

Microbial Control in Air Handling and Water Systems of Facilities

Introduction

1. Micro-organisms (microbes) are present in almost every environment found on the surface of the earth. In buildings, micro-organisms are normally present in low concentrations and are found on surfaces (such as carpet, tiles) or as floating dust/aerosol particles. The primary objective of this policy is to assist in the control of micro-organisms in building systems, particularly those associated with bacterial genus *Legionella* such as Legionnaires' disease, humidifier fever, and pontiac fever. To a lesser extent control is sought of other micro-organisms sources, such as *Pseudomonas* (eg causing skin rashes or ear infections), amoebic meningitis, herpes, chlamydia and gastro-intestinal infections.

Scope

2. The policy expounded in this document is to apply to:

- a. Cooling water systems as defined in SAA/SNZ HB32,
- b. Air handling systems in buildings,
- c. Air conditioning plants - applicable only in a State or Territory where it is defined under their respective Occupational Health and Safety Act, that air conditioning plant "is a specified high risk plant",
- d. Water storage systems associated with potable water,
- e. Water storage systems associated with fire sprinkler systems,
- f. Water storage systems associated with irrigation,
- g. Hot water systems,
- h. Warm water ablution systems, and
- i. Heated pools (includes spa and hydrotherapy).

3. Manager Defence Estate (MDE), appropriate staff, contractors, operation and maintenance personnel, and other related parties shall be aware of the responsibilities concerning design, installation, commissioning, operation and maintenance of the above listed plants in clause 2 in order to reduce the risk of an outbreak of micro-organisms. The intent of this policy and related standards applies to all existing, new and replacement equipment. This policy shall be read in conjunction with Defence Occupational Health and Safety Manual (DOHSMAN), and particularly Annex E 'Indoor air quality' of Chapter 7 'Work environment – general'. Related State/Territory statutory law(s) shall also be complied with unless the Commonwealth law(s) have more stringent requirements.

Legionella Bacteria

4. Legionella bacteria can be found in most fresh water environments, in natural and constructed water sources, mud and soil. So it is not surprising the bacteria is often present in building water systems. The bacterium thrives in particular environments, which are outlined below:

- a. Warm water, the optimum temperature range being 35°C-37°C. Growth of the legionella below 25°C is rare, but the organism may remain dormant at lower temperatures, whilst growth ceases above 45°C, the cells can be killed by long exposure at 50°C or exposures at higher temperatures;
- b. Presence of sediment, sludge, scale and organic material, all act as nutrient sources and providing a surface for attachment;
- c. Some materials, such as natural rubber, used for tap washers, are a known nutrient source, care is required;
- d. Presence of other waterborne micro-organisms, such as algae, amoebae and other bacteria may provide nutrient sources. Algal slimes provide a stable environment for growth;
- e. Biofilm formation: the formation of a biofilm, which is a layer of micro-organisms, may form a thin slime on surfaces in contact with water. As legionella has been shown to be a biofilm organism, the biofilm formation, may protect the Legionella from concentrations of biocide that would otherwise kill or inhibit growth;
- f. Growth niches such as dead legs in piping system, temperature stratification in calorifiers are examples of locations well suited for Legionella growth;
- g. The growth of the bacteria is very responsive to the presence of iron and zinc; thus unprotected, rusting galvanised iron is an undesirable construction material in wet cooling towers; and
- h. The presence of oxygen and carbon dioxide

During the design and installation, consideration shall be given to the above listed factors, in establishing appropriate control measures for Legionella in water systems. The selection of equipment which is not prone to the proliferation of Legionella shall be required for new and replacement equipment.

