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# Code of Practice for Prevention of Legionnaires' Disease
# 預防退伍軍人病工作守則

Prevention of Legionnaires' Disease Committee, Hong Kong
香港預防退伍軍人病委員會

The Government of the Hong Kong Special Administrative Region
香港特別行政區政府

# Foreword

The development of a healthy environment for our community necessitates actions to improve the physical and socio-economic environment affecting health, helping one another to evolve their maximum potential. With the impact of globalisation, new patterns of consumption and communication, environmental degradation, urbanisation and changes in the pattern of diseases and in the social determinants of health, there is a need for us to take a fresh look on the concept of health, and to adopt new approaches and strategies to improve our citizens' health.

As the number of reported cases of Legionnaires' disease in Hong Kong is increasing in the recent years, effective protection of the community from this disease is vital. The establishment of the Prevention of Legionnaires' Disease Committee (PLDC) can surely provide an effective platform for medical and engineering professionals to join hands in offering expert advice on formulation of strategies for preventing Legionnaires' disease.

The Code of Practice for Prevention of Legionnaires' Disease was firstly published in 1994 and subsequently revised in 2000, 2007 and 2012 respectively. Taking into account the experience and the evolving knowledge of other countries and lessons from major cases in recent years, this revised edition is featured with enhanced precautions in association with hot and cold water supply systems, and other general updates, from which broader practical guidelines for proper design, operation, maintenance and handling of related facilities to avoid the spread of legionella can be provided. We are confident that this revised code of practice can surely safeguard our environment and enhance the quality of our lives.

Prevention of Legionnaires' Disease Committee, Hong Kong
December 2016

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# 1 Background

**1.1** Legionnaires' disease (LD) was first recognised in July 1976 when an outbreak occurred among delegates attending an American Legion Convention in Philadelphia, USA in which more than two hundred cases were reported and 34 people died. After medical investigations, it was identified that the responsible bacterium of the disease was previously unknown, and was subsequently given the name *Legionella pneumophila*.

**1.2** Since the identification of legionellae, cases ranging from sporadic infection to outbreak were subsequently reported in USA, Canada, UK, Australia, Singapore, etc.

# 2 Medical Aspects

**2.1** LD is a type of bacterial pneumonia caused by legionella, with patients presenting symptoms of fever, headache, malaise, muscle pain, cough and breathlessness; and may result in respiratory failure. The disease has an incubation period of 2 to 10 days.

**2.2** The bacteria that cause LD are small coccobacilli measuring up to 0.5μm by 1-3μm, with occasional longer forms of 10-15μm or more, within the genus legionellae. Over 50 species of legionellae have been identified and the *Legionella pneumophila* serogroup 1 is most commonly responsible for LD outbreaks.

**2.3** Legionellae survive and multiply in natural fresh water, including lakes, rivers, streams, ponds, mud and soil, as well as man-made water systems. The optimum temperature for proliferation of the bacteria is around 20°C to 45°C, and particularly in the range of 35°C to 43°C. The proliferation ceases above 46°C and below 20°C, while the survival time decreases to a few minutes at above 60°C. At 70°C the organism is killed virtually instantaneously.

**2.4** The organism appears to be insensitive to pH but requires as nutrition the presence of simple organic life (such as algae and micro-organism in sludge, scale, biofilm, etc.), inorganic substances (such as nitrogen based substances, small concentration of iron, zinc, etc. in fresh water piping systems), and organic substances (such as certain types of rubber) for survival. Nevertheless the bacteria can hardly survive in salt water and domestic water supplies which are well chlorinated.

**2.5** Transmission of the bacteria to human is mainly by inhalation of aerosols or mist containing the bacteria into the lungs where they are deposited. According to previous reported cases, sources of the aerosols causing an outbreak were mainly traced to water systems in buildings including evaporative cooling towers and humidifiers of air-conditioning systems, hot and cold water systems, whirlpool or spas, industrial heating and cooling processes, etc. Cases associated with decorative water fountains, home respiratory therapy devices, humidifiers and mist machines have also been reported. Normal range of operation temperature of these systems is conducive to the growth of legionellae.

**2.6** The correlation between the proliferation temperature of the bacteria and the operating temperature of commonly found water systems is shown in Figure 1.

**2.7** Evidence available so far does not suggest that LD is readily transmitted by person to person contact.

**2.8** The following types of people are more susceptible to LD :

(a) patients who have low resistance to infection, especially those with respiratory disease, or on renal dialysis or immuno-suppressant drugs;
(b) smokers;
(c) people of increasing age, particularly over 50 years old;
(d) males; and
(e) drinkers.

**2.9** To summarise, the infection of LD is due to a combination of the following factors as shown in Figure 2 :

(a) aerosol containing legionellae;
(b) inhalation of the aerosol; and
(c) susceptible person.

# 3 The Hong Kong Situation

**3.1** Following the outbreak of LD in 1985 at Stafford District General Hospital, UK, the Prevention of Legionnaires' Disease Committee was set up in Hong Kong in the same year. The Committee initially comprised members from the then Works Bureau, the Department of Health, the Electrical & Mechanical Services Department, the Architectural Services Department, the Water Supplies Department, the University of Hong Kong and the Chinese University of Hong Kong.

**3.2** Initially, the terms of reference of the Committee were confined to areas of immediate concern, especially on the preventive measures against LD in government hospitals. Starting from 1987 the recommendations of the Committee were gradually implemented in government hospitals. A set of the recommendations was also sent to all subvented hospitals and private hospitals in July, 1989. In January, 1990, technical guidelines were issued to the project design teams and operation and maintenance teams of Government buildings to ensure that they are aware of the issue and will adopt proper attitude and appropriate measures in handling the relevant design, operation and maintenance of engineering plants/ equipment.

**3.3** To further promote the awareness of the public on the disease, the Committee published the pamphlet "Understanding Legionnaires' Disease" and this Code of Practice so as to present guidelines to the public on prevention of LD and to allay unnecessary alarm and fear caused by the overwhelming publicity of the issue. Furthermore, Subcommittees were established to assist in the publicity launch and to advise the Committee on technical matters, such as preparation of publicity materials, drawing up investigation procedures and plans to handle an outbreak, and collection and analysis of technical information. In order to strengthen the representation, the Committee was re-organised in 2002 and chaired by a public health expert with members representing government bureaux and departments concerned and experts nominated from the medical faculty of universities and the engineering profession. The organisational relationship, the membership of the Committee and the terms of reference are shown in Figures 3A and 3B.

**3.4** In March 1994, LD has been listed as a notifiable disease under the former Quarantine and Prevention of Disease Ordinance (Cap. 141) (subsequently replaced by the Prevention and Control of Disease Ordinance (Cap. 599) in July 2008). Medical practitioners are required by law to notify cases to the Department of Health using the latest 'FORM 2' of the Prevention and Control of Disease Ordinance which can be downloaded from the website at http://www.chp.gov.hk.

**3.5** There were 313 reported cases of LD between 1994 and 2015. All were sporadic cases Table 1 shows a summary of the cases.

**Table 1: Summary of Notified Cases of Legionnaires' Disease 1994 – 2015**

| Year | No. of Cases | Year | No. of Cases |
|---|---|---|---|
| 1994 | 3 | 2005 | 11 |
| 1995 | 1 | 2006 | 16 |
| 1996 | 2 | 2007 | 11 |
| 1997 | 2 | 2008 | 13 |
| 1998 | 1 | 2009 | 37 |
| 1999 | 1 | 2010 | 20 |
| 2000 | 2 | 2011 | 17 |
| 2001 | 3 | 2012 | 28 |
| 2002 | 4 | 2013 | 28 |
| 2003 | 3 | 2014 | 41 |
| 2004 | 3 | 2015 | 66 |

**3.6** LD was added into the list of notifiable occupational disease under the Occupational Safety and Health Ordinance (Cap. 509) in June 1999. Medical practitioners are required to notify the Commissioner of Labour of any cases of LD if the patient's occupation involves repair, maintenance or service of either cooling system that uses fresh water or hot water service system. The notification form can be downloaded from the website at http://www.labour.gov.hk. Moreover, it is also prescribed for compensation under the Employees' Compensation Ordinance (Cap. 282).

# 4 Guidelines on Design, Operation and Maintenance of Water-Using Apparatus

Water-using apparatus should mean any apparatus or equipment utilising or consuming water in its normal operation.

Under all circumstances, the first option to be considered is to avoid, where reasonably practicable, the use of equipment which can create a spray of contaminated water. Where the use of such equipment cannot be avoided, the risk should be prevented or controlled by measures to reduce exposure to contaminated water droplets and to prevent conditions which allow the proliferation of legionellae in water.

## 4.1 Water Safety Plan for Water-Using Apparatus

**4.1.1** Developing a Water Safety Plan (WSP) for water-using apparatus is the preferred approach to manage specific health risks of exposure to legionellae.

**4.1.2** Owners or operators of water-using apparatus should develop the specific WSPs for their systems. Major benefits of developing and implementing WSP are the systematic and detailed assessment and prioritisation of hazards (biological, chemical or physical agents, or water conditions, with the potential to cause adverse health effects), and the operational barriers and control measures.

**4.1.3** The steps involved in developing a WSP are shown in Figure 10. WSP should consist of the following key components:

(a) System assessment – determination of whether the water quality at the point of potential exposure or use meets the health-based target, based on a risk assessment for the population likely to be exposed.

(b) Monitoring – identification and monitoring of control measures used to ensure water quality (e.g. biocide, temperature, pH).

(c) Management and communication – to document the results of system assessment and monitoring, and describe actions to be taken during normal operation and after incidents, including documentation and communication (e.g. a plan for remedial actions after adverse monitoring results, such as low residual biocide levels, and listing those to be informed of an event). The actions should be taken as soon as practicable.

**4.1.4** The WSP should be prepared in conjunction with the relevant parties (e.g. building facility managers, system operation and maintenance staff, water treatment service providers, etc.). The WSP should be reviewed on a regular basis to reflect changes and ongoing improvements in the system, the available evidence base and the surrounding environment. Finally the WSP should be amended if control is not maintained.

**4.1.5** The relevant details of the WSP can be referred to "Legionella and the Prevention of Legionellosis" published by World Health Organization (WHO) in 2007 (Item [1] in Section 9 of this Code).

## 4.2 Cooling Towers

Cooling towers are commonly used as heat rejection equipment for air conditioning and industrial cooling processes. The operation temperature of the coolant water is optimal to the growth of legionellae (Figure 1) and the generation of aerosol during the cooling process in the cooling tower easily leads to the dispersion of aerosol to the surroundings. Improperly designed, operated and maintained cooling towers have been one of the main sources of legionellae causing LD outbreaks. The longitudinal view of a typical cooling tower and the schematic diagram of a typical cooling tower system are shown in Figures 4A and 4B respectively.

**4.2.1** Design Precautions

(a) The cooling tower should be sited sufficiently far away from fresh air intakes of a building or an air conditioning system, operable windows, outlets of air exhaust system, and public thoroughfare. Minimum separation distances are given in the latest edition of Code of Practice for Fresh Water Cooling Towers – Part 1: Design, Installation and Commissioning.

(b) The cooling tower system should be provided with water treatment facilities, physical and/or chemical, to prevent the installation from corrosion and scale deposition and to suppress the growth of micro-organisms in cooling water.

