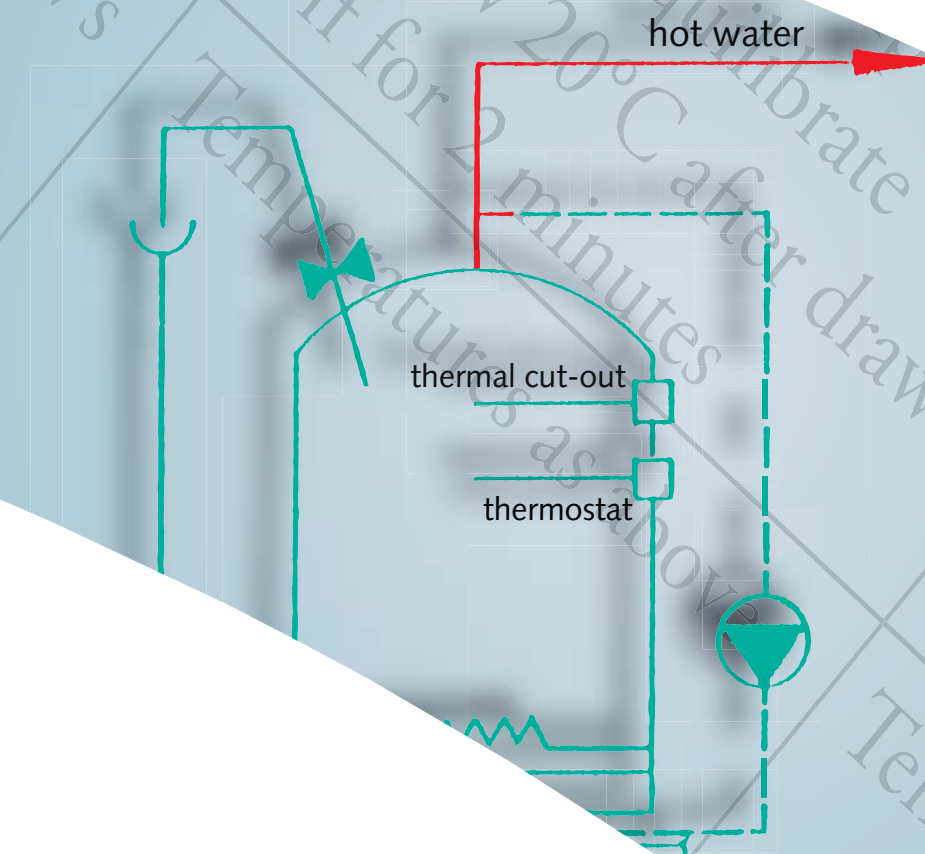


# Water systems

## Health Technical Memorandum 04-01: The control of *Legionella*, hygiene, "safe" hot water, cold water and drinking water systems

*Part B: Operational management*



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HR / Workforce	Performance	
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## **Water systems**