Micro-organism Management and Control

5. Micro-organism management and control shall comply with the following requirements as a minimum:
 - a. Design, installation, commissioning, maintenance and operation of air handling and water systems (other than heated pools) shall comply with AS/NZS 3666.1 and AS/NZS 3666.2. Water storage systems shall also comply with AS/NZS 3500.1. Hot water systems and warm water ablution systems shall also comply with AS/NZS 3500.4.2.
 - b. Performance based maintenance of cooling water systems shall comply with AS/NZS 3666.3.
 - c. SAA/SNZ HB 32 shall be used as guidance for microbial control of both air handling and water systems to support the specific requirements of AS/NZS 3666.
 - d. Design, construction and operation of heated pools and spas (hot tubs) shall comply with the requirements of AS 2610.1 (Spa pools – Public spas).
 - e. Design, construction and operation of hydrotherapy pools shall comply with the requirements of AS 3979.
 - f. State/Territory statutory law(s), and related guidelines and code of practice.
6. The following documents should also be used as guidance where applicable:
 - a. Guidance for the control of Legionella – National Environmental Health Forum Monographs – Water series no. 1
 - b. AIRAH application manual DA17 – Cooling towers
 - c. AIRAH application manual DA18 – Water treatment
7. MDEs shall ensure that the maintenance contractor(s), responsible for the maintenance of the systems and equipment listed at Clause 2, have developed a plan for the management and control of micro-organisms in systems and equipment that are considered as a potential source of bacteria multiplication (eg Legionella). The plan shall include appropriate maintenance and operation instructions that are to be recorded in the ID's facilities data base (DEMS-FM). The maintenance and operation instructions shall comply with Clause 5.
8. The Maintenance contractor(s) shall ensure compliance with the State/Territory statutory law(s). Maintenance personnel shall adhere to the safety requirements of AS 2865, AS/NZS 3666, SAA HB 9, SAA/SNZ HB 32, the State/Territory statutory law(s) and materials safety data sheets. Consideration must be given to use of personal protective equipment, handling of chemicals and confined spaces prior to commencing work.
9. New and Replacement Equipment. The design, installation and commissioning of new equipment, or the replacement and commissioning of equipment shall comply with Clause 5. Consideration should be given to the location of the equipment, construction materials, and maintenance requirements including cleaning and monitoring.

Certification

10. A practising engineer shall be required to certify a cooling water or warm water storage systems' compliance to AS/NZS 3666. Copies of the certification shall be submitted in writing to MDE, State/Territory Health Department (where necessary), or upon request by DSMA or COMCARE. This requirement applies only to new cooling water or warm water storage systems.
11. For the purpose of this document, a practising engineer is an engineer registered with the National Engineering Registration Board (NPER) to the level of NPER-3 and registered to practice in the areas of mechanical engineering or building services engineering.
12. Where any modification to a cooling water or warm water storage system takes place, a practising engineer shall certify the cooling tower's or warm water storage system's compliance to AS/NZS 3666. A copy of the certification shall be submitted in writing to MDE, State/Territory Health Department (where necessary), or upon request by DSMA or COMCARE.
13. The certification shall be recorded in the ID's facilities data base (DEMS-FM).

Cooling Water systems

14. The biological process of rapid growth of the bacteria, resulting in high concentrations of the Legionella in the water equipment (eg cooling tower, evaporative condenser), is essential before the water is considered potentially hazardous for causing Legionellosis.
15. Design of cooling water systems shall facilitate cleaning, control bacterial growth, and minimise drift. In addition to complying the relevant requirements in Clause 5, design of the systems, and siting and selection of cooling tower plants should consider the requirements in Clause 6.