(c) The cooling tower should be equipped with effective drift eliminator, which should also be extended across the air stream without any bypass. The permissible drift emission is given in the latest edition of Code of Practice for Fresh Water Cooling Towers – Part 1: Design, Installation and Commissioning.

(d) The fill and drift eliminator should be easily removable for cleaning or replacement and the materials should have adequate strength to withstand cleaning by water jet.

(e) The surfaces of all cooling tower construction materials should be non-porous and easy-to-clean.

(f) The water pipework of the cooling tower should be designed to avoid dead legs. If the existence of dead legs cannot be avoided, mitigation measures, such as manual/automatic drain valve for periodic drain-off, should be provided.

(g) Louvres, where appropriate, should be provided to prevent water from spilling out and to obstruct direct sunlight from entering the cooling water basin.

(h) The water basin should be smooth, without dirt trapping pattern, accessible, cleanable, and provided with drains of adequate size at the lowest point and at screeners.

(i) The cooling tower should be provided with easy access to all internal surfaces for inspection and removal of components. Ladder, handrail, platform and toe board should also be provided to facilitate cleaning, maintenance and inspection.

(J) A water tap should be fitted at the pipework for the collection of water samples for testing the water quality. The location of the water tap should be at a representative sampling point, preferably where the warm cooling water enters the cooling tower, and not adjacent to the make-up water inlet or the chemical dosing point(s).

### **4.2.2** Operation and Maintenance Precautions

#### **4.2.2.1** Water Treatment

(a) A comprehensive water treatment programme should be adopted to continuously or intermittently filter and treat the water with corrosion inhibitors, surfactants, and anti-fouling chemicals, or other proven physical methods. The water treatment programme should aim at controlling the fouling of the cooling tower system due to silt, scale and microbial growth in order to maintain efficient heat transfer at metal surfaces, ensure free flow of water throughout the system, and control the proliferation of bacteria.

(b) The selection of water treatment systems (physical or chemical) for eliminating and controlling general biological growth should be based on the following criteria:

(i) The water treatment system or the water treatment chemicals should preferably be proprietary products manufactured by a manufacturer to an international or national standard, and have proven record when used or dosed in accordance with the manufacturer’s recommendations in respect of frequency, dose strength, preparation, etc.

(ii) The water treatment system or the water treatment chemicals should be chemically and physically compatible with the cooling water.

(iii) The water treatment chemicals should be compatible and non-corrosive to piping materials.

(iv) The water treatment chemicals should be safe and easy to use.

(v) The water treatment chemicals and their end-products should be environmentally friendly and have no mammalian toxicity. They should be chemically and biologically degradable. They should not cause any hazards or adverse impacts to the environment through drainage and meet all relevant requirements and regulations of the Environmental Protection Department.

(vi) The water treatment chemicals should be compatible with each other, and should remain effective under a wide range of temperature changes, varying flow velocities, pH, conductivity, total dissolved solids and suspended matters commonly found in water circuit of a cooling tower system. The chemicals should be capable of penetrating foam, sludge, slime and scale.

(c) Water treatment chemicals should be added to turbulent zones within the water system to assist in rapid dilution and mixing. Also, if there are possible interactions between the treatment chemicals used, separate dosing points should be used to ensure dilution of one potentially reactive chemical prior to adding a second chemical.

(d) The method of dosing should either be:

(i) Automatic continuous drip feed or metered dosing with dosing rate and concentration control. This dosing method is highly recommended.

(ii) Manual slug dosing on regular basis (e.g. daily, twice-weekly, weekly, biweekly, etc.)

(iii) Automatic metered dosing controlled by timers or make-up water flowmeter, etc.

(e) The following water treatment strategies may also be considered:

(i) To use two chemicals, each of which should comply with the criteria aforementioned, alternatively at periodic intervals.

(ii) To use a combination of two compatible chemicals to provide better control against a range of micro-organisms.

(iii) To carry out occasional slug dosing or intermittent shock dosing with a high level of chlorine.

(f) The water treatment work should be carried out under the direction of suitably qualified and experienced persons. Chemicals should be handled with care by personnel wearing appropriate protective clothing, including goggles, gloves, face-shield and chemical-proof apron to prevent contact with these agents. Personnel involved in the work procedures should be trained in safety procedures, including the use and maintenance of protective equipment. They should wash and thoroughly dry hands before eating, drinking and smoking.

#### **4.2.2.2** Bleed-off

(a) Water in the cooling tower water circuit evaporates during normal cooling tower operation, leaving the dissolved substances behind in the water circuit and thus increasing the total dissolved solids (TDS) in the cooling water. This increase in TDS will lead to metal corrosion, chemical sedimentation, as well as growth of those bacteria which depend on the dissolved solids as nutrients.

(b) To overcome these problems, some amount of cooling water should be bled off and replaced with make-up water, thus limiting the concentration of the total dissolved solids.

(c) Bleed-off is preferred to be performed automatically by conductivity sensor. Intermittent discharge by timer control or manually operated drain valve is not preferred unless automatic bleed-off is not practicable.

(d) In order to conserve water, the cycle of concentration in designing bleed-off system should not be less than 6.

#### **4.2.2.3** Routine Cleaning and Disinfection

(a) Cooling towers should be cleaned, desludged and disinfected regularly. The frequency of cleaning should be based on tower cleanliness and the particular site environment. As a guide, the frequency of cleaning should be half-yearly. Less frequent cleaning intervals, but not exceeding yearly, is acceptable if the relevant performance is good. If not, more frequent cleaning may be required.

(b) Cleaning, desludging and disinfection should also be carried out if the cooling tower has been:

(i) contaminated during construction, or by dusts, inorganic or organic matters.

(ii) shut down for a prolonged time, say more than 1 week.

(iii) mechanically altered or disrupted in a manner which may lead to contamination.

(iv) infected or may have been infected by an adjacent cooling tower which has been confirmed as a source of LD case or outbreak.

(c) Cleaning, desludging and disinfection should be carried out as follows:

(i) To chlorinate the water and circulate for six hours, maintaining a minimum level of free residual chlorine at 5 ppm through the entire cooling tower water circuit.

(ii) To drain the entire water circuit and the make-up tank.

(iii) To manually clean the tower, sump, fill, eliminator, make-up tank and the water circuit system. Accessible areas of the towers and the fill pack should be adequately washed. Cleaning methods which create excessive spray such as high pressure water jetting should be avoided as far as possible. Staff involved in water jetting should be adequately trained, wear suitable respiratory protective equipment such as a cartridge respirator containing a particulate filter of appropriate efficiency. They should wash and thoroughly dry hands before eating, drinking and smoking.

(iv) To refill with water, rechlorinate and recirculate for at least six hours, maintaining a minimum level of free residual chlorine at 5 ppm.

(v) To drain and flush the system.

(vi) To refill with water and dose with the appropriate start-up level of treatment chemicals.

(vii) To re-commission the system.

**4.2.2.4** Important Points for Collecting Water Samples for Bacterial Tests

(a) Water samples should be collected from the water sampling point of the cooling tower system and away from the chemical dosing point, water inlet and bleed-off position. Sampling tap and hose, if provided, should be run with cooling water for at least 30 seconds prior to sampling.

(b) When a sampling point is not available, water should be collected from the cooling tower basin, or from where water falls from the fill into the basin.

## 4.3 Design, Operation and Maintenance Precautions of Other Components in Air-Conditioning Systems

**4.3.1** Condensate Drain Sealing Traps at Air Handling Unit/Fan Coil Unit (AHU/FCU)

Design, operation and maintenance precautions should include the following:

(a) Drain valves should be provided at the lowest points of the drain pipework to facilitate flushing.

(b) Adequate sloping at AHU/FCU condensate collection pan should be provided and the drain pipe should be connected at the lowest position of the drip tray to avoid accumulation of water (Figure 5).

(c) Condensate drain pans for AHU/FCU should be properly connected to the building drainage pipework.

(d) An air break and a suitable trap, such as anti-syphonage trap or U-trap, should also be provided at the condensate drain pipework before it is connected to the building drainage pipework to prevent backflow of drain from other AHU/FCU (Figure 6).

(e) Drain pans should be regularly inspected, cleaned and disinfected.

(f) Horizontal drain pipes should be regularly inspected for possible clogging.

**4.3.2** Air Duct and Air Filters

Design, operation and maintenance precautions should include the following:

(a) Appropriate air duct cleaning points/access panels should be provided to facilitate inspection and cleaning.

(b) Air duct servicing access points or panels should be provided at air duct at intervals of around 3 metres between centres in accessible positions. Access points or panels should also be provided at positions, such as around duct bends, tees, branches, duct heaters/reheaters, air mixing boxes, variable air volume (VAV) boxes, duct humidifiers, in-line booster fans, dampers and silencers, to facilitate cleaning and inspection.

(c) Air duct servicing access panels should preferably be of size not less than 250 mm x 250 mm. They should not cause dripping or condensation at their surfaces even at the worst condition under the prevailing weather in Hong Kong. In this connection, adequate thermal insulation should be provided between the cooling air flowing in the air duct and the metalwork of the servicing access panels against the hot and humid surrounding air around the access panels. In particular all metalwork forming a bridge through the insulation from the hot surrounding air to the cooled metal parts should be avoided or properly insulated and complete with an overall vapour barrier.

(d) Air filters in air conditioning system should be regularly inspected, cleaned or replaced to minimise the collection of dust and micro-organisms, so as to ensure good indoor air quality and to prevent the spread of bacteria causing infectious diseases.

**4.3.3** Humidifiers

Design, operation and maintenance precautions should include the following:

(a) Steam humidifier should be the first choice to be used for humidification.

(b) Water spray type humidifier and humidifier that operates on the principle of evaporation of cold water will generate fine mists and would become an infectious source of LD if water contains legionellae. Such humidifiers should be avoided in new installations, and should be replaced if used in existing installations.

(c) Recirculating water spray humidifiers should preferably be equipped with sidestream ultraviolet radiation for recirculating water.

(d) Recirculating water spray humidifiers should be cleaned frequently and to be purged prior to start-up. The water reservoir should be drained each day and the system should be disinfected at least once every six months. If the humidifier is shut down for over a month, it should be disinfected before being brought into use again.

**4.3.4** Air Washers

Design, operation and maintenance precautions should include the following:

(a) Because of utilising high pressure nozzles for producing small water droplets for air cleaning, the air washer should be designed and operated below or above the temperature range suitable for proliferation of legionellae.

(b) Dead end piping and any area in the water distribution system where water may become stagnant should be avoided.

(c) Water filters and air filters for the system should be regularly cleaned or replaced.

(d) Appropriate disinfectant device, such as photochemical ozone generator or ultraviolet radiation device, should be used to control microbiological growth in water.

(e) The complete air washer system should be cleaned not less than once a month.

## 4.4 Hot Water Supply Systems[1]

### 4.4.1 Centralised Hot Water Supply Systems

Centralised hot water supply systems usually operate at 35°C to 55°C. These temperatures are ideal for the growth of legionellae.

#### 4.4.1.1 Design Precautions

(a) The hot water storage device of the system (e.g. direct or indirect heated calorifier, storage vessel, etc.) should be designed to operate at 60°C or above to effectively kill the bacteria. The water reaching the thermostatic mixing valve or the tap outlet (for systems without mixing valve) should be at least 50°C within one minute of running the water or at least 55°C[2] in healthcare premises (such as hospitals) within one minute of running the water.

