

Australian Standard™

**Power station cooling tower water
systems—Management of legionnaires'
disease health risk**



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Airconditiong and Refrigeration Equipment Manufacturers Association of Australia
Australasian Fire Authorities Council
Australian Building Codes Board
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STANDARDS AUSTRALIA

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OF

AS 5059—2006

**Power station cooling tower water systems—Management of legionnaires' disease
health risk**

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NOTES

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PREFACE

This Australian Standard was prepared by the Standards Australia Committee ME-062, Ventilation and Airconditioning to supersede AS 5059(Int)—2003.

This Standard is applicable to the cooling tower condensing water systems and major auxiliary plant cooling water systems of power stations connected to the national or regional grids that supply electricity for public consumption. The impetus for the Standard was recognition that the series of Standards under AS/NZS 3666, *Air-handling and water systems of buildings—Microbial control*, were not appropriate to apply to these systems. The application of the Standard in place of the AS/NZS 3666 series requires that comprehensive water treatment programs are maintained and health risks are managed in accordance with this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

This Standard incorporates a Commentary on some clauses. The Commentary is set directly following the relevant clause and is designated by ‘C’ preceding the clause number and printed in italics in a panel. The Commentary is for information only and does not need to be followed for compliance with the Standard.

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FOREWORD

Legionnaires' disease is an acute bacterial infection of the lower respiratory tract. Infection is caused by exposure to, and inhalation of, tiny airborne water droplets containing the *Legionella* bacteria. Among the elderly and people whose body resistance is weakened by other concurrent illnesses, the infection can be fatal. Healthy people are at a much lower risk of infection.

Legionella bacteria is very widespread and can survive and multiply in natural fresh water systems such as rivers, lakes and underground water systems, and can readily enter man-made water systems. It proliferates in the presence of sludge, scale, rust, algae and, most importantly, in water of temperature in the range of 20°C to 45°C.

Poorly maintained cooling water towers in building airconditioning systems have been identified as a source of outbreaks of infection. They provide an environment in which *Legionella* can proliferate and can become airborne in droplets of water that could be inhaled. Procedures and practices that have been established to reduce the risk of infection from these sources require decontamination of the cooling water systems, using prescribed chemical treatment and shutdown and cleaning of the cooling towers and associated systems. As described below, such requirements are not appropriate to apply to the major cooling tower water systems used in power stations.

Based on evidence up to date, cooling towers used in power stations have been recognized as being of low-disease risk. Cases of legionnaires' disease infection have not been identified as being caused by a cooling tower that is part of the condensing water systems or major auxiliary plant cooling water systems used in power stations, despite the frequent unavoidable presence of bacteria in these systems, due mainly to the indifferent quality of water which is drawn into the systems from external sources. Cases of Legionnaires' disease that have occurred at power stations have been associated with small auxiliary cooling towers serving compressor plant and the like, which are not covered by this Standard and are required to be maintained in accordance with AS/NZS 3666.

As optimum cooling system performance is critical to the efficient production of electricity and the commercial viability of these power plants, the cleanliness of power station condensing water and major auxiliary plant cooling tower water systems is closely managed and monitored by on-site specialists. This management regime is an essential difference between these power station systems and many of the much smaller systems that have been associated with *Legionella* infection. Maintenance of cooling system cleanliness is achieved through chemical treatment programs that are continually applied, and which are designed and developed to inhibit growth of organisms and to minimize corrosion and depositions in the systems, using experience gained from each individual plant. These programs take into account the condition of the water supply the system draws on, plant-operating conditions and the materials of construction of the system, and include monitoring and control of *Legionella* concentrations. Some of these decontamination procedures may be impractical to use in power station cooling tower water systems because of the corrosive damage they are likely to cause to the plant.

Power station cooling towers associated with condensing water systems and major auxiliary plant may be required to run continuously for many years without shutdown. *Legionella* control regimes that require more frequent shutdowns are not practicable, as they would add very significantly to the cost of electricity and could result in shortages in public electricity supply, the consequences of which could be widespread and serious.

Practical control of *Legionella* populations within power plant cooling water systems and appropriate control measures are needed in order to provide a safe community and power station working environment, while maintaining efficient and cost-effective power generation.

This Standard was developed to further minimize the risk of legionnaires' disease and relates to the management of legionnaires' disease health risk associated with power station condensing water and major auxiliary plant cooling tower water systems. It recognizes that the power plant environment is characterized by unique conditions that are not compatible with conventional intervention practices such as shutdown or use of alternating biocides. These conditions include continuous in-service duty requirements; elevated water temperatures; variable quality of source water; presence of microorganisms including low *legionellae* counts as normal.

This Standard sets out control strategies considered to be suitable for use for the major cooling tower water systems at power stations. The strategies follow risk management principles and may also be suited to other large cooling tower water systems for which shutdown is impractical.

