** Provides a tabulated summary of worksheet for monitoring property and cooling tower water consumption;
- **Section 3e: Cooling Tower Water Consumption Evaluation:** Provides a template for monthly monitoring of cooling tower water consumption compared with desired consumption based upon a cycles of concentration evaluation process;
- **Section 3f: Cooling Tower Water Audit Checklist:** A tabulated checklist that can be used to undertake a formal cooling tower water audit process;
- **Section 3g: Cooling Tower 'Water Efficiency Ratio' – Advanced:** An advanced cooling tower water efficiency process based upon monthly correlations of water consumption versus actual cooling tower system heat load characteristics.

### 3a. Property and Contractor Details

A summary of the property as well as key stakeholders involved with the management, operation and maintenance of the cooling tower system should be documented for internal purposes and to ensure transparency across the organisation. Understanding the roles and responsibilities of each stakeholder is a key component of a successful water efficiency program.

The following table is a summary of the property and the water management team members involved with this process.

**Site and Contractor Details:**

| | |
|---|---|
| Date CTWMP completed: | Jun-17 |
| Next Review date: | Jun-18 |

| **Site Details** | | |
|---|---|---|
| Site Address | 111 Sydney Street, Sydney | |
| Site Contact | Name | A. Smith |
| | Telephone | 02 9999 9999 |
| | Email | a.smith@abc.com.au |
| | Position | Sustainability Manager |

| **Contractor Details** | | |
|---|---|---|
| Mechanical Services Contractor | Company name | XYZ Pty Ltd |
| | Contact | M.Smith |
| Water Treatment Contractor | Company name | FGH Pty Ltd |
| | Contact | J.Smith |

**Property Information:**

| | |
|---|---|
| Property Net Lettable Area (NLA) or/ | 25,000 |
| Property Gross Lettable Area (GLA) | |
| Operating Days per Week | 5 |
| Operating Hours per Day | 10 |

**Cooling Tower Water Management Plan Team Members:**

(it is recommended that a range of stakeholders are included in this process)

| Name | Company/Department | Role |
|---|---|---|
| B. Smith | ABC Pty Ltd | Sustainability Manager |
| C.Smith | XYZ Pty Ltd | Contract Manager |
| J.Smith | FGH Pty Ltd | Contract Manager |

### 3b. Water Charge Details

Documenting and understanding water and wastewater charge details is a very important step in a comprehensive cooling tower water management plan. The costs of operating a cooling tower system from a potable water perspective can be significant and understanding the impact that water conservation initiatives have on overall property costs should be understood and documented.

Table below provides a simplified summary of cooling tower potable consumption and costs based upon site based information as well as Sydney Water charge structures.

**Cooling Tower Water Charge Details:**

| Charge Type | Previous 12 months |
|---|---|
| Total Property Water Consumption (kL) | 15,000 |
| Total Cooling Tower Water Consumption (kL) | 5,000 |
| Cooling Tower Water Consumption – % of Total (%) | 33% |
| | |
| Water Usage Charge Rate ($/kL) | 2.2 |
| Wastewater Usage Charge Rate ($/kL) | 1.1 |
| Sewer Usage Discharge Factor (%) | 90% |
| Total Water Charge Rate ($/kL) | $3.19 |
| | |
| Cooling Tower Water Charge Cost ($/yr) | $11,000 |
| Cooling Tower Wastewater Charge Cost ($/yr) | $4,950 |
| | |
| **Total Cooling Tower Water Charge Costs ($/yr)** | $15,950 |
| **Total Property Water Charge Costs ($/yr)** | $47,850 |

Note: These costs are estimates only and do not include any other fixed charges included in the relevant water authority bills.
Should be used for indication purposes only.

It should be noted that this is a simplified breakdown on potable water consumption and costs and does not take into account any other fixed charges that may be applicable for the site. These figures can be used when determining water efficiency saving opportunities and subsequent project payback or Return on Investment (ROI) calculations.

An alteration to a property's Sewer Usage Discharge Factor (SUDF) may also be possible and potential savings be included in any ROI calculations.

### 3c. Cooling Tower System Technical Information

The documentation and understanding of existing cooling tower systems on a property is an important part of managing cooling tower assets and understanding system performance.

The table below provides a detailed summation of each cooling tower system and its design and operating details.

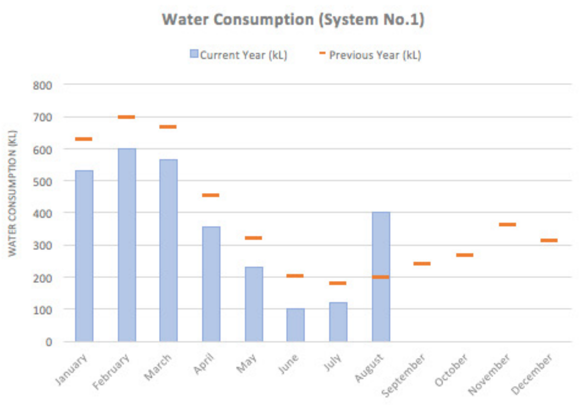
**Cooling Tower Systems Technical Information:**