16. A performance-based approach in accordance with AS 3666.3 shall be required for maintaining and monitoring any newly installed and existing cooling water systems in order to minimise the growth and dissemination of micro-organisms.
17. A practising engineer shall undertake risk assessment for cooling water systems every five years or as directed by MDE in accordance with AS/NZS 3666.3. Copies of the risk assessment shall be submitted to MDE, State/Territory Health Department (where necessary), or upon request by DSMA or COMCARE. The risk factor given in Table 2.1 "Risk factors to be assessed and controlled" of AS 3666.3 shall be assessed and documented for each site. Appropriate control measures shall be implemented by compliance with the relevant requirements in Clause 5. Key performance indicators identified in the Table 2.1 shall be monitored and controlled in accordance with Section 3 "Performance monitoring and control" of AS 3666.3. The measures may identify additional operation and maintenance requirements that shall be included in the maintenance contractor(s)' plans in Clause 7. Initial risk assessment should be carried out as soon as practical or as required by the State/Territory laws and regulations. It is recommended that for a new installation, initial risk assessment should commence at design phase and be reviewed at initial operation phase of the installation. The risk assessment reports and control measures shall be recorded in the ID's facilities data base (DEMS-FM).
18. The management of system water quality is an important strategy in minimising health risks associated with cooling water systems. Automatically regulated water treatment systems shall be required for effective management of corrosion, scaling, fouling and microbial growth. The effectiveness of the water quality management system (including water treatment) shall be assessed, at least monthly when the systems are used, in accordance with AS 3666.3. The temperature of the operating systems shall also be assessed at least monthly when in use.
19. Sampling for Legionella is a monitoring activity in the performance-based approach. Such specific tests will be complemented with other assessments such as heterotrophic colony count (HCC) and system quality characteristics to provide reassurance that the system is well maintained and operating in a hygienic condition. Available data suggest that most outbreaks are associated with a concentration of Legionella of 1000 cfu/mL or greater. The examination for the presence of Legionella shall be carried out monthly in accordance with AS 3896 in a NATA accredited laboratory. A control strategy shall be immediately initiated in accordance with AS 3666.3 whenever a 'detectable' concentration of Legionella is found (10 cfu/mL or greater) in order to ensure that the system is hostile to these organisms. The testing of HCC shall be carried out monthly in accordance with AS 4276.3.1 in a NATA accredited laboratory. A control strategy shall be immediately initiated in accordance with AS 3666.3 whenever a HCC is greater or equal to 100,000 cfu/mL .
20. The following equipment in an existing cooling water installation shall be upgraded as soon as practical if they do not comply with the relevant requirements in Clause 5. The upgrade shall be certified by a practising engineer:
- Drift eliminators – a vital part of preventing Legionnaires' disease outbreaks from a cooling water system, and helping to retain a system's chemically treated water. (The upgrade may increase air flow resistance and reduce the capacity of heat dissipation. These impacts should be evaluated and catered for.)
 - Automatic bleed-off equipment – Allowing for the automatic bleed-off of cooling tower water to waste to limit the build-up of dissolved and non-dissolved solids.
 - Automatic dosing equipment - Allowing automatic dosing of chemicals for the control of microbial growth, corrosion, scaling and fouling. (A lock-out shall be installed to prevent chemicals being injected while automatic bleed-off to drain is operating.)
21. When a system has not been in operation for a period for more than 30 days an assessment shall be carried out in accordance with AS 3666.3.
22. A system that is on stand-by shall be run at least one hour per week to circulate corrosion inhibitors and biocide. Stand-by systems shall comply with the requirements in Clause 5.
23. All cooling towers shall have a written start-up, operation and shut-down procedure displayed near to the cooling tower. The procedure shall be protected from weathering.
24. All results and records shall be prepared, retained and readily available for inspection in accordance with AS 3666, and State/Territory laws and regulations.

Water Systems

25. Hot, warm and cold water systems shall be designed to avoid conditions likely to encourage Legionella multiplication. In addition to complying the relevant requirements in Clause 5, the requirements in item a of Clause 6 should be considered.
26. Incoming cold water should be protected against heat gains which may inadvertently increase water temperature from around 20°C initially, up to 30°C or more, where practical.
27. All hot water systems should be of the pressure mains type and thermostatically set to 60°C or greater. Large central hot water systems with long runs should incorporate a recirculating pump to ensure the temperature of the water in the reticulation system and storage is maintained above 60°C. A new or extended hot water (or cold) water system shall be cleaned and disinfected before commissioning in accordance with AS/NZS 3500.1 and AS/NZS 3500.4.