(b) However, in places where persons with decreased self-care ability may use hot water (such as paediatric, geriatric and psychiatric wards of hospitals, elderly homes, Residential Care Homes for Persons with Disabilities), the hot water supply temperature at outlets should not exceed 43°C to prevent accidental scalding.

(c) The water supply system and the size of the hot water storage device should be so designed that the water within the device should have reached 60°C for at least 5 minutes prior to being discharged to the distribution system under normal loading conditions.

(d) Drain outlets should be provided at the lowest points of hot water storage devices for flushing away settled sludge. The system should be easy to drain and clean.

(e) In order to overcome the problem of temperature stratification and stagnation of water in hot water storage devices and pipework, circulation pumps should be provided where necessary (Figure 7).

(f) The junction where cold and hot water mixes before reaching the outlet (e.g. at the thermostatic mixing valve) should be installed as near to the tap outlets as possible.).

(g) Thermostatic mixing valves should be used for mixing hot and cold water automatically to provide water at a preset temperature (Figure 8). Typically such thermostatic mixing valves should comply with the following:-

(i) The mixed water at the outlet of the tap should be within +2°C of the preset outlet temperature while the hot water supply temperature changes from 60°C to 50°C or 55°C.

(ii) The outlet temperature, if adjustable, should be resettable only with the aid of tools or else the mechanism for adjusting the temperature should be concealed and inaccessible to the users.

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1 For the parts of the system storing cold water (e.g. inlet water to the hot water system) or connected to the cold water supply system, please refer to Section 4.5.

2 Ref.: para 4.3.31.2.2.3 of BS 8558:2015, Para 2.156 of HSG274: Legionnaires' disease - Technical guidance Part 2 and Para 10.5 of Health Technical Memorandum 04-01: Safe water in healthcare premises (Part A: Design, installation and commissioning).

(iii) The valve should be fail-safe such that in case the cold water supply fails, the valve should automatically shut off the water supply within 4 seconds once the outlet water temperature is 10°C above the preset temperature.

(iv) The valve should be of durable design and be able to react quickly to hot and cold water temperature changes, as well as fluctuations in supply water pressure and back pressure from the final hot water outlets.

(v) The valve should be installed as near to the tap outlets as possible and the manufacturer's recommendations regarding the maximum number of tap outlets to be supplied by each thermostatic valve should be strictly followed.

(h) Dead legs and stagnant corners in the hot water pipework should be avoided. The number and length of spurs of hot water piping tap outlets should be minimised.

(i) The use of natural rubber, porous and organic matters (e.g. leathers) as parts of the pipework (e.g. as materials for washers) should be avoided since these materials provide nutrients and a favourable environment for the growth of micro-organisms. Materials such as neoprene and suitable synthetic materials which do not support microbial growth should be used instead.

(j) Hot water storage devices should be well insulated to prevent loss of heat down to a temperature (i.e. below 60°C) at which legionellae may survive.

(k) Short circuiting of the cold make-up water through the hot water storage devices should not be possible and the system should be designed to ensure that water is adequately heated to a temperature at 60°C or above prior to leaving the storage devices.

(l) Tap diffusers should not be installed in high risk areas such as hospitals. Mixing valves should be installed as close to the water outlets as possible, and shower fittings should be detachable so that they can be regularly cleaned and disinfected.

(m) All new piping systems and associated hot water storage devices, including existing systems undergoing major extensions or alterations subsequently, should be flushed clean to remove rust, sludge and sediment and disinfected upon commissioning. Where a system is not brought into use immediately after commissioning, it should also be disinfected before bringing into use unless it has been flushed at regular intervals of up to 30 days.

(n) New piping system and hot water storage devices are recommended to follow Water Supplies Department’s (WSD) current guidelines on cleansing and disinfection. Details of WSD's guidelines are available at the following:

http://www.wsd.gov.hk/en/pldc1/index.html
(WSD’s guidelines on cleansing and disinfection of fresh water inside service)

http://www.wsd.gov.hk/en/pldc2/index.html
(WSD’s guidelines on fresh water storage tanks)

#### **4.4.1.2** Operation and Maintenance Precautions

(a) Hot water storage devices should be operated at 60°C or above and the temperature before reaching the thermostatic mixing valve or at the tap outlet (for systems without mixing valve) should be maintained at least at 50°C or 55°C in all areas except those specified in 4.4.1.1 (b) above.

(b) Hot water storage devices should be regularly cleaned and drained to avoid contamination, sludge, slime, algae, fungi, rust, scale, dust, dirt and other foreign materials. The frequency of cleaning should depend on the accumulation rate of sediments, which is primarily dependent on the quality of the inlet water. Under normal circumstances, the cleaning frequency should be at least once per year.

(c) The following modifications/improvements should be carried out as necessary:

(i) To remove redundant pipework that may lead to stagnant water;

(ii) To retrofit existing hot water storage devices so as to provide drains at the lowest point of the devices;

(iii) To provide secondary pumped circulation where necessary to reduce temperature stratification within the hot water storage devices (Figure 7); and

(iv) To provide purge valves at the pipe ends of all unavoidable spurs or stagnant points in the pipework for draining/purging the dead ends for a minimum period of one minute at least on a weekly basis.

(d) Hot water outlets which are infrequently used or are connected to stagnant water supply pipework should be flushed at full flow for a minimum period of one minute at least on a weekly basis and before use. It is important that this procedure is carried out with minimum production of aerosols, e.g. additional piping may be used to purge contaminated water to drain.

(e) When thermostatic mixing valves are used, the following maintenance practices are recommended:

(i) To check the outlet water temperature with a thermometer monthly or at least quarterly to detect any shift in the outlet temperature from the required setting;

(ii) To carry out comprehensive maintenance involving inspection, dismantling for cleaning, replacing faulty parts and other parts as recommended by the manufacturer yearly. In areas with poor water quality, more regular servicing may be required;

(iii) To perform fail-safe test on each valve after comprehensive servicing by shutting down the cold water supply to the valve. Water flow from the valve should cease in accordance with 4.4.1.1(g) (iii);

(iv) Strainers in water taps and shower heads should be inspected, cleaned, descaled and disinfected regularly or on a frequency defined by the proper risk evaluation, taking account of the manufacturer's recommendations; and

(v) Installation of domestic water filters is not recommended due to potential health hazards if not properly maintained. If domestic water filters are installed, they should be cleaned or changed regularly in accordance with the manufacturer’s recommendations.

### 4.4.2 Localised Water Heater for Hot Water Supply

Hot water may be supplied by the installation of a localised water heater, which may be of instantaneous type or storage type, and mixed with cold water supply through a mixing valve for supply to water outlets. The following preventive measures should be observed:

(a) Dead legs and stagnant corners in the hot water pipework should be avoided. Length of hot water pipe should be minimised.

(b) The mixing valve should be installed as close to water outlets as possible.

(c) Water taps and shower heads connecting to water heaters if not frequently used should be flushed at full flow for a minimum period of one minute at least on a weekly basis and before use. It is important that this procedure is carried out with minimum production of aerosols, e.g. additional piping may be used to purge contaminated water to drain.

(d) For storage type localised water heater, hot/warm water inside the storage tank should be heated to 60°C or above before use.

## 4.5 Cold Water Supply Systems

Legionellae can also exist in the cold water supply systems when there are increased temperatures, appropriate nutrients and stagnated water in the systems.

### 4.5.1 Design Precautions

The following preventive measures on the design of cold water supply systems should also be observed for prevention of LD:

(a) Fresh water storage tanks should be fitted with a tight-fitting lid, and an appropriately sized drain valve and associated pipework to facilitate flushing, cleaning and decontamination. Overflow pipes and air vents should be fitted with a mesh to exclude vermin, dusts and other extraneous materials.

(b) Fresh water storage tanks should be installed at a shady location and insulated, if necessary, to ensure that the bulk of water stored does not rise to temperatures where legionellae will proliferate. Sufficient space, access, cleaning and drainage facilities should be available to permit easy inspection and maintenance.

(c) The use of natural rubber, porous and organic matters (e.g. leathers) as parts of the pipework (e.g. as materials for washers) should be avoided since these materials provide nutrients and a favourable environment for the growth of micro-organisms. Materials such as neoprene and suitable synthetic materials which do not support microbial growth should be used instead.

(d) Dead legs and stagnant corners in the cold water pipework should be avoided. The number and length of spurs of the piping should be minimised.

(e) All new piping systems and associated fresh water storage tanks, including existing systems undergoing major extensions or alterations subsequently, should be flushed clean to remove rust, sludge and sediment and disinfected upon commissioning. Where a system is not brought into use immediately after commissioning, it should also be disinfected before bringing into use unless it has been flushed at regular intervals of up to 30 days.

(f) New piping system and fresh water storage tanks are recommended to follow WSD's current guidelines on cleansing and disinfection. Details of WSD's guidelines are available at the following:

https://www.wsd.gov.hk/filemanager/article/en/upload/283/cir0212.pdf
(WSD's guidelines on cleansing and disinfection of fresh water inside service)

https://www.wsd.gov.hk/en/faqs/index.html#12-205
(WSD's guidelines for cleansing of fresh water tanks)

**4.5.2** Operation and Maintenance Precautions

The following preventive measures on the operation and maintenance of cold water supply systems should also be observed for prevention of LD:

(a) Fresh water storage tanks should be drained and cleaned regularly to avoid contamination, sludge, slime, algae, fungi, rust, scale, dust, dirt and other foreign materials. The tanks are recommended to follow WSD's current guidelines on cleaning and disinfection. The frequency of cleaning of fresh water storage tanks should be at least on a quarterly basis, or more frequent depending on the level of corrosion, sludge and sediment experienced. Details of WSD's guidelines are available at the following:

https://www.wsd.gov.hk/en/faqs/index.html#12-205
(WSD's guidelines for cleansing of fresh water tanks)

(b) Any corroded covers of fresh water storage tanks should be replaced to remove possible nutrients for microbial growth.

(c) Cold water outlets which are infrequently used or are connected to stagnant water supply pipework should be flushed at full flow for a minimum period of one minute[3] at least on a weekly basis and before use.

(d) Redundant pipework that may lead to stagnant water should be removed.

(e) Purge valves should be provided at the pipe ends of all unavoidable spurs or stagnant points in the pipework for draining/purging the dead ends for a minimum period of one minute at least on a weekly basis.

(f) Strainers in water taps and shower heads should be inspected, cleaned, descaled and disinfected regularly or on a frequency defined by the proper risk evaluation, taking account of the manufacturer's recommendations.

(g) Installation of domestic water filters is not recommended due to potential health hazards if not properly maintained. If domestic water filters are installed, they should be cleaned or changed regularly in accordance with the manufacturer's recommendations.

3 For measures to reduce risk of lead from water pipework, please refer to WSD's leaflet "Water Use Tips: How to reduce the risk of lead intake". (http://www.wsd.gov.hk)

## 4.6 Architectural Fountains

In man-made water fountains (including indoor decorative fountains and those installed in the indoor environment such as shopping centres for visual excitement), water is either sprayed in the air to form different features or splashed on the rocks to form cascades and returns to the man-made pool. A system that is operated intermittently may have greater chance to be detected with legionellae in the water.

### 4.6.1 Design Precautions

(a) Pipe runs should be as short as practicable to avoid dead legs and stagnant water in the pipework.