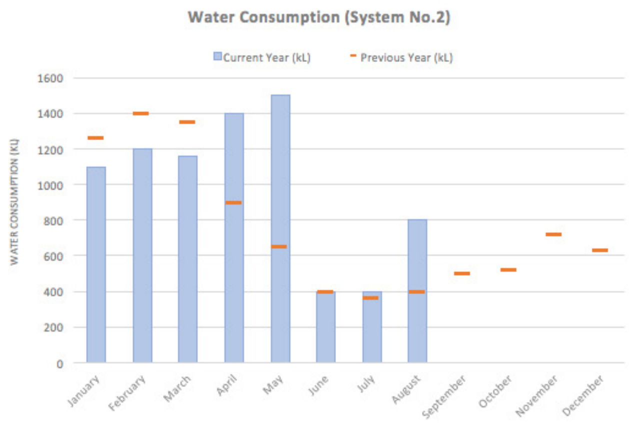
| Description | Details | | |
|---|---|---|---|
| | System No.1 | System No.2 | System No.3 |
| System Identification | Main System | | |
| Cooling Towers (No of.) | 2 | | |
| Cooling Towers (Make) | Aqua-Cool | | |
| Cooling Towers (Model No.) | AFT 8515 | | |
| Cooling Towers (Type) | Induced draught cross flow | | |
| Location | Level 23 | | |
| Equipment served by Towers | 1 x Carrier Centrifugal Chiller | | |
| Typical Hours of Operation | 12 hours/day: Mon-Fri | | |
| Design Water Flow – per Tower (l/s) | 82.5 | | |
| Design Water Flow – System (l/s) | 165 | | |
| Design Heat Rejection – per Tower (kW) | 1,900 | | |
| Design Heat Rejection – System (kW) | 3,800 | | |
| System Volume (m3) – estimated | 30,000 | | |
| Bleed Conductivity Setpoint (us/cm): | 1,700 | | |

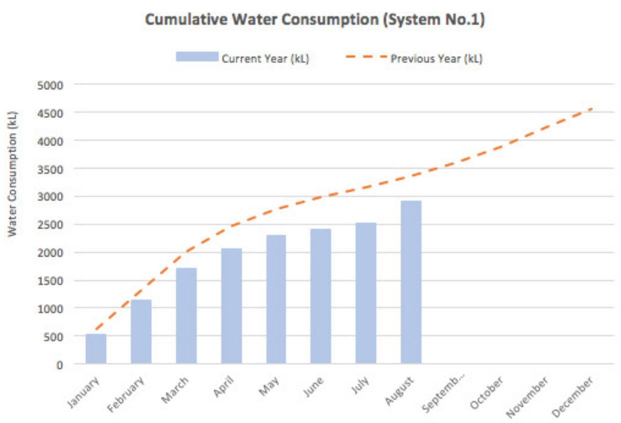
### 3d. Cooling Tower System Water Consumption Tracking

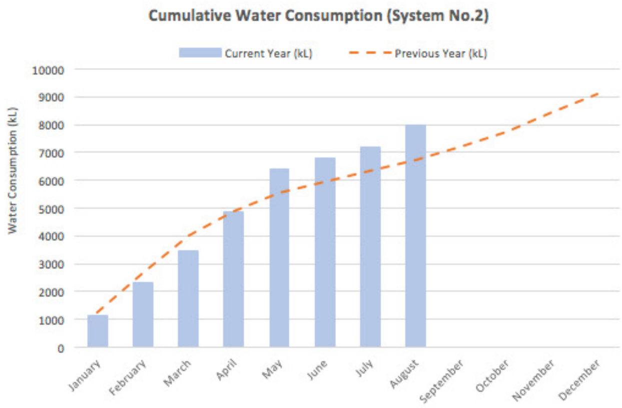
Documenting and understanding historical cooling tower water consumption is a vital component of a best practice water efficiency program. Understanding and tracking cooling tower water consumption trends, both historical and current, allows better overall monitoring and control. This table allows a basic overview of cooling tower water consumption to be monitored and evaluated to ensure a basic level of understanding.

| Description | Details | | | | | |
|---|---|---|---|---|---|---|
| | System No.1 | | System No.2 | | System No.3 | |
| System Identification | Tenant System | | Main System | | | |
| Water Meter Identification Number | ABC 12345 | | ABC 54321 | | | |
| **Historical Water Consumption:** | | | | | | |
| **Cooling Tower Water Consumption** | **Previous Year (kL)** | **Current Year (kL)** | **Previous Year (kL)** | **Current Year (kL)** | **Previous Year (kL)** | **Current Year (kL)** |
| January | 630 | **530** | 1260 | **1100** | | |
| February | 700 | **600** | 1400 | **1200** | | |
| March | 667 | **567** | 1350 | **1160** | | |
| April | 457 | **357** | 900 | **1400** | | |
| May | 323 | **232** | 650 | **1500** | | |
| June | 204 | **100** | 400 | **400** | | |
| July | 181 | **120** | 360 | **400** | | |
| August | 199 | **400** | 400 | **800** | | |
| September | 242 | | 500 | | | |
| October | 268 | | 520 | | | |
| November | 363 | | 720 | | | |
| December | 315 | | 630 | | | |
| TOTAL | 4548 | **2906** | 9090 | **7960** | | |
| | | | | | | |
| Average Monthly Water Consumption (kL/month) | 379 | 363 | 758 | 995 | | |
| Average Daily Water Consumption (kL/day) | 12.5 | 8.0 | 24.9 | 21.8 | | |