28. Warm water ablation systems typically supply warm water at, nominally 43°C, for safe bathing purposes in patient care buildings. All warm water systems should produce warm water for instantaneous use by the mixing of hot (60°C) and cold (20°C) water. This may be achieved by using for example, a thermostatic mixing valve fitted and maintained in accordance with relevant Australian Standards.
29. When a warm water storage system, of equal to or greater than 500 litres capacity, maintains a water temperature of between 30°C and 60°C, the following requirements shall be complied:
- The examination for the presence of Legionella shall be carried out every two months in accordance with AS 3896 in a NATA accredited laboratory. A control strategy should be immediately initiated in accordance with Annex A whenever a 'detectable' concentration of Legionella is found (10 cfu/mL or greater) in order to ensure that the system is hostile to these organisms.
 - The system shall be cleaned and disinfected every three months as per the requirements in Annex A.
30. All cold water storage and cold water feed tanks and systems associated with potable water systems, water storage tanks and systems associated with fire sprinkler systems, and water storage tanks and systems associated with irrigation shall be maintained, cleaned and inspected as required by the local water authority, AS/NZS 3500.1 and SAA/SNZ HB 32.
31. Grey water storage tanks and systems associated with irrigation shall be maintained, cleaned and inspected as required by the local water authority and State/Territory law(s).

Notification

32. MDEs shall notify DSMA and COMCARE within 24 hours after receiving a result of Legionella concentration of greater than or equal to 1000 cfu/mL, or after receiving a result of heterotrophic colony count of greater than or equal to 5,000,000 cfu/mL. They are classified as dangerous occurrence (high risk events) and shall be notified in accordance with the procedures in the Incident and Fatality Report AC563.
33. MDEs shall also notify the State/Territory Health Departments in a timely manner of any dangerous occurrence in accordance the State/Territory statutory law(s). In the event of a dangerous occurrence, MDEs shall consult with the State/Territory Health Departments, DSMA and COMCARE immediately about actions required for preventing an outbreak of the disease Legionellosis.
34. MDEs should keep the related occupational, health and safety (OH&S) committees informed of all testing results (including low/high risk events) and measures taken to assure that the equipment/systems defined in Paragraph 902 are well maintained and operating in a hygienic condition. When a dangerous occurrence arises, MDEs should notify the OH&S committees about actions taken for eliminating the risk, and subsequent testing results.

Reporting of an outbreak

35. Legionellosis is a reportable disease under the State/Territory Health Act applicable to the region. MDEs shall ensure their maintenance contractor(s) and contract manager responsible for the installation and/or maintenance of the equipment/systems defined in Paragraph 2, report any outbreak of Legionellosis. Also, both the maintenance contractor/s and contract manager shall make themselves aware of the statutory regulations relating to the terms and conditions of reporting a Legionellosis outbreak, or other reportable communicable diseases such as *Pseudomonas* (eg causing skin rashes or ear infections), amoebic meningitis, herpes, chlamydia and gastro-intestinal infections.
36. MDEs shall report an outbreak to DSMA and COMCARE in accordance with the procedures in the Incident and Fatality Report AC563. MDEs should also report an outbreak to the related OH&S committees in a timely manner. MDEs shall consult with the State/Territory Health Departments, DSMA and COMCARE immediately about actions required for controlling an outbreak.