Background information on *Legionella* and guidance on general principles of control may be found in the National Environmental Health Forum monograph found at <http://enhealth.nphp.gov.au/council/pubs/ecpub>.

STANDARDS AUSTRALIA

Australian Standard

Power station cooling tower water systems—Management of legionnaires' disease health risk

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out control strategies suitable for the management of legionnaires' disease health risk from the cooling tower water systems of power stations connected to the national or regional grids used to supply electricity for public consumption. It applies to the cooling tower water systems associated with—

- (a) condensing systems of steam-driven turbines driving electricity generators; and
- (b) main power station auxiliary plant, such as coal pulverizing mills and turbine plant heat exchangers, where—
 - (i) a chemical dosing regime is applied to maintain the cleanliness of those systems and is demonstrably effective in the control of concentrations of *Legionella* bacteria; and
 - (ii) shutdown for cleaning of those systems would require total or partial shutdown of electricity generation by the power station, which may not be practicable.

The approach to management of legionnaires' disease health risk set out in this Standard is based on the principles and generic process set out in AS/NZS 4360. This approach involves setting the context, identifying risks, and then evaluating treating and monitoring risks, and ensuring that the information is communicated effectively.

This Standard is not applicable to associated power station site services such as air-conditioning systems of buildings, or other relatively smaller cooling tower water systems in power stations that can be taken out of service without affecting electricity generation. The AS/NZS 3666 series of Standards applies to microbial control in these systems.

NOTE: This Standard does not prohibit the operation of associated site services that use condenser water from a main power generation cooling tower.

1.2 OBJECTIVE

The objective of this Standard is to establish appropriate means for minimizing the possibility of outbreaks of legionnaires' disease, as a result of operation of power station cooling tower water systems.

CI.2 *The public supply of electricity is an essential service, which is required to be available 24 h per day, every day, all year, at moderate cost and with extremely high reliability. Interruptions to supply can be very costly to the community and economy, and a threat to safety.*

To meet these demands and to achieve necessary economies of scale, power stations that are connected to the public electricity supply grid are equipped with large electricity generating units, which may be kept continuously in service (several years). These power stations recycle large volumes of water to cool steam condensers and heat exchangers as part of the electricity generation process. Large natural draught or mechanical draught cooling towers are used to lower the cooling water temperature before reuse within the power station. To make up for evaporation and discharges used to control resulting increasing salt concentrations, large volumes of water are daily drawn into the systems from external sources. This source water may contain high levels of nutrients, suspended and dissolved solids, bacteria (including Legionella), and protozoa.

An example of the size and operation of a typical large system is illustrated in the following table.

<i>Element</i>	<i>Details</i>
<i>Generator turbine</i>	<i>500 MW, steam driven</i>
<i>Cooling tower</i> <i>Type</i> <i>Height</i> <i>Basin volume</i>	<i>Hyperbolic (natural draught)</i> <i>100 m</i> <i>16 ML</i>
<i>Condenser cooling water system</i> <i>Volume</i> <i>Make-up water volume</i> <i>Discharge (blow-down operation)</i> <i>water volume</i>	<i>20 ML (including tower basin)</i> <i>23 ML per day</i> <i>4 ML per day</i>

Like the generating units, the associated cooling water systems have to be kept in continuous operation and the cooling water circulated continuously. As a consequence of this continuous operation, the cleanliness of the cooling towers associated with the generator turbine and main auxiliary plant cooling water systems must be closely monitored and maintained to ensure that growth of organisms is inhibited. This function is usually performed by trained on-site specialist staff using sophisticated technologies to monitor, adjust, record and report cooling water quality with regard to chemical and biological factors.

Chemical treatments used are suited to individual power stations and are designed and developed—

- (a) with experience of the plant performance and the quality of water that is drawn into the system;*
- (b) taking into account the materials of construction;*
- (c) balancing the achievement of optimal conditions for inhibiting growth of organisms and minimizing corrosion of the heat exchange systems;*
- (d) to ensure that water quality in the systems is acceptable for discharge to local waterways; and*

- (e) *to effectively control Legionella and arrest high concentrations of the bacteria, as may occur with intakes of water to the system from external sources such as lakes, rivers and underground sources.*

Power station cooling towers present a situation where certain conditions that have been associated with legionnaires' disease exist. These are the presence of Legionella bacteria in water systems with temperatures in the range of 20°C to 45°C, in which the bacteria proliferates, and where that water may become airborne in tiny droplets that could be inhaled.

Notwithstanding that these conditions exist, there are a number of factors that make power station cooling towers much less likely to be a cause of the disease. The chemical treatment regime described above, which is supported by established expertise and systems and well-documented evidence of control of Legionella concentrations, is a significant feature of power stations.

Another important factor is that industries are required by legislation to pay attention to the occupational health and safety of employees, and contractors and visitors to the site. This includes instruction on workplace safety risks, and rules and practices for safely working in the vicinity of such risks, using appropriate control measures and personal protective equipment. The power industry has such measures in place on each site.