Water Consumption (System No.1)
Current Year (kL)
Previous Year (kL)
WATER CONSUMPTION (KL)
0
100
200
300
400
500
600
700
800
January
February
March
April
May
June
July
August
September
October
November
December


Water Consumption (System No.2)
Current Year (kL)
Previous Year (kL)
WATER CONSUMPTION (KL)
0
200
400
600
800
1000
1200
1400
1600
January
February
March
April
May
June
July
August
September
October
November
December


Cumulative Water Consumption (System No.1)
Current Year (kL)
Previous Year (kL)
Water Consumption (kL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
January
February
March
April
May
June
July
August
Septemb...
October
November
December


Cumulative Water Consumption (System No.2)
Current Year (kL)
Previous Year (kL)
Water Consumption (kL)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
January
February
March
April
May
June
July
August
September
October
November
December

## 3e. Cooling Tower Water Consumption Evaluation

Undertaking regular evaluations of cooling tower water efficiency is a good way of understanding system operation. This spreadsheet allows the regular evaluation of cooling tower water consumption against optimal water consumption based upon average monthly operating data. Continuous monitoring of cooling tower water efficiency is recommended. However, those systems that do not have online monitoring systems can utilise this spreadsheet for reporting purposes. Please note that is a simplified evaluation and does not take into account impact of system heat load variations.

| Month | Total Building Water Usage (kL) | Cooling Tower Water Usage (kL) | Cooling Tower Usage as a % of Building Usage | Average Daily Peak Temp. (°C) | Makeup Water EC (µS/cm) | Average System EC (µS/cm) | EC Set Point (µS/cm) | Estimated Blow-down (kL) | Estimated Evapor-ation (kL) | Optimal Water Usage (kL) | Excess Water Usage (kL) | Excess Water Usage % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jan-16** | **957** | **337** | **35%** | 25.2 | 170 | 1650 | 1700 | 3 4.7 | 302.3 | 334.8 | **2.2** | **1%** |
| **Feb-16** | **988** | **307** | **31%** | 31.0 | 170 | 1400 | 1700 | 37.3 | 269.7 | 298.7 | **8.3** | **3%** |
| **Mar-16** | **998** | **300** | **30%** | 28.7 | 170 | 1200 | 1700 | 42.5 | 257.5 | 285.2 | **14.8** | **5%** |
| **Apr-16** | **865** | **195** | **23%** | 26.7 | 170 | 1100 | 1700 | 30.1 | 164.9 | 182.6 | **12.4** | **7%** |
| **May-16** | | | | | | | | | | | | |
| **Jun-16** | | | | | | | | | | | | |
| **Jul-16** | | | | | | | | | | | | |
| **Aug-16** | | | | | | | | | | | | |
| **Sep-16** | | | | | | | | | | | | |
| **Oct-16** | | | | | | | | | | | | |
| **Nov-16** | | | | | | | | | | | | |
| **Dec-16** | | | | | | | | | | | | |
| **Total/ Average** | **3,808.0** | **1,139.0** | **30%** | **27.9** | **170.0** | **1338** | **1700** | **144.6** | **994.4** | **1,101.4** | **37.6** | **3.4%** |

The following information should be inputted into the relevant columns to enable a complete analysis to be undertaken.

Step 1: Insert ‘Monthly’ building water consumption values (kL) into cells C9-C20

Step 2: Insert ‘Monthly’ cooling tower water consumption values (kL) into cells D9-D20

Step 3: Insert ‘Average Daily Peak Temperature’ into cells E9-E20 as taken from Bureau of Meterology Data or site data.

Step 4: Insert ‘Makeup Water Electrical Conductivity’ into cells F9-F20 as taken from Sydney Water Data or from water treatment sevice reports.

Step 5: Insert ‘Average System Electrical Conductivity’ into cells G9-G20 as taken from water treatment sevice reports. An average value is recommended if multiple values are available

Step 6: Insert ‘Electrical Conductivity (EC) Setpoint’ into cells H9-H20. Should be 1700 us/cm unless otherwise noted.

### 3f. Cooling Tower Water Audit Checklist

The overall water efficiency of a cooling tower system should be regularly reviewed and optimised where possible to ensure good overall management. This audit or review process can be used during normal operating scenario's or used as a troubleshooting tool when issues have been flagged and investigation is required. The following checklist outlines the major areas that should be reviewed during a cooling tower water audit process.