Sponsor: ETS

Microbial Control in Air Handling and Water Systems of Facilities - Annex A

1. Cleaning and Disinfection of Warm Water Storage Systems
 - a. Cleaning
2. Warm water storage systems shall be drained and cleaned to remove sludge and sediment.
 - b. Disinfection
3. Warm water storage systems shall be disinfected by one of the following methods:
 - a. Heat Disinfection
 - i. Take all safety precautions and give adequate notice to ensure that the risk of scalding to building occupants, and operation and maintenance personnel is prevented during the heat disinfection process. An appropriate timeframe, when the disturbance to the building occupants is minimal, should be selected to carry out the work
 - ii. Raise the temperature of the water in the warm water storage system to 70°C for one hour.
 - iii. Flush each outlet in turn for two minutes with water at a minimum temperature of 60°C.
 - iv. Reset the temperature and recommission the system, and allow the system to be used after all check for safety has been carried out.
 - v. Heat disinfect systems which lie idle for two or more weeks as per (i), (ii), (iii) and (iv) above, before use.
 - vi. Record details in a maintenance log book.
 - b. Chlorine Disinfection
 - I. Take all safety precautions and give adequate notice. An appropriate timeframe, when the disturbance to the building occupants is minimal, should be selected to carry out the work
 - II. Isolate the heat source.
 - III. Drain any sludge from the bottom of the warm water storage system.
 - IV. Ensure that an air break is incorporated between the water supply mains and the warm water system to prevent contamination of water within the utility distribution system.
 - V. Add sodium hypochlorite solution to produce a free chlorine residual of approximately 10 mg/L in the warm water storage system as measured by a DPD Test Kit or similar test kit. Maintain the pH of the water between 7.0 and 7.6.
 - VI. Ensure thorough mixing and circulation throughout the warm water storage system and any ring mains.
 - VII. Flush each outlet in turn until there is a distinct smell of chlorine. If there is any doubt, check the free chlorine level with a DPD Test Kit or similar test kit.
 - VIII. Check that the free chlorine residual in the water is not less than 7 mg/L at one outlet, preferably at the furthest point downstream of the warm water storage system.
 - IX. Allow the water to stand for one hour.
 - X. Check that the free chlorine residual in the water is not less than 2 mg/L at the outlet in (viii).
 - XI. Repeat the above procedure if the free chlorine residual is less than 2 mg/L.
 - XII. Drain the warm water storage system of the free chlorine residual is 2 mg/L or greater and refill the warm water storage system with water and re-commission the system.
 - XIII. Record details in a maintenance log book.

Microbial Control in Air Handling and Water Systems of Facilities - References

- A. Standards Australia/Standards New Zealand HB 32, Control of Microbial Growth in Air-Handling and Water Systems of Buildings.
- B. Defence Occupational Health and Safety Manual (DOHSMAN).

<http://dsma.dcb.defence.gov.au/defweb/DOCS/OHS/OHSLibrary/ohs/index.htm>

- C. Australian/New Zealand Standard 3666 Parts 1-3, Air Handling and Water Systems of Buildings – Microbial Control.

Part 1 – Design, installation and commissioning.

Part 2 – Operation and maintenance.

Part 3 – Performance-based maintenance of cooling water systems.

- D. Australian/New Zealand Standard 3500, National Plumbing and Drainage, Part 1 Water Supply.
- E. Australian/New Zealand Standard 3500, National Plumbing and Drainage, Part 4 Hot Water Supply Systems.
- F. Australian Standard 2610 Part 1, Spa Pools.
- G. Australian Standard 3979, Hydrotherapy pools.
- H. Australian Standard 2865, Safe working in a confined space.
- I. Standards Australia HB 9, Handbook – Occupational personal protection.
- J. Australian/New Zealand Standard 3896, Examination for Legionella including Legionella pneumophila.
- K. Australian Standard 4276.3.1, Water microbiology – heterotrophic colony count methods – pour plate method using plate count agar.
- L. Incident and Fatality Report AC563, Department of Defence.

<http://pubsdb.cbr-dps.defence.gov.au/wfs/>

- M. Guidance for the control of Legionella – National Environmental Health Forum Monographs – Water series no. 1.
- N. AIRAH application manual DA17 – Cooling towers.
- O. AIRAH application manual DA18 – Water treatment.