(b) Drain valves should be provided and situated at the lowest levels of the basin and the piping to facilitate flushing, cleaning and disinfection.

(c) Filters or strainers should be installed to remove sediments, dirt and debris in water.

(d) A water treatment system, such as physical methods, dosing of biocides and other chemicals, should be provided to control the microbial growth, scale formation and corrosion in the system, as well as to disinfect the circulating water.

(e) Adequate access for pipework, water pumps and filters should be provided for maintenance.

### 4.6.2 Operation and Maintenance Precautions

(a) The installation should be regularly and visually inspected for general cleanliness.

(b) The installation, including filters and strainers, should be regularly cleaned or replaced to reduce the accumulation of dirt, organic matter and other debris.

(c) A certain amount of pool water should be drained regularly and replenished with clean fresh water.

(d) The water treatment programme to control microbial fouling should be regularly reviewed for monitoring its effectiveness.

## 4.7 Spa Pool System

### 4.7.1 General

A spa pool is a self-contained body of warm, agitated water designed for sitting or lying in and not for swimming or total body immersion. Spa pools contain water heated usually between 30–40 °C, which is filtered and chemically disinfected. They have air-jet circulation with or without air-induction bubbles and can be sited indoors or outdoors. Such systems have the ability to produce aerosols by means of air jets or similar devices. A spa pool is usually drained, cleaned or refilled after a number of bathers or a maximum period of time rather than after each bather. A schematic diagram of a typical spa pool system is shown in Figure 9.

### 4.7.2 Design Precautions

(a) The pipework surface area should be smooth to minimise colonisation by biofilm bacteria. The use of flexible corrugated plastic pipes should be avoided because the surface area in the valleys between the ridges of the corrugations is difficult to clean.

(b) The pipework should be designed to minimise the length of pipe runs, the surface area and the number of pipe fittings. Dead legs of pipework, which cause stagnant water, should be avoided to prevent microbial growth.

(c) Provision should be made in the design to facilitate ease of access to all pipework for maintenance, draining, cleaning and disinfection.

(d) The system should be designed to have water continuously circulated, filtered, chemically and/or physically treated and heated.

(e) Chemicals added to the spa pool water as a solution should normally be added by dosing pumps, which can be adjusted to vary the volume of the chemicals dosed per stroke and the number of strokes per hour.

### 4.7.3 Operation and Maintenance Precautions

(a) The spa pool water should be continuously recirculated, filtered and disinfected, and with pH control to minimise the proliferation of micro-organisms. It is recommended to maintain a pH value of 7.2 to 7.8[4] for chlorinating disinfectants.

(b) When chlorinating disinfectants are used, a free chlorine residual of 3 to 5 ppm should be maintained in the pool water. Other biocides of effective concentration can also be used.

(c) The spa pool system should be checked daily before opening the spa pool, periodically throughout the day and at the end of the day after closing the spa pool for water clarity, condition of water filters, condition of automatic chemical dosing equipment, pool equipment cleanliness, residual disinfectant concentration, etc.

(d) Monthly, quarterly and annual programmes for checking and cleaning all equipment of the spa pool should be drawn.

(e) The spa pool system should be drained and cleaned, normally once a week. Excessive use of pools can lead to accumulation of soluble matter in the water. Any organic materials deposited on the sides of the pool should also be removed. The system should be refilled with clean water at intervals.

(f) Accessible pipework and jets should be inspected weekly and cleaned as necessary.

### 4.7.4 Whirlpool Baths

Whirlpool bath water is normally untreated and is intended to be filled and emptied after each use. Whirlpool baths have the potential for similar problems to spa pools, such as the formation of biofilms within the pipework system associated with the air and/or water booster jets, and should be regularly disinfected.

4 Ref.: s.8.4.1, page 132, Legionella and the Prevention of Legionellosis, WHO, 2007

## 4.8 Design, Operation and Maintenance Precautions of Other Water-Using Apparatus

**4.8.1** Dental equipment, misting devices for fruit and vegetable display cabinets in retail outlets, ice making machine, swimming pools, vehicle washers, high velocity water jet, emergency showers and eye wash sprays and respiratory therapy equipment are known water-using apparatus that have been suspected or confirmed in association with LD.

**4.8.2** The water using apparatus listed in 4.8.1 should be cleaned and disinfected in accordance with the manufacturer's recommendations or manufacturer's advice after due consultation. The water in use can be sterilised/distilled/boiled water to suit the applications in order to control bacterial growth, scale formation and to remove silt, dirt, sludge etc.

**4.8.3** Patients should seek and follow doctor's professional advice regarding the use and maintenance of home respiratory devices and use only sterile water (not distilled or tap water) to clean and fill the reservoir. Clean and maintain the device regularly according to manufacturer's instructions. After cleaning/ disinfection, rinse the device with sterile water, cooled freshly boiled water or water filtered with 0.2 μm filters. Never leave stagnant water in the device. Empty the water tank, keep all surface dry, and change the water daily.

# 5 Collection of Water Samples for Testing Legionella, Heterotrophic Colony Count (HCC), and Other Water Quality Parameters

**5.1** Regular collection of water samples from cooling towers for testing legionellae, HCC and other water quality parameters (such as total dissolved solids, suspended solids, conductivity, pH, total alkalinity, calcium hardness, inhibitors concentration, biocide concentration and residual chlorine) is important for monitoring and validating the effectiveness of the water treatment programme in order to prevent the proliferation of legionellae in the system. The frequency of collection of water samples from cooling towers for testing Legionella, HCC, other water quality parameters, the testing methods, the target ranges, and the associated actions required when their testing results were found falling outside the predetermined target ranges should be referred to the Code of Practice for Fresh Water Cooling Towers, Part 2 – Operation and Maintenance (Item [3] in Section 9 of this Code).

**5.2** The collection of water samples from other water-using apparatus for regular testing of legionellae, HCC and other water quality parameters should be based on risk assessment and specified in the WSP accordingly. Regular testing for legionella in cold/hot water systems in buildings in the community is generally not required. The WHO holds the view that the most important factors concerning control of legionella proliferation are appropriate design, control of risk factors and maintenance of individual systems.

**5.3** The testing methods or procedures for *Legionella* and HCC should comply with the current version of internationally recognised standards, such as:

| Legionella | Heterotrophic Colony Count |
|---|---|
| AS/NZS 3896 | AS 4276.3.1 |
| BS 6068-4.12 | BS 6068-4.5 |
| ISO 11731 | BS EN ISO 6222 |
| | APHA 9215B |

**5.4** The methods for collecting water samples and preservation and handling of water samples for testing *Legionella* and HCC should comply with the current version of relevant internationally recognised standards, such as AS 2031, BS 7592 or BS EN ISO 5667-3.

**5.5** The laboratory which carries out the above tests should be accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS) or any equivalent accreditation authority.

# 6 Control Measures during Outbreak of Legionnaires' Disease

The authority concerned may impose more stringent control measures to all water-using apparatus being suspected to be the potential sources during an outbreak of LD.

# 7 Design, Operation and Maintenance Records

**7.1** A formal design, operation and maintenance record for the system with accurate and adequate information should be kept and be made available for inspections if demanded by Government appointed officials.

**7.2** The record should include, but not limited to:

(a) the name, contact phone and address of the person and/or company who is responsible for design, operation and maintenance of the system.

(b) a description of the system, such as location, make, model, capacity and year of manufacture/installation, as well as details on the correct and safe operation.

(c) a schematic layout plan of the plant or system.

(d) a programme for routine water treatment, cleaning, desludging and disinfection of the system.

(e) details of maintenance such as:

(i) date and result of visual inspection;

(ii) date of cleaning, desludging and disinfection;

(iii) date of water treatment with details on the treatment carried out;

(iv) maintenance work and date executed;

(v) method of bleed-off and details of the automatic bleed-off controls, if any; and

(vi) report on defects/irregularities of the system.

(f) Each activity listed in (i) to (vi) should be authenticated by the signature of the person who has carried out the task.

**7.3** Arrange regular inspection of plumbing system on a quarterly basis and keep proper records of all activities of inspections, repairs, cleaning, draining/purging, and follow-up actions on the incidents of the plumbing system.

**7.4** Record books should be kept for at least 24 calendar months. The name, contact phone and address of the person or company who is holding the record book should be indicated by a durable label attached to or painted on the system.

# 8 Handling Garden Soils, Composts and Potting Mixes

**8.1** Garden soils, composts and potting mixes can be harmful to human health if people handling them do not take precautions. Soil surveys in Australia and Japan found that the soil samples were positive for *legionellae*. Infections with one species, *Legionella longbeachae*, have been associated with gardening and use of potting soil in Australia, Japan and United states.

**8.2** The likely routes of transmission of *Legionella longbeachae* are from contaminated hands to mouth and by breathing in aerosol and dust from contaminated materials. However, there is no known effective way of preventing proliferation and multiplication of *Legionella longbeachae* in garden soils, composts and potting mixes.

**8.3** To help prevent infection, the following precautions should be taken when handling such materials:

(a) Read the warning on bagged garden soils, composts and potting mixes.

(b) Wear gloves and a face mask.

(c) Carefully dampen contents in the bag before opening it fully.

(d) Open composted potting mixes slowly and direct the opening away from the face.

(e) Gently water gardens and composts using low pressure.

(f) Avoid breathing in dust of garden soils, composts and potting mixes.

(g) Avoid working in poorly ventilated places such as enclosed greenhouses.

(h) Wet the soil to reduce dust when potting plants.

(i) Wash hands immediately and thoroughly after handling garden soils, composts and potting mixes.

(j) Dispose of gloves and face mask carefully.