It should be noted that this checklist is not a comprehensive list but includes sufficient information to undertaken a medium level of review. If issues are identified during the audit process or the audit process does not provide enough detail for troubleshooting purposes then the further investigation by competent persons would be required.

| | |
|---|---|
| Cooling Tower System Name: | |
| Cooling Tower System Location: | |
| Audit Date: | |
| Audit Completed By: | |
| Reason for Audit: | |

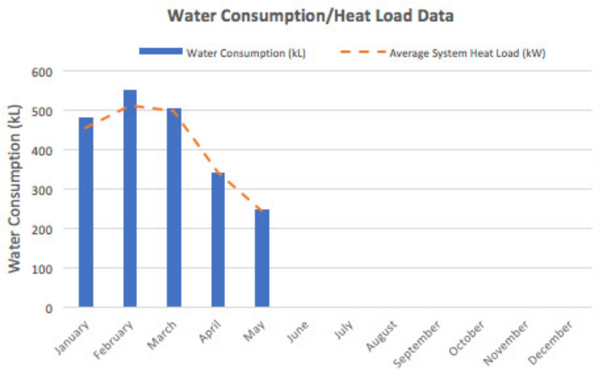
| Area: | Review Area: | Items | Audit Comments |
|---|---|---|---|
| **Cooling Tower:** | **Air Inlet:** | Check for any obstructions or contamination. Assess for short circuiting of discharge air. | |
| | **Casing:** | Check for any evidence of splashing, leaks or damage around tower | |
| | **Fill Pack:** | Check for any evidence of blockages, damage or contamination | |
| | **Drift Eliminators:** | Check for any evidence of blockages, damage or drift | |
| | **Water Distribution:** | Check for poor distribution or blockages | |
| | **Fan:** | Check for any evidence of malfunction, poor control or damage | |
| | **Level Control:** | Check basin level control and operation of makeup control mechanism. | |
| **Ancillary Equipment:** | **Pumps:** | Check for any evidence of leaking pumps | |
| | **Filters:** | Check for any evidence of filter failure, blockage or leaks/bypassing | |
| | **Pipework:** | Check for any evidence of leaking pipework or damage | |
| | **Valves:** | Check for any evidence of leaking valves or damage | |
| **Water Meters:** | **Inlet Water Meter:** | Check operation and functionality of inlet water meter/s | |
| | **Bleed Water Meter:** | Check operation and functionality of bleed water meter/s | |
| **Water Treatment:** | **Control Equipment:** | Check functionality and operational setpoints of bleed control system. | |
| | | Check functionality and operational setpoints of water treatment control equipment. | |
| | **Water Quality** | Check pH, conductivity and temperature of cooling tower water | |
| | | Check pH and conductivity of mains water | |

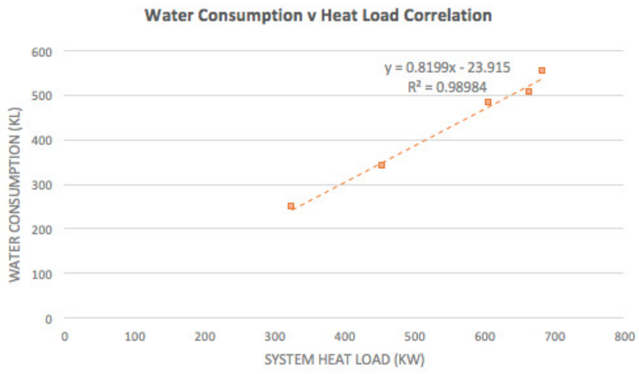
### 3g. Cooling Tower "Water Efficiency Ratio" – Advanced

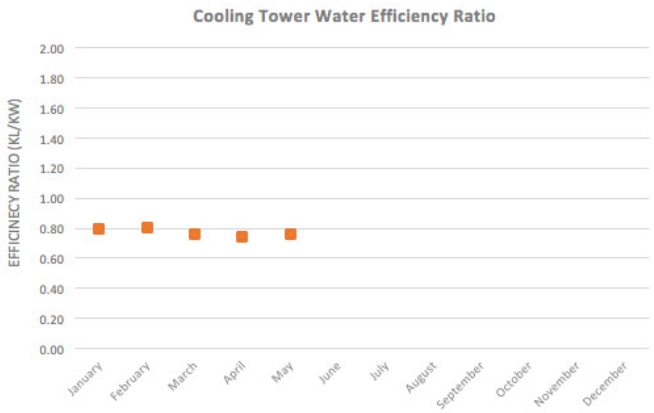
Overall cooling tower water consumption is fundamentally driven by the water lost via evaporation. As detailed in Equation 2 on page 10, the rate of evaporation is a direct function of system heat load. A cooling tower system that monitors system heat load can correlate water consumption and measured heat load to provide a 'Water Efficiency Ratio (kL/kW)'. This ratio calculates the amount of water that is consumed per kW of system heat load. Monitoring and evaluating this Water Efficiency Ratio (WER) can ensure a high level of water efficiency is maintained. The table below provides a template and monitoring tool for this advanced evaluation technique.