Other factors that may apply to differing extents from power station to power station and are to be assessed in accordance with the risk management requirements covered by this Standard include the following:

- (i) *The design of the cooling tower. Large water volume compared with wetted surface area, stable chemical environment and low aerosol production capability will lower the risk.*
- (ii) *The proximity of cooling towers to populated residential, institutional or commercial areas. There is lower level of risk to susceptible persons external to site, or coming in contact with aerosols from a cooling tower that is located in a secure area, well away from populated areas, as is the case at many power station sites.*

Where effective and robust water treatment operation and maintenance regimes apply in a power station that is connected to the public electricity supply grid, it is considered appropriate to address the potential effect on public and occupational health that operation of the cooling tower water system may present through a risk management approach.

Accordingly, this Standard specifies requirements for design, operation and maintenance of power station cooling tower water systems in order to manage the potential legionnaires' disease health risk associated with those systems.

1.3 APPLICATION

This Standard is intended for use by power station designers, constructors, owners, operators, and regulatory authorities.

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Standard.

AS

4276 Water microbiology

4276.3.1 Part 3.1: Heterotrophic colony count methods—Pour plate method using plate count agar

AS/NZS

- 2031 Selection of containers and preservation of water samples for microbiological analysis
- 3666 Air-handling and water systems of buildings—Microbial control (all parts)
- 3896 Waters—Examination for legionellae including *Legionella pneumophila*
- 4360 Risk management

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Aerosol

Airborne water particles less than 10 µm in diameter.

1.5.2 Automatically controlled (water treatment)

Dosage regulated by feedback control loop or timer.

1.5.3 Biocide

A physical or chemical agent that kills bacteria and other microorganisms.

1.5.4 Bio-film

A layer of microorganisms contained in a matrix that may form a layer of slime on surfaces in contact with water.

1.5.5 Blow-down (or bleed)

The removal of water from a system, to limit the concentration of dissolved solids and suspended solids.

1.5.6 BOD

Biochemical oxygen demand.

1.5.7 Chemical treatment

The application of chemicals to the water or the utilization of a chemical process or reaction on the water of a cooling tower water system for the management of corrosion, scaling, fouling or microbial growth.

1.5.8 Clean

Maintenance having the objective of a plant that is free from visible sludge, foam, slime (including algae and fungi), rust, scale, dirt, dust and any deposit or accumulation of impurities, or any other foreign material.

1.5.9 COD

Chemical oxygen demand.

1.5.10 Commissioning

A systematic and progressive process of putting the components of a system into operation, calibrating instruments and controls, and then making adjustments and checks to ensure that the total system is providing satisfactory operation and performance.

1.5.11 Continuous

Where used in expressions such as ‘continuous dosing’ means having a continuous effect.

1.5.12 Cooling tower

A device for lowering the temperature of water by evaporative cooling in which atmospheric air is in contact with falling water, thereby exchanging heat.

1.5.13 Cooling (tower) water system

A heat exchange system comprising a heat rejection plant and interconnecting water recirculating pipework and associated pumps, valves and controls.

1.5.14 Dead leg

An area of piped water that is non-circulating.

1.5.15 Drift

Water lost from the cooling tower as liquid droplets, excluding condensation.

NOTE: Drift is not to be confused with plume, i.e., condensed water vapour.

1.5.16 Generator

An electrical device that is driven by mechanical means such as a steam turbine to produce electricity.

1.5.17 Grid

An interconnected system of electrical power transmission and distribution lines used to transport electricity from power stations to consumers in homes, businesses, factories, farms, institutions and public places.

1.5.18 HCC (or total plate count)

Heterotrophic colony count.

1.5.19 Legionnaires' disease

A potentially fatal illness characterized by pneumonia and caused by infection with *Legionella* bacteria species, commonly *Legionella pneumophila*. The incubation period of the disease is from 2 to 10 days, and the attack rate is low. Symptoms include an abrupt onset of high fever, non-productive cough, chills, headache and muscle pain.

1.5.20 Maintenance

Regular, routine activity aimed at preserving the safe operational standard and cleanliness of equipment, which includes inspection, servicing, treatment, adjustment and repair.

1.5.21 Monitoring

Systematic regular surveillance of a situation. It may be carried out by measuring certain parameters, particularly the concentrations of substances/agents using specific instrumentation and methods.

1.5.22 Power station

A facility, connected to the national or regional public supply grids, in which one or more condensing turbine-driven electricity generators is installed and operated.

1.5.23 Regulatory authority

Any authority that is authorized by statute to exercise jurisdiction over matters such as the health and safety of individuals who may be at risk of exposure to *Legionella* infection due to a power station cooling tower water system.

1.5.24 Reporting

A process of recording and advising for decision making on results of monitoring and maintenance of systems.