# 9 References


(1) Legionella and the Prevention of Legionellosis, World Health Organization (WHO), 2007

(2) Occupational Safety & Health Administration (OSHA) Technical Manual, Chapter 7, Department of Labour, USA

(3) Code of Practice for Fresh Water Cooling Towers – Part 1 to Part 3, Electrical and Mechanical Services Department, Hong Kong Special Administrative Region, China, 2016

(4) Code of Practice for the Control of Legionnaires' Disease, New South Wales Department of Health, Australia, 2004

(5) Code of Practice for the Control of Legionella Bacteria in Cooling Towers, Institute of Environmental Epidemiology, Ministry of Environment, Singapore, 2001

(6) Approved Code of Practice and Guidance – The Control of Legionella Bacteria in Water Systems, Health and Safety Executive, UK, 2013

(7) TM13:2013 Minimising the Risk of Legionnaires' Disease, CIBSE, UK, 2013

(8) ASHRAE Guideline 12-2000 Minimizing the Risk of Legionellosis Associated with Building Water System, American Society of Heating, Refrigeration and Air Conditioning Engineers, USA, 2000

(9) Enjoy gardening without the risk of *Legionella Longbeachae*, Government of South Australia, 2013 (http://www.lga.sa.gov.au)

(10) Management of SPA Pools: Controlling the Risk of Infection, Health Protection Agency, UK, 2006

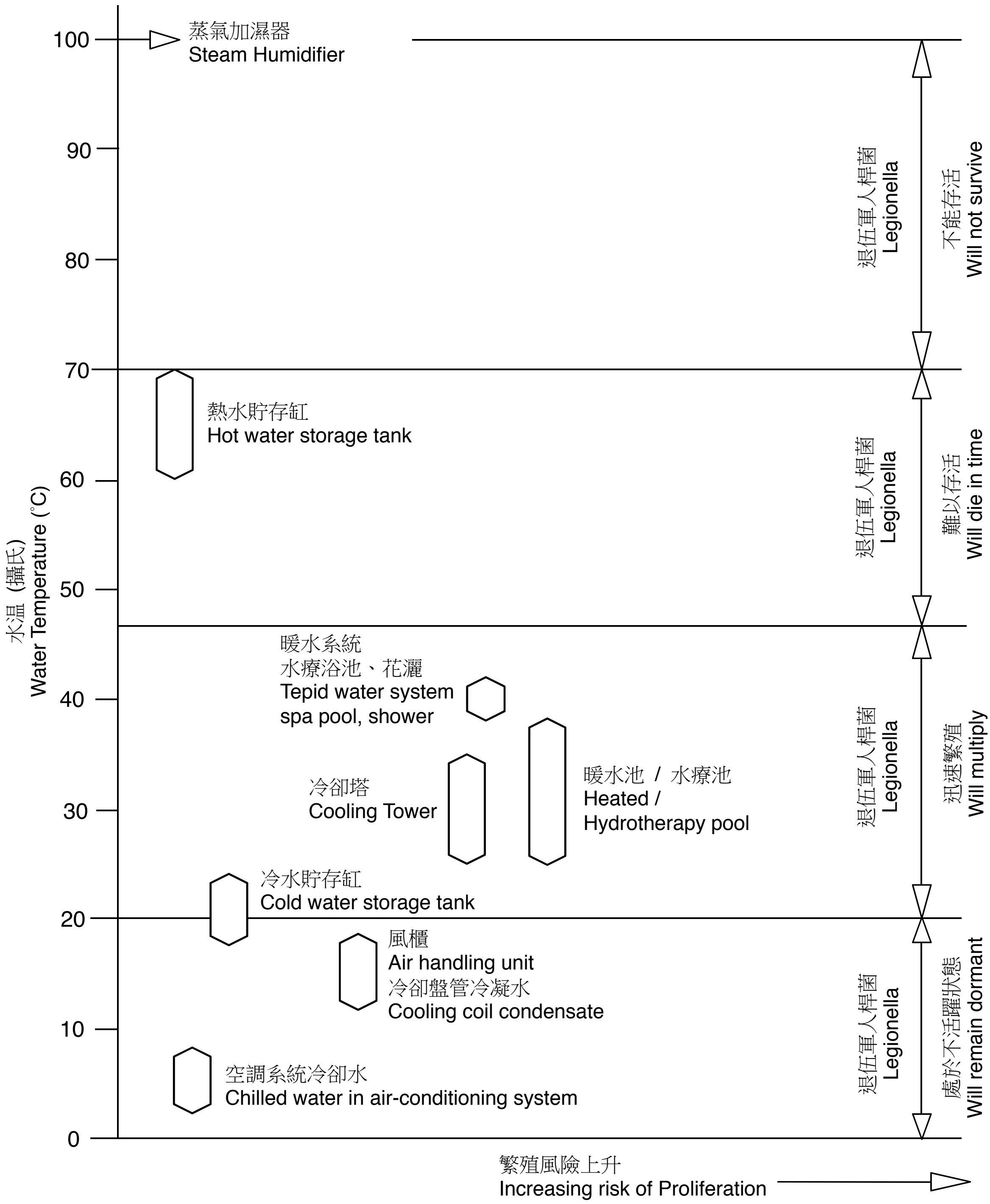
(11) National Guidelines for the Control of Legionellosis in Ireland, 2009, Health Protection Surveillance Centre, Ireland, 2009

(12) BS 8558:2015 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806, The British Standards Institution, UK, 2015

## FIGURE 1 圖 1

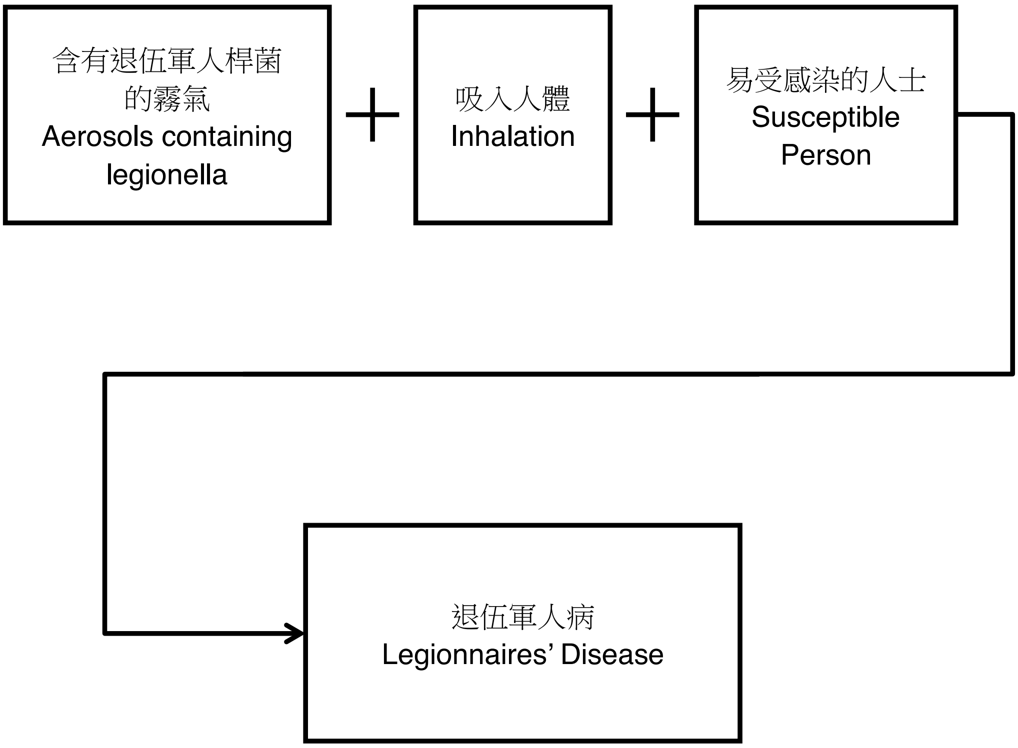
## Relationship between Proliferation of Legionella and Temperature of Water Systems

## 退伍軍人桿菌的繁殖與供水系統温度的關係



## FIGURE 2 圖 2

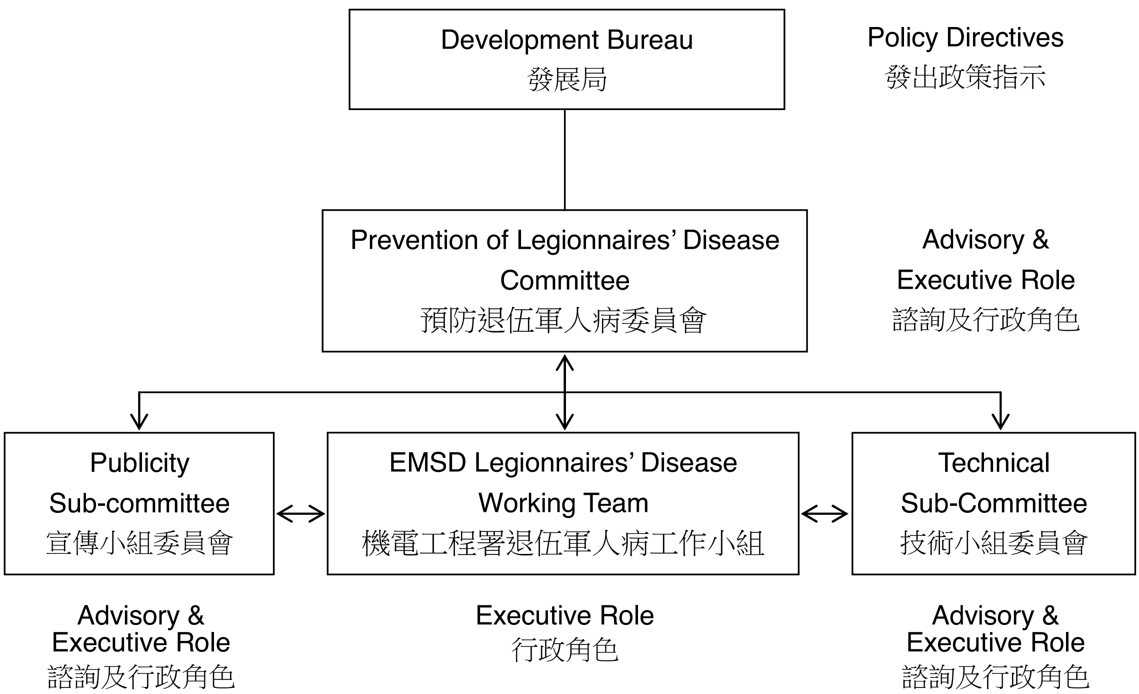
## Transmission of Legionnaires' Disease
## 退伍軍人病的傳播



# FIGURE 3A 圖 3A

## Organisation of The Prevention of Legionnaires' Disease Committee

## 預防退伍軍人病委員會組織圖




**Publicity Sub-committee 宣傳小組委員會**

Members 委員

1. EMSD 機電工程署
2. DH 衞生署
3. ISD 政府新聞處

Members Attending on as-and-when Required Basis
在有需要情況下出席的委員

1. Members of Medical Profession 醫學界委員
2. Members of Engineering Profession 工程界委員

**Technical Sub-Committee 技術小組委員會**

Members 委員

1. EMSD 機電工程署
2. DH 衞生署
3. ArchSD 建築署

Members Attending on as-and-when Required Basis
在有需要情況下出席的委員

1. BD 屋宇署
2. FEHD 食物環境衞生署
3. LD 勞工處
4. WSD 水務署
5. Members of Medical Profession 醫學界委員
6. Members of Engineering Profession 工程界委員

**Note 註**：

| | | |
|---|---|---|
| ArchSD | 建築署 | Architectural Services Department |
| BD | 屋宇署 | Buildings Department |
| DH | 衞生署 | Department of Health |
| EMSD | 機電工程署 | Electrical and Mechanical Services Department |
| FEHD | 食物環境衞生署 | Food and Environmental Hygiene Department |
| ISD | 政府新聞處 | Information Services Department |
| LD | 勞工處 | Labour Department |
| WSD | 水務署 | Water Supplies Department |

## FIGURE 3B 圖 3B

## Terms of Reference and Composition of Prevention of Legionnaires' Disease Committee

## 預防退伍軍人病委員會職權範圍及委員名單

**Terms of Reference 職權範圍**

To advise the Government from the public health, microbiology and engineering services perspectives on:

(a) the minimization of the risk of Legionnaires' disease; and

(b) the promotion of good practices to the building owners and associated practitioners to prevent the outbreak of Legionnaires' disease.