| **Description** | **Details** | | |
|---|---|---|---|
| System Identification | Main Cooling Tower System | | |
| Water Meter Identification Number | ABC 12345 | | |
| | | | |
| | **Monthly Water Consumption (kL)** | **Average System Heat Load (kW)** | **Water Efficiency Ratio (kL/kW)** |
| January | 481 | 607 | 0.79 |
| February | 551 | 684 | 0.81 |
| March | 506 | 667 | 0.76 |
| April | 340 | 457 | 0.75 |
| May | 250 | 327 | 0.76 |
| June | | | |
| July | | | |
| August | | | |
| September | | | |
| October | | | |
| November | | | |
| December | | | |
| **AVERAGE** | 426 | 548 | 0.77 |

| | |
|---|---|
| **Maximum Desired Efficiency Ratio (kL/kW)** | 0.90 |


Water Consumption/Heat Load Data
Water Consumption (kL)
Average System Heat Load (kW)
Water Consumption (kL)
600
500
400
300
200
100
0
800
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December


Water Consumption v Heat Load Correlation
y = 0.8199x - 23.915
$R^2$ = 0.98984
WATER CONSUMPTION (KL)
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
SYSTEM HEAT LOAD (KW)


Cooling Tower Water Efficiency Ratio
EFFICINECY RATIO (KL/KW)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
January
February
March
April
May
June
July
August
September
October
November
December

# 4. contract clauses

The following clauses should be evaluated and included in the relevant cooling tower management documents and third-party contracts where considered practical and appropriate.

| Section | Clauses |
|---|---|
| **Responsibility and Performance** | a) The Contractor acknowledges and will use all reasonable endeavours to assist the Principal to reach the cooling tower water efficiency targets agreed with the Principal and in accordance will all Key Performance Indicators (KPI's) and will ensure that sufficient processes are in place to deliver these targets.<br>b) Where water efficiency targets are not reached, the Contractor shall explain variances from the targets and will work with the Principal or their nominated representative in order to develop solutions to enable the targets to be met.<br>c) Where the contractor sub-contracts out any services referenced in this document, responsibility for compliance remains with the lead Contractor and the obligations will be passed through to any sub-contracted party.<br>d) The Contractor shall work with the Property Manager of the Principal to ensure effective operation of the cooling tower system to ensure timely resolution of emerging issues.<br>e) The Contractor shall {annually} review the Cooling Tower Water Management Plan (CTWMP) with the Principal, Property Manager and other involved parties to determine enhancements, sustainability initiatives and other cooling tower operational initiatives. |
| **Cycles of Concentration:** | 1.1. *{insert water treatment service provider}* shall ensure that the Electrical Conductivity (EC) of the cooling tower water is maintained as close as practically possible, but not exceed 1,700µs/cm.<br>1.2. *{insert water treatment service provider}* shall ensure that the automatic bleed setpoint on the water treatment control equipment be set at 1,700 µs/cm or its corresponding Total Dissolved Solids (TDS) level.<br>1.3. *{insert water treatment service provider/mechanical services provider}* shall connect the water treatment control equipment to the building management system or other similar information platform to allow automatic monitoring of cooling water electrical conductivity or total dissolved solids levels.<br>1.4. *{insert water treatment service provider/mechanical services provider}* shall ensure that the information platform selected has the ability to record and collect data on an hourly, daily and monthly basis for evaluation purposes.<br>1.5. *{insert water treatment service provider/mechanical services provider}* shall ensure that the information platform selected has the ability to provide a suitable alarm system to allow notification of out-of-specification water quality levels. |

| Section | Clauses |
| --- | --- |
| **Cycles of Concentration:** | **Water Meters:**<br>1.6. *{mechanical services provider}* shall ensure that the all cooling tower systems be fitted with a dedicated water meter for all incoming mains water supply. *{mechanical services provider}* shall connect all cooling tower water meters to the building management system or other similar information platform to allow automatic monitoring of cooling tower water consumption.<br>1.7. *{insert water treatment service provider/mechanical services provider}* shall ensure that the information platform selected has the ability to record and collect data on an hourly, daily and monthly basis for evaluation purposes.<br>1.8. *{insert water treatment service provider/mechanical services provider}* shall ensure that the information platform selected has the ability to provide a suitable alarm system to allow notification of out-of-specification water quality levels.<br>1.9. *{insert water treatment service provider/mechanical services provider}* shall ensure that water meters be installed on bleed/blowdown lines when sewerage discharge factors are being monitored and evaluated for water billing purposes.<br>**Cooling Tower Overflow:**<br>1.10. *{mechanical services provider}* shall ensure that all cooling towers be fitted with an overflow detection device to automatically notify building operators of water loss in the event of a makeup water valve failure or other system malfunction.<br>**Drift Eliminators:**<br>1.11. *{mechanical services provider}* shall ensure that all cooling towers be equipped with modern high-efficient drift eliminators that achieve drift reduction to below 0.002 percent of the recirculated water volume as per AS/NZS 3666:2011. A certificate or formal letter from the cooling tower supplier stating compliance of the drift eliminators to AS/NZS3666.2:2011 and tested as per the guidelines in AS 4180.1.<br>1.12. *{mechanical services provider}* shall ensure that all drift eliminators are installed and orientated correctly with no gaps or bypass permitted. *{mechanical services provider}* shall ensure that no damage is incurred when high pressure cleaning of drift eliminators is undertaken.<br>**Water Minimisation:**<br>1.13. *{mechanical services provider/water treatment service provider}* shall minimize the amount of water used in the cooling tower system in keeping with good operational practices consistent with system design.<br>1.14. *{mechanical services provider/water treatment service provider}* shall regularly review the operation of the cooling tower system and provide recommendations on minimising system water consumption.<br>1.15. *{Building owner}* shall evaluate the potential for recycling and/or reuse of water within a cooling tower system. Subject to a definitive risk assessment and project feasibility, *{mechanical services provider/water treatment service provider}* shall implement this recycling and/or reuse system after sign-off from the *{Principal}*. |

| Section | Clauses |
|---|---|
| **Cycles of Concentration:** | **Cooling Tower Efficiency:**<br><br>1.16. *{mechanical services provider}* shall provide recommendations to the property owner to ensure that the cooling tower system is operating at a high level of overall efficiency. This includes, but not be limited to, the following:<br>■ Installation variable speed drives on cooling tower fans where applicable;<br>■ Measurement and optimisation of cooling system water flowrates based upon refrigeration system operation and cooling tower operational guidelines;<br>■ Measurement and optimisation of cooling tower air flowrates for all operating conditions. All cooling towers that are housed in enclosures, adjacent permanent structures or within internal plant rooms should be evaluated to ensure design air flows are achieved and short circuiting is not taking place.<br>■ Evaluate and document cooling tower Liquid/Gas (L/G) ratio and maintain within cooling tower manufacturer specifications for all operating conditions.<br><br>**Cooling Tower Water Consumption:**<br><br>1.17. *{mechanical services provider/water treatment service provider}* shall ensure that the cooling tower system be operated to achieve the best possible levels of water efficiency without compromising on aspects such as microbiological, corrosion and scale control.<br><br>1.18. *{Principal}* shall evaluate cooling tower water consumption against operational parameters such as building or system heat load, outside ambient air temperature (if relevant), water quality control, building occupation and other seasonal impacts.<br><br>1.19. Once the *{Principal}* has defined an appropriate operational benchmark (i.e. kL/, kL/month, kL/kW System Heat Load) for cooling tower water consumption, it is a requirement that *{mechanical services provider/water treatment service provider}* regularly monitor and review performance against this defined benchmark.<br><br>1.20. Communication of actual water consumption values and comparisons versus the defined benchmarks will be provided on a monthly basis by *{Principal}* to *{mechanical services provider/water treatment service provider}*.<br><br>1.21. Cooling tower water consumption has been nominated by *{Principal}* as a property Key Performance Indicator (KPI) and *{mechanical services provider/water treatment service provider}* shall be regularly assessed on performance to this property KPI.<br><br>1.22. *{mechanical services provider/water treatment service provider}* shall ensure that they are aware of cooling tower water consumption benchmarks/targets and aim to achieve greater than 90% compliance against the nominated values. |

| Section | Clauses |
|---|---|
| **Cycles of Concentration:** | **Water Balance:**<br>1.23. *{Principal}* shall undertake a formal cooling tower water balance every *{3/5}* years. This formal water balance will ensure ongoing understanding of cooling system operating dynamics and documentation of performance of all water saving initiatives. This formal water audit shall include, but not be limited to, the following review areas;<br>▪ Cooling tower system water consumption trends,<br>▪ Cooling tower system performance and operational trends,<br>▪ Implemented and performance of previously undertaken water saving opportunities;<br>▪ Future water saving opportunities and any other system improvement plans.<br>Once a high level of system automation is implemented, *{Principal}* shall review previous water balance figures on a *{monthly/quarterly}* basis for ongoing monitoring and performance measurement.<br>**Asset Management:**<br>1.24. *{mechanical services provider/Principal/Consultant}* shall undertake a detailed condition assessment of the cooling tower system components including, but not limited to, the following;<br>▪ Cooling tower structure;<br>▪ Cooling tower internals;<br>▪ System components including pipework, valves and pumps;<br>▪ Heat exchange components; and<br>▪ Water treatment equipment and other accessories.<br>*{mechanical services provider/Principal/Consultant}* shall undertake a detailed inspection of the drift eliminators and cooling tower fill pack on a 5-year cycle due to the typical operational life of these components being 7–10 years. *{mechanical services provider}* shall remove components for inspection and replace where required.<br>**Water Treatment Chemical Dosing and Control Equipment:**<br>1.25. *{mechanical services provider/water treatment service provider}* shall ensure that the cooling tower system is equipped with an automatic chemical dosing and control system.<br>1.26. *{mechanical services provider/water treatment service provider}* shall ensure that the water treatment dosing and control equipment be equipped with an internal communication protocol (modem, wi-fi or Ethernet) to allow remote monitoring and control of water treatment parameters.<br>1.27. *{mechanical services provider/water treatment service provider}* shall connect the water treatment and dosing control equipment to the building management system or other similar information platform to allow automatic monitoring and control of water treatment parameters.<br>1.28. *{mechanical services provider/water treatment service provider}* shall provide *{Principal}*, where possible, with a summary of the historical water treatment parameter control on a *{quarterly}* basis based upon information downloaded from the water treatment dosing and control system. |