從公眾健康、微生物學及工程服務的角度，就以下事宜向政府提供意見：

(a) 減低退伍軍人病的風險；以及

(b) 向建築物擁有人及有關從業員推廣良好作業方法，以預防爆發退伍軍人病。

| | | |
|---|---|---|
| **Terms of Appointment** | : | 3 years |
| **任期** | : | 三 年 |

**Composition 成員**

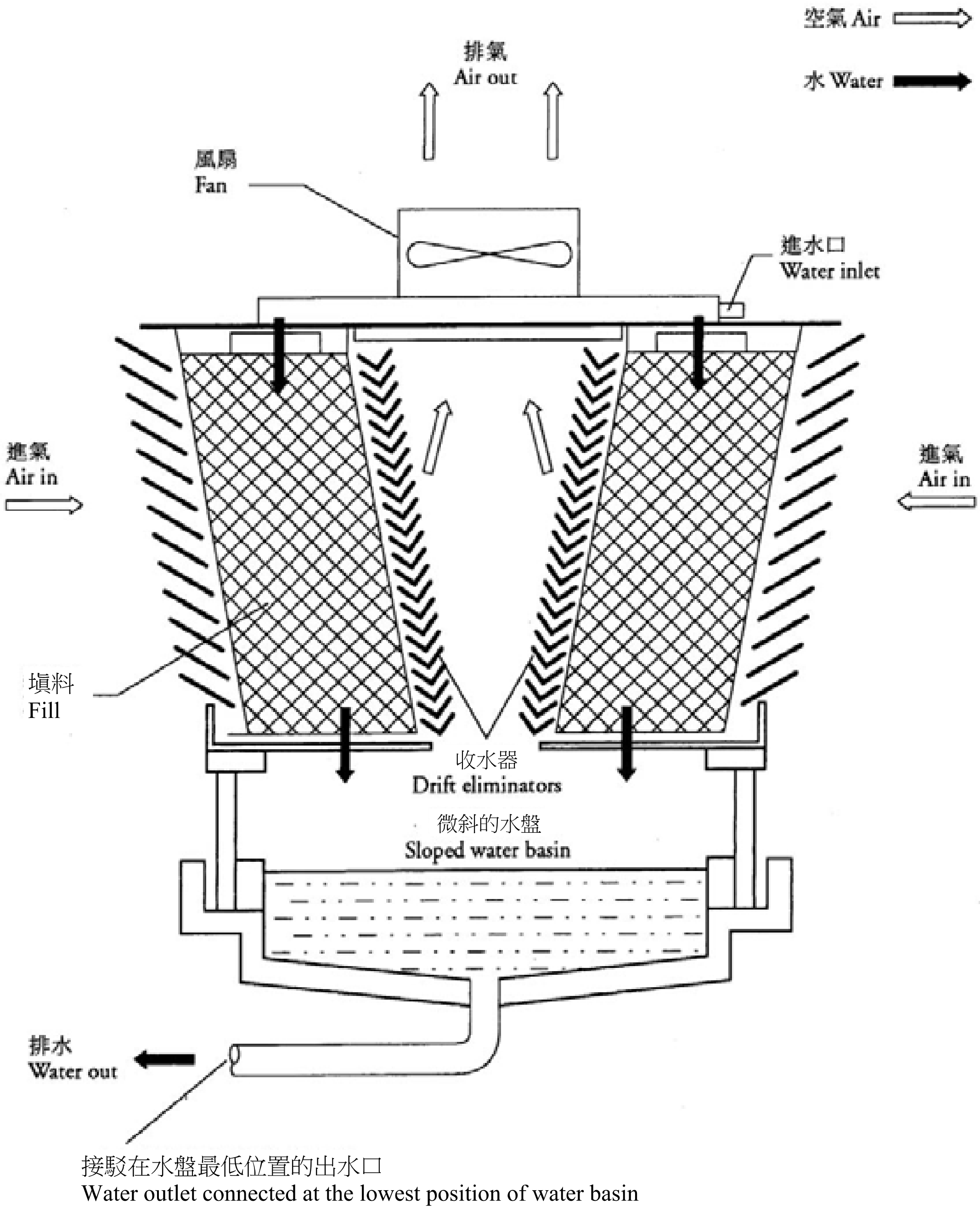
| | |
|---|---|
| Chairman<br>主席 | A renowned medical professional #<br>一位著名的醫學專家 |
| Vice-chairman<br>副主席 | An Assistant Director of Electrical & Mechanical Services Department<br>一位機電工程署助理署長 |
| Members<br>委員 | <u>Non-official Members # 非官方委員</u><br>A nominee from the Li Ka Shing Faculty of Medicine, the University of Hong Kong<br>一位由香港大學李嘉誠醫學院提名的人士<br>A nominee from the Faculty of Medicine, the Chinese University of Hong Kong<br>一位由香港中文大學醫學院提名的人士<br>A nominee from the Hong Kong Institution of Engineers<br>一位由香港工程師學會提名的人士<br>A nominee from the Hong Kong Federation of Electrical & Mechanical Contractors<br>一位由香港機電工程商聯會提名的人士<br><u>Official Members 官方委員</u><br>A representative of the Secretary for Development<br>一位發展局局長的代表<br>A representative of the Director of Architectural Services<br>一位建築署署長的代表<br>A representative of the Director of Buildings<br>一位屋宇署署長的代表<br>Two representatives of the Director of Health<br>兩位衞生署署長的代表<br>A representative of the Director of Water Supplies<br>一位水務署署長的代表 |
| Secretary<br>秘書 | A Senior Professional of Electrical & Mechanical Services Department<br>一位機電工程署的高級專業人員 |

# appointed on a personal basis
以個人身份委任

| | |
|---|---|
| Membership List<br>委員名單 | http://www.emsd.gov.hk |

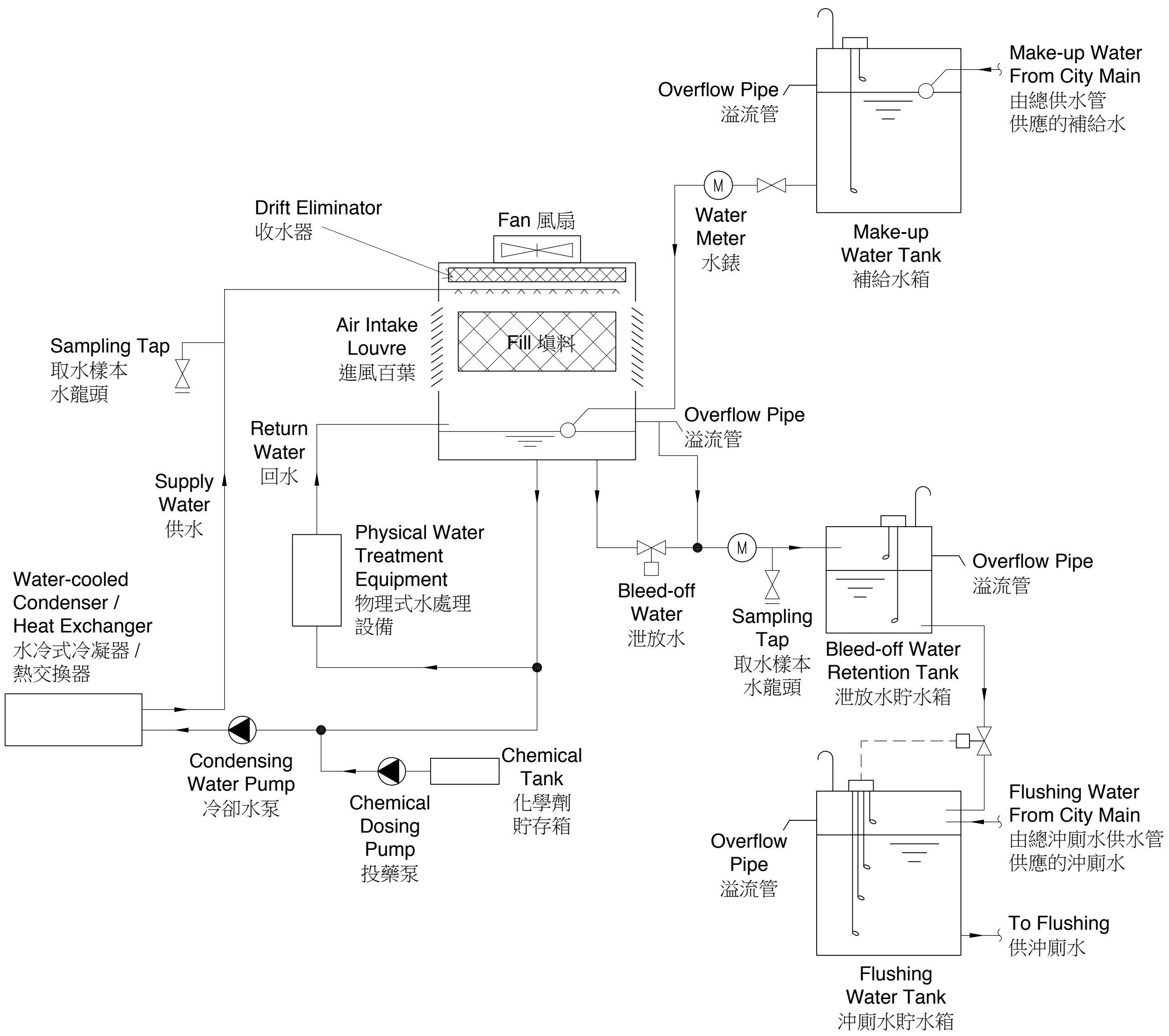
## FIGURE 4A 圖 4A

## Longitudinal Section of a Typical Cooling Tower
## 典型冷卻塔縱切面圖



# FIGURE 4B 圖 4B

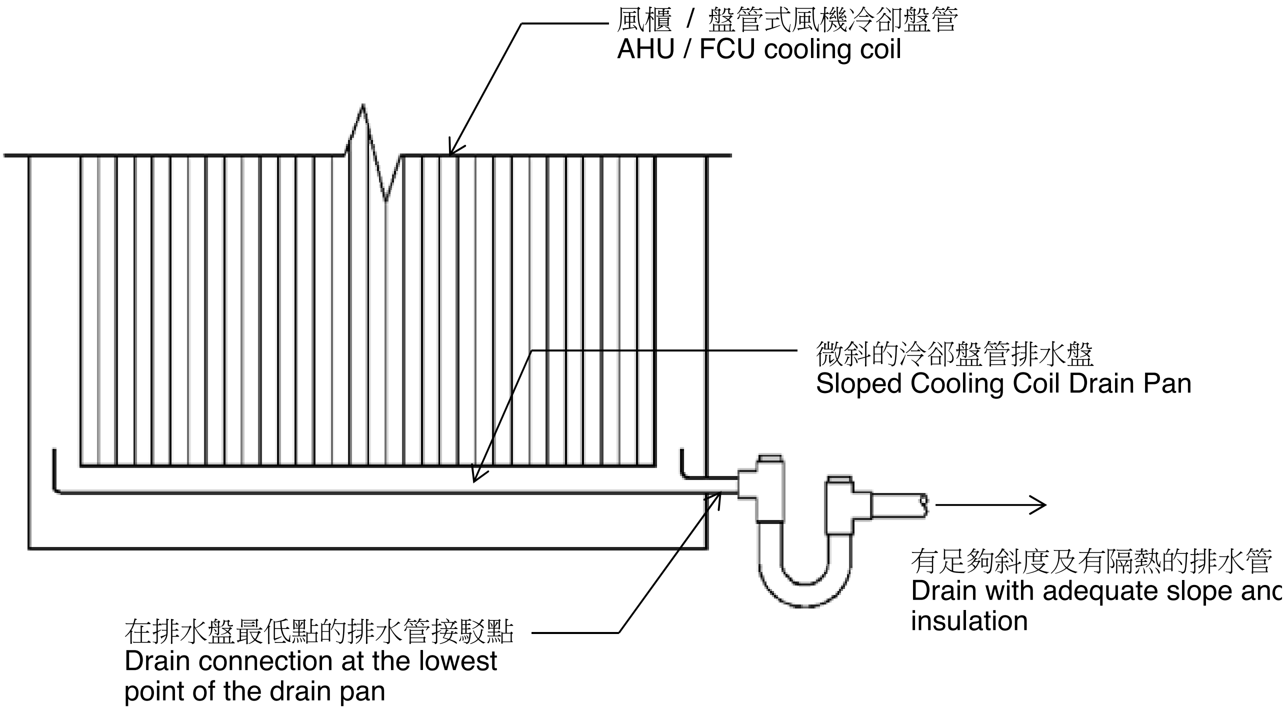
## Schematic Diagram of a Typical Cooling Tower System
## 典型冷卻塔系統示意圖