| Section | Clauses |
| --- | --- |
| **Cycles of Concentration:** | **Cooling Tower Risk Management:**<br>1.29. Where required by Legislation, *{Principal}* shall ensure a detailed risk assessment is conducted on all cooling tower systems on at least an annual basis. The cooling tower risk assessment program shall evaluate the risks associated with cooling tower operation including, but not limited to:<br>■ Stagnant water;<br>■ Nutrient growth;<br>■ Poor water quality;<br>■ Deficiencies in the cooling tower system; and<br>■ Location and access.<br>1.30. *{Principal}* shall ensure that the cooling tower risk assessment be conducted by an independent, suitably qualified and competent party who is not currently involved with maintaining, operating or treatment of the cooling tower system.<br>**Alternate Heat Rejection Equipment:**<br>1.31. Where appropriate, *{mechanical services provider/Principal/Consultant}* shall evaluate the potential for replacing the cooling towers with a suitable air-cooled alternative. *{mechanical services provider/Principal/Consultant}* shall undertake a complete lifecycle analysis and present the findings to the *{Principal}* for consideration if there is a potential to remove the cooling tower/s. |

# 5. cooling tower water efficiency rating protocol

Evaluating and implementing a robust and comprehensive cooling tower water efficiency program requires a detailed understanding of all aspects of the cooling tower system and its operation. To facilitate a review of an individual property, or a portfolio of properties, and the current management programs and processes, a cooling tower water efficiency rating protocol has been developed.

The rating protocol was designed to assist an organisation to:

- Understand existing level of cooling tower water efficiency processes and protocols;
- Facilitate improvement in internal processes towards achieving best practice status;
- Improve understanding of cooling tower systems and their operations;
- Improve understanding of water efficiency performance and facilitate generation of Key Performance Indicators or system benchmarks to enable comparisons between systems;
- Achieve a high level of transparency on reporting and overall outcomes.

Organisations should utilise this rating protocol at both a corporate and individual site level to facilitate discussions and actions to enable improvement programs to be specifically tailored on a site by site basis.

The overall rating protocol is a combination of the following six individual rating areas:

- Organisational Management
- Water Treatment Services
- Mechanical Services
- Risk Management
- Asset Management
- Metering, Monitoring and Water Efficiency

Table 1 on the following page provides a descriptive breakdown for evaluation of each of the six individual rating areas.

*(It should be noted that due to its prescriptive basis, exact conformance to the details in each of the Gold, Silver and Bronze sections may not necessarily apply. The final determination should match as close as possible to that detailed in each individual section and evaluated accordingly).*

**Table 1: Individual Area Rating Protocol**

| | GOLD | SILVER | BRONZE | NOMINAL |
|---|---|---|---|---|
| **Organisational Management** | Corporate objectives documented and conveyed to all stakeholders | Corporate objectives documented and conveyed to all stakeholders | Corporate objectives documented and conveyed to all stakeholders | No corporate objectives documented |
| | Stakeholder roles and responsibilities documented | Stakeholder roles and responsibilities documented | Stakeholder roles and responsibilities documented | Stakeholder roles and responsibilities not documented |
| | Cooling Tower Water Management Plan (CTWMP) developed | No Cooling Tower Water Management Plan (CTWMP) developed | No Cooling Tower Water Management Plan (CTWMP) developed | No Cooling Tower Water Management Plan (CTWMP) developed |
| | Corporate documents include cooling tower water efficiency requirements. | Corporate documents include cooling tower water efficiency requirements. | Corporate documents do not include cooling tower water efficiency requirements. | Corporate documents do not include cooling tower water efficiency requirements. |
| | Monthly reporting of performance | Regular reporting of performance | No regular reporting of performance | No regular reporting of performance |
| **Water Treatment Services** | Comprehensive water treatment contract | Comprehensive water treatment contract | Basic water treatment contract or agreement only | No water treatment contract |
| | Water treatment KPI's documented and reviewed | Water treatment KPI's documented and reviewed | No water treatment KPI's documented and/ or reviewed | No water treatment KPI's documented and/ or reviewed |
| | Contracts include specific water efficiency performance | No specific clauses detailing water efficiency measures | No specific clauses detailing water efficiency measures | No specific clauses detailing water efficiency measures |
| **Mechanical Services** | Comprehensive mechanical services contract | Comprehensive mechanical services contract | Basic mechanical services contract or agreement only | No mechanical services contract |
| | Mechanical services KPI's documented and reviewed | Mechanical services KPI's documented and reviewed | No mechanical services KPI's documented and/ or reviewed | No mechanical services KPI's documented and/ or reviewed |
| | Contracts include specific water efficiency performance | Contracts do not include specific water efficiency performance | Contracts do not include specific water efficiency performance | Contracts do not include specific water efficiency performance |
| **Risk Management** | Annual risk assessment undertaken (independent party) | Annual risk assessment undertaken (non-independent party) | Risk Assessment undertaken every 5 years | No risk assessment undertaken in past 5 years |
| **Asset Management** | Comprehensive asset management plan and lifecycle analysis | Basic asset management plan and lifecycle analysis | Basic asset management plan only | No asset management plan and lifecycle analysis |

| | GOLD | SILVER | BRONZE | NOMINAL |
|---|---|---|---|---|
| **Metering, Monitoring & Water Efficiency** | Automatic metering and monitoring system installed and connected to site BMS or other telemetry system. Comes complete with automated alarm notification to relevant stakeholders | Automatic metering and monitoring system installed and connected to site BMS or other telemetry system. | Monthly manual reading and trending of water meter consumption information only | No sub-meters installed and minimal information on water consumption data |
| | Water balance undertaken including review of water consumption interval data for past 3 years. Correlate water consumption data against relevant site based operating parameters to determine a relevant Key Performance Indicator | Water balance undertaken for past 12 months. Water balance based upon monthly water consumption values only. No correlation made against relevant site based operating parameters | Basic review of monthly and yearly water consumption data only with no determination of Key Performance Indicator | No water balance undertaken. No understanding of system Key Performance Indicator |
| | Monthly review of water consumption against a nominated site based Key Performance Indicator as evaluated in water balance | Monthly/Quarterly review of water consumption against previous year usage | Six Monthly/ Annual review of water consumption information. No understanding of water consumption Key Performance Indicator | No review of water consumption data. No water consumption KPI |

To determine the overall rating for an individual property, each of the six individual areas is assessed against the Gold, Silver, Bronze and Nominal ratings in Table 1and the allocated a ‘Performance Score’ as per Table 2.

**Table 2: Individual Area Scoring System**

| Rating Protocol | Performance Score |
|---|---|
| Gold | 10 points |
| Silver | 7 points |
| Bronze | 5 points |
| Nominal | 2 points |

The overall 'Site Performance Score' is a summation of the six 'Individual Performance Scores' with a maximum score of 60 being achievable. A summation of the scores for each of the individual areas will result in a cumulative total that then can be reviewed against the following overall Gold, Silver, Bronze and Nominal rating protocol system.

Table 3 below outlines a summary of the overall site rating protocols.

**Table 3: Overall Performance Rating Protocol**

| Rating Protocol | Site Performance Score |
|---|---|
| Gold | Sum of 'Individual Performance Score' = 50–60 |
| Silver | Sum of 'Individual Performance Score' = 35–50 |
| Bronze | Sum of 'Individual Performance Score' = 25–35 |
| Nominal | Sum of 'Individual Performance Score' = 0–25 |

The rating protocols provided in this section can either be used at an individual property level or at a corporate level. It can be used at an individual property level to facilitate improvements and programs to improve overall site management and performance. Alternatively, it can be used as a comparative tool within a larger organisation to evaluate the level of implementation of cooling tower water efficiency programs across a portfolio of properties.

It is recommended that an annual review of the rating protocols and scoring system be undertaken to understand performance of the programs and track overall improvement initiatives.

By regular reviews and constant reinforcing of strong operational practices at an organisation and individual site basis, it is expected that a cooling tower system will more likely be operated at or near peak efficiency.

# 6. definitions

The following definitions are provided for information purposes:

**Approach Temperature:** Difference between the cold-water temperature and wet-bulb temperature.

**Blowdown:** Water discharged from the system to control concentrations of salts and other impurities in the circulating water.

**Capacity:** The amount of water that a cooling tower will cool through a specified range, at a specified approach and wet bulb temperature.

**Circulating Water Rate:** Quantity of hot water entering the cooling tower.

**Cold Water Temperature:** Temperature of the water leaving the cooling tower.

**Cycles of Concentration:** The ratio of dissolved solids in the circulating water to the dissolved solids in the makeup water.

**Drift:** Circulating water lost from the tower as liquid droplets entrained in the exhausted air stream.

**Drift Eliminator:** An assembly of baffles or labyrinth passage through which the air passes prior to its exist from the tower, for the purposes of removing entrained water droplets from the exhaust air.

**Evaporation Loss:** Water evaporated from the circulating water into the air stream in the cooling process.

**Heat Load:** Total heat to be removed from the circulating water by cooling tower per unit of time.

**Hot Water Temperature:** Temperature of circulating water entering the tower.

**Liquid to Gas (L/G) ratio:** A ratio of total mass flows of water and dry air in a cooling tower.

**Makeup:** Water added to the circulating water system to replace water lost by evaporation, drift, windage, blowdown and leakage.

**Temperature Range:** Difference between the hot water temperature and the cold-water temperature.

**Wet Bulb Temperature:** The temperature of entering or ambient air adjacent the cooling tower as measured with a wet-bulb thermometer.

Prepared by:
Environmental Technical Working Group
Better Buildings Partnership


For more information visit:
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