## FIGURE 5 圖 5

## Condensate Drain Sealing Trap at AHU / FCU Cooling Coil Drain Pan

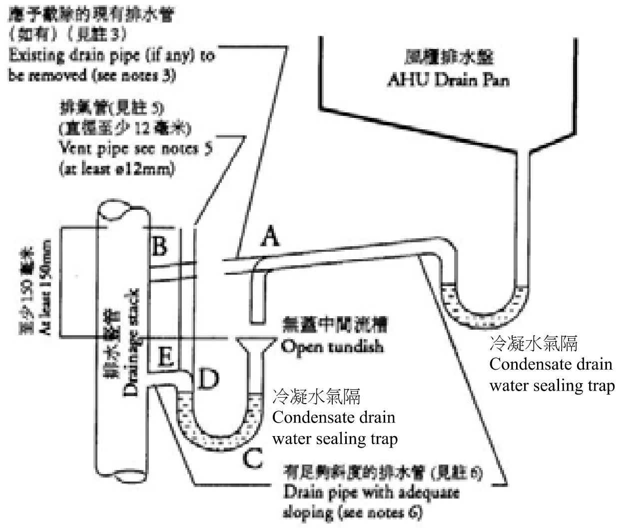
## 風櫃 / 盤管式風機排水盤的冷凝水氣隔



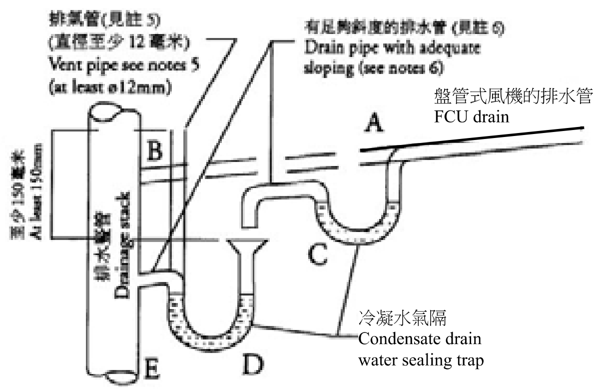
# FIGURE 6 圖 6

## Condensate Drain Water Sealing Trap at AHU/ FCU Condensate Drain Pipework

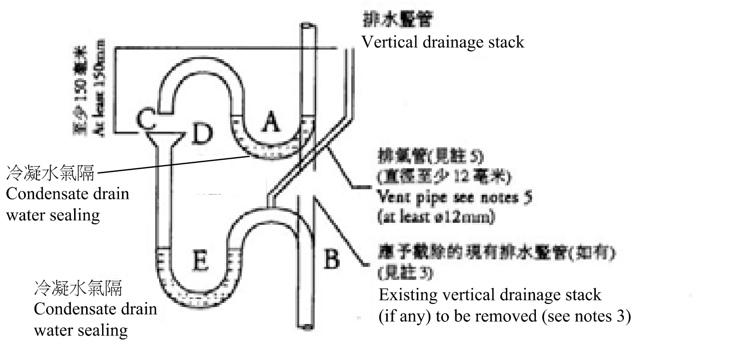
## 風櫃 / 盤管式風機冷凝水排水喉管的冷凝水氣隔




i) 風櫃排水管的接駁方式 AHU drain connection




ii) 盤管式風機排水管的接駁方式 FCU drain connection




iii) 排水豎管的其他設計方法 Alternative design at vertical draining stack

註 Notes:

1. 視乎實地情況，應採用i)、ii)或iii)類的方法設計水封。
   Depend on the site condition, the design of the water seal should be of type i), ii) or iii).

2. 排水管及無蓋中間流槽應予隔熱。
   Drain pipes and open tundish should be insulated.

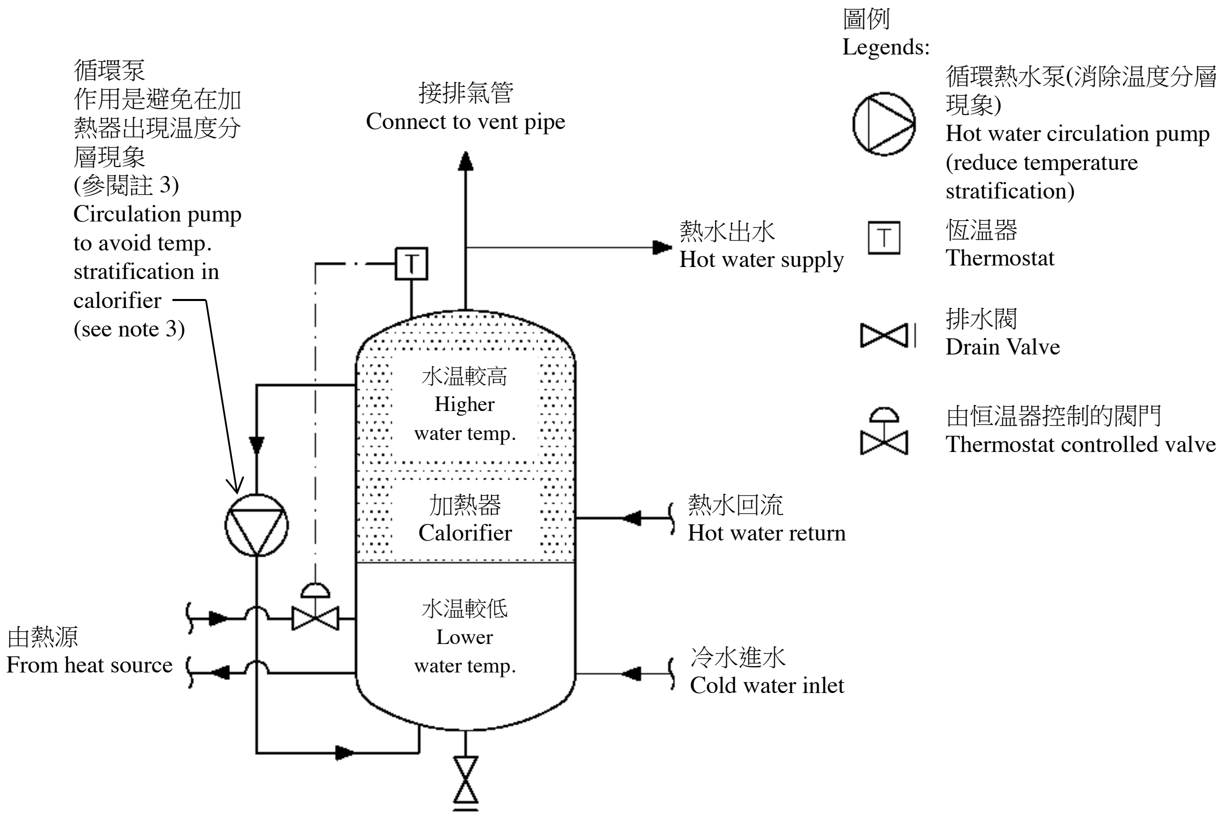
3. 如現已設有排水管，則該管的A至B段應予截除。所有受破壞的隔熱應予修妥。
   The existing drain pipe (if any) from A to B should be removed. All damaged insulation should be made good.

4. 冷凝水氣隔應有足夠水封來承受來自風櫃 / 盤管的最大靜止壓力
   Condensate drain water sealing trap shall be of sufficient depth to withstand maximum total static pressure in AHU / FCU casing.

5. 應視乎需要按繪圖所示加裝排氣管，或可選擇安裝反虹吸的氣隔。
   The additional vent pipe shown in the drawing should be required as necessary or using alternative design with anti-syphonage trap.

# FIGURE 7 圖 7

## Pumped Circulation in Calorifier to Reduce or Eliminate Temperature Stratification
## 在加熱器內施行泵壓循環以減低或消除溫度分層現象




註 Notes:

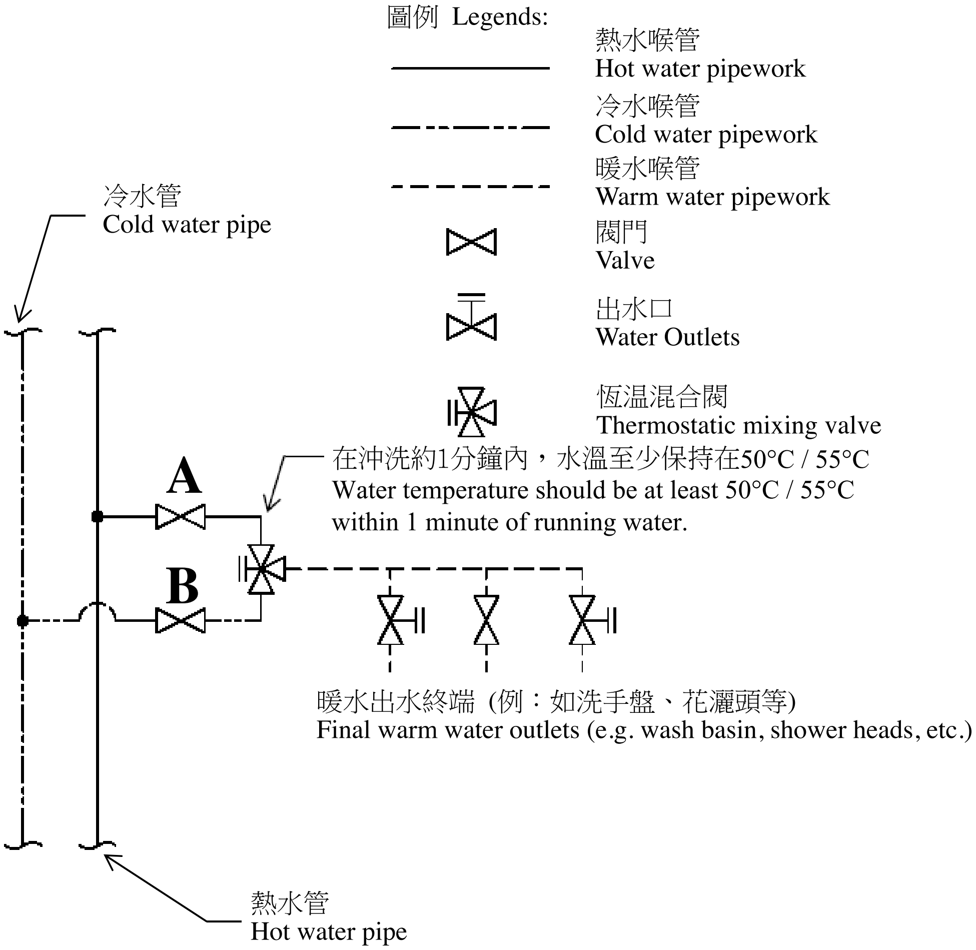
1. 低壓、高流量的循環泵的流量，應按實際情況釐定。作為一項指引，可將熱水系統每小時的最高需求除以該系統內運作的加熱器總數，作為初步設定的流量。
   The flowrate of the low head, high flowrate circulation pump should be determined on site. As a guideline, the flowrate could first be set at the calculated peak hourly demand of the hot water system divided by the total no. of operating calorifiers in the system.

2. 循環泵可以用定時器控制，亦可持續不斷地操作。在設定泵操作的總運行時間及頻率時，應顧及要減低或消除加熱器出現溫度梯度現象。
   The circulation pump may be timer controlled or continuously operated. The total run time and frequency of operation should be so selected to reduce or eliminate the temperature gradient within the calorifier.

3. 除非已察覺到熱水供應系統提供了適合退伍軍人桿菌繁殖的環境，否則無須採取減低或消除加熱器出現溫度分層現象的措施。
   If was not considered necessary to take any action to reduce or eliminate temperature stratification in calorifiers unless it was recognized that the hot water supply system could provide an environment suitable for the proliferation of legionella.

# FIGURE 8 圖 8

## Thermostatic Mixing Valve
## 恆溫混合閥




註 Notes:

1. 在正常情況下閥門 A 及閥門 B 應該開啟。當恆溫混合閥進行例行故障保險測試時，應把閥門 B 關掉。
   Valves A and B shall be turned on normally. Valve B should be shut off for routine fail-safe test of the thermostatic mixing valve.

2. 每個恆溫混合閥可供接駁的暖水出水終端數目上限，應遵循製造商所作的建議。
   Maximum no. of final warm water outlets to be supplied by each thermostatic mixing valve shall follow the recommendation of the manufacturer.

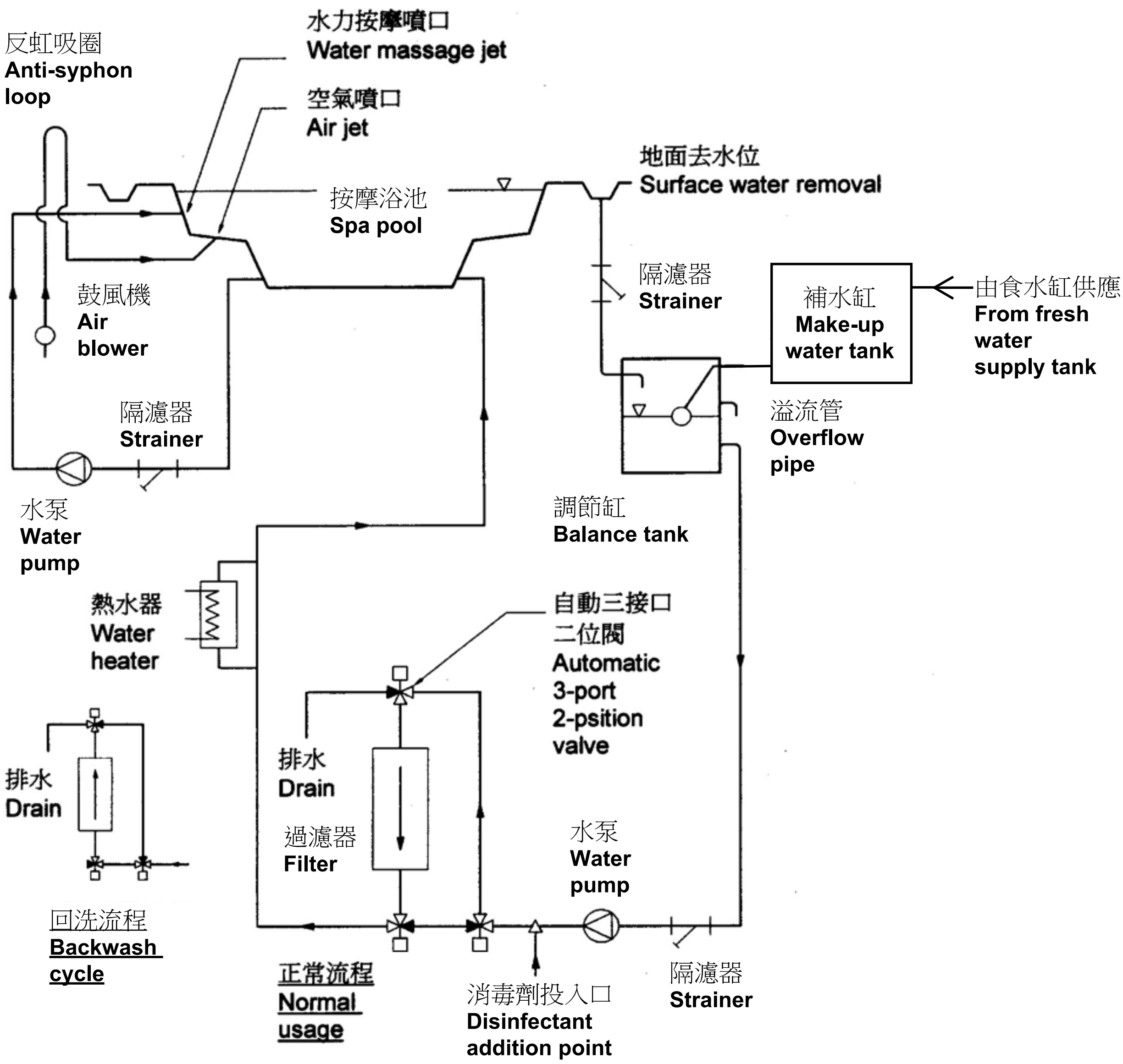
3. 恆溫混合閥應盡量安裝在靠近暖水出水終端的位置。
   Thermostatic mixing valve should be installed as near to the final warm water outlets as possible.

4. 作為一種安全措施而言，理想出水溫度於暖水出水終端應由恆溫混合閥調節。
   The desirable outlet temperature at water fitting is regulated by thermostatic mixing valve as a safety measure.

5. 水到達恆溫混合閥或水龍頭出水口（在沒有混合閥的系統）在沖洗的一分鐘內，都必須至少保持在攝氏 50 度或於醫療地方（如醫院），熱水龍頭出水口在沖洗的一分鐘內，必須保持在攝氏 55 度。
   The water reaching the thermostatic mixing valve or the tap outlet (for systems without mixing valve) should be at least 50°C within one minute of running the water or at least 55°C in healthcare premises (such as hospitals) within one minute of running the water.

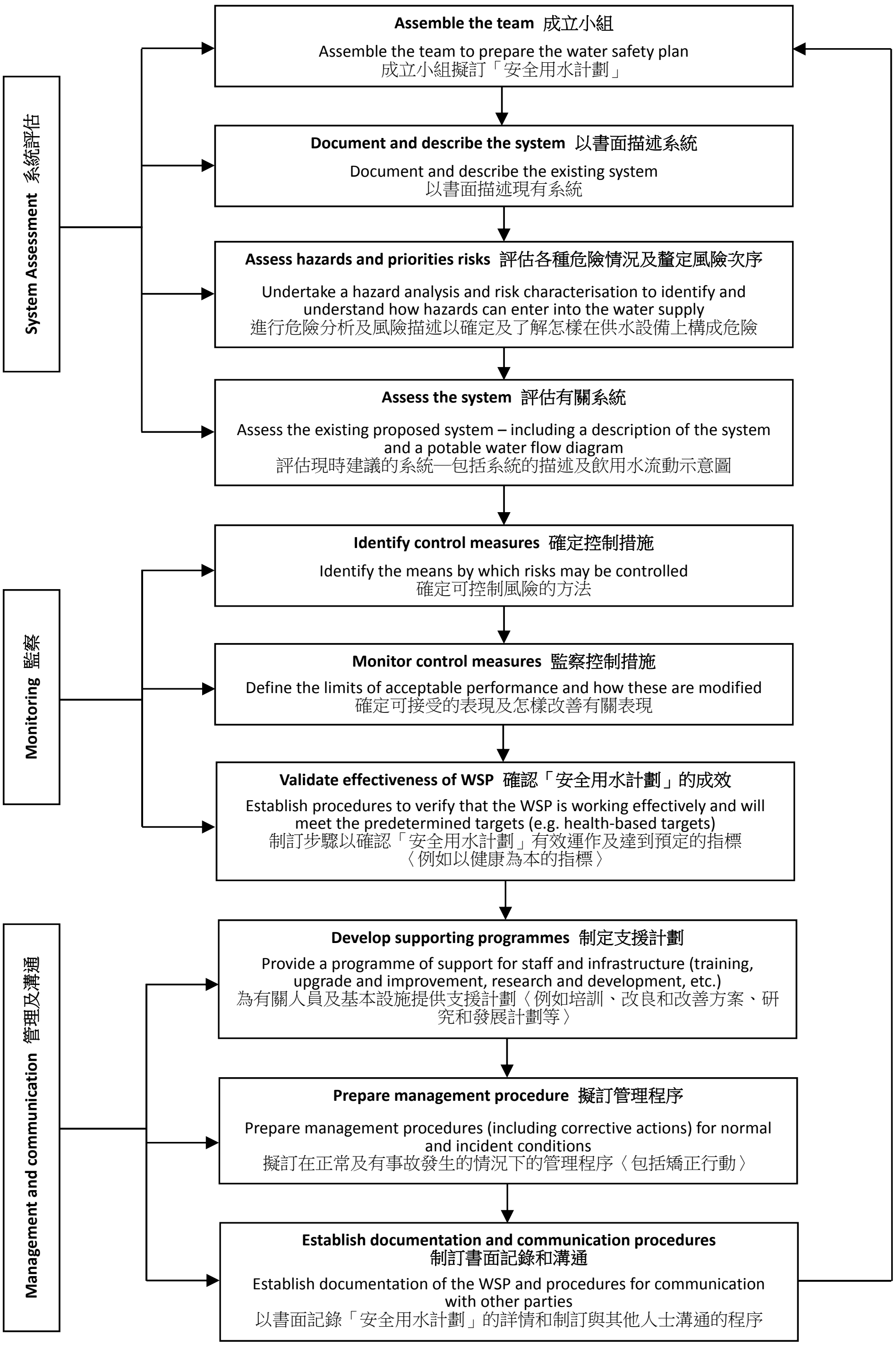
# FIGURE 9 圖 9

## Schematic Diagram of a Typical Spa System
## 典型按摩浴池系統示意圖



# FIGURE 10 圖 10

## Overview of the Key Steps in Developing a Water Safety Plan
## 制訂安全用水計劃的主要步驟概要




Source: Adapted from "Legionella and the Prevention of Legionellosis" published by WHO in 2007
來源：根據世衞在 2007 年出版的"Legionella and the Prevention of Legionellosis"制訂

Secretariat, Prevention of Legionnaires' Disease Committee,Hong Kong
香港預防退伍軍人病委員會秘書處

Address: 3 Kai Shing Street, Kowloon, Hong Kong
地址：香港九龍啟成街3號

Tel. 電話：3757 6156 Fax 傳真：2890 6081

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