### **Health Technical Memorandum 04-01:**

# **The control of *Legionella*, hygiene, “safe” hot water, cold water and drinking water systems**

## **Part B: Operational management**



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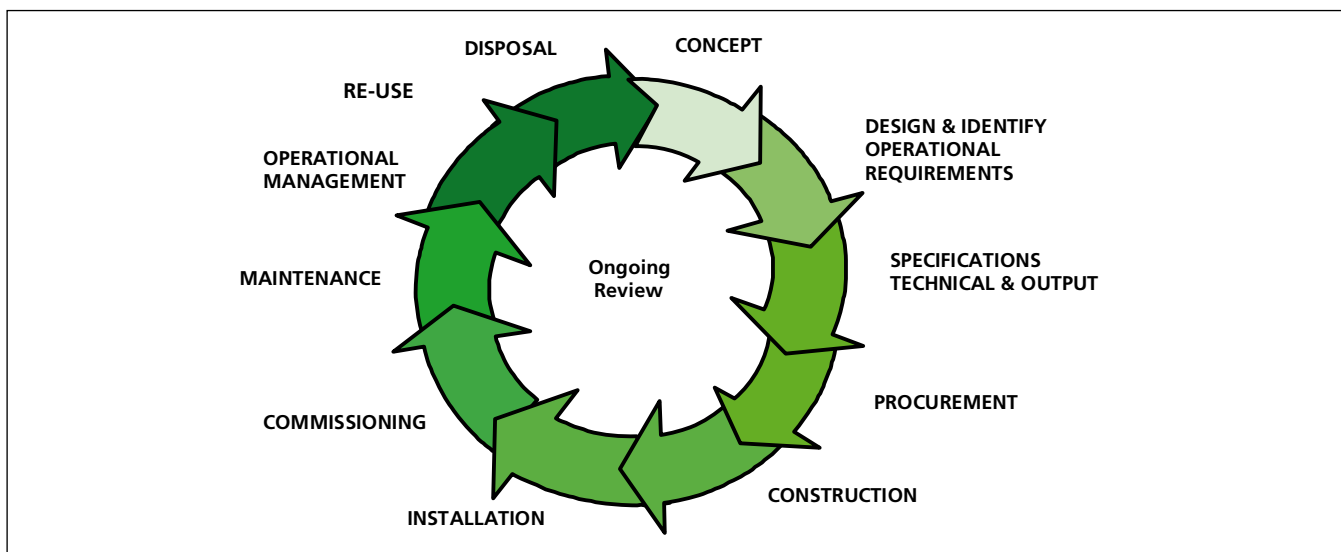
# Preface

## About Health Technical Memoranda

Engineering Health Technical Memoranda (HTMs) give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of HTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle:

Figure 1 Healthcare building life-cycle



Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

It is not the intention within this suite of documents to unnecessarily repeat international or European standards, industry standards or UK Government legislation. Where appropriate, these will be referenced.

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Health Technical Memorandum guidance is the

main source of specific healthcare-related guidance for estates and facilities professionals.

The core suite of nine subject areas provides access to guidance which:

- is more streamlined and accessible;
- encapsulates the latest standards and best practice in healthcare engineering;
- provides a structured reference for healthcare engineering.

## Structure of the Health Technical Memorandum suite

The series of engineering-specific guidance contains a suite of nine core subjects:

- Health Technical Memorandum 00  
Policies and principles (applicable to all Health Technical Memoranda in this series)
- Health Technical Memorandum 01  
Decontamination
- Health Technical Memorandum 02  
Medical gases

Health Technical Memorandum 03  
Heating and ventilation systems

Health Technical Memorandum 04  
Water systems

Health Technical Memorandum 05  
Fire safety

Health Technical Memorandum 06  
Electrical services

Health Technical Memorandum 07  
Environment and sustainability

Health Technical Memorandum 08  
Specialist services

Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Health Technical Memorandum 06-02 Part A will represent:

Electrical safety guidance for low voltage systems

In a similar way Health Technical Memorandum 07-02 will simply represent:

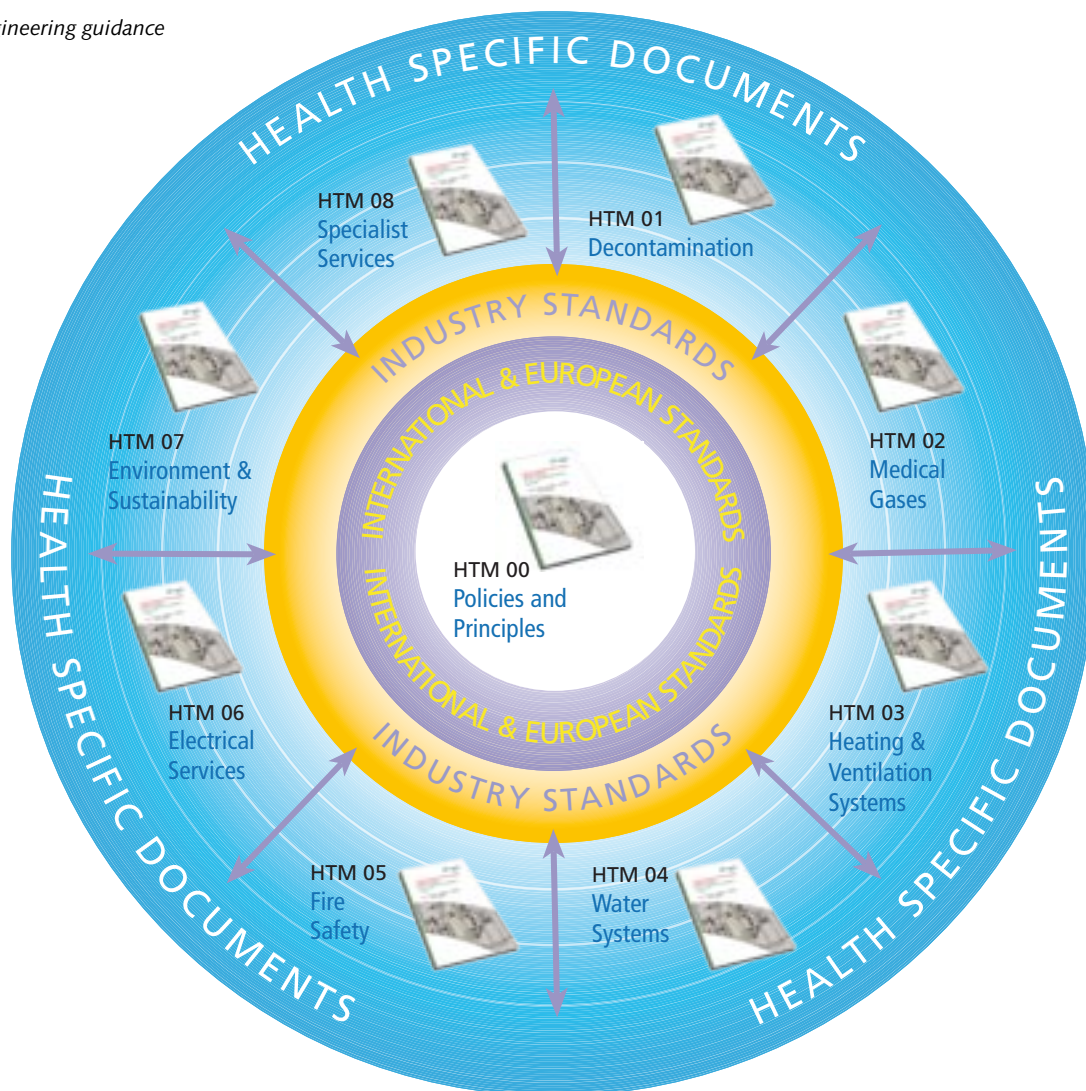
Environment and Sustainability – EnCO<sub>2</sub>de.

All Health Technical Memoranda are supported by the initial document Health Technical Memorandum 00 which embraces the management and operational policies from previous documents and explores risk management issues.

Some variation in style and structure is reflected by the topic and approach of the different review working groups.

DH Estates and Facilities Division wishes to acknowledge the contribution made by professional bodies, engineering consultants, healthcare specialists and NHS staff who have contributed to the review.

Figure 2 Engineering guidance



# Executive summary

## Preamble

Health Technical Memorandum 2027 – ‘Hot and cold water supply, storage and mains services’ and Health Technical Memorandum 2040 – ‘The control of *Legionella* in healthcare premises: a code of practice’ have both been revised, and have, at the same time, been combined into this single document: Health Technical Memorandum 04-01 – ‘The control of Legionella, hygiene, “safe” hot water, cold water and drinking water systems’.

The guidance has been revised in line with changes to relevant regulations, standards and other guidance, and also technical developments.

Health Technical Memorandum 04 now supersedes Health Technical Memorandum 2027 and Health Technical Memorandum 2040.

## Introduction

The development, construction, installation and maintenance of hot and cold water supply systems are vital for public health. Healthcare premises are dependent upon water to maintain hygiene and a comfortable environment for patients and staff, and for clinical and surgical care.

Interruptions in water supply can disrupt healthcare activities. The design of systems must ensure that sufficient reserve water storage is available to minimise the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution systems.

This Health Technical Memorandum gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises. It is equally applicable to both new and existing sites.

## Aims of this guidance

This guidance has been written to:

- provide information on thermostatic mixing valve configurations, usage and maintenance requirements;
- outline how quality and hygiene of water supply can preserve system components and safe use by occupants;
- provide a point of reference to legislation, standards and other guidance pertaining to water systems;
- provide a basic overview of possible bacterial contaminants;
- outline key criteria and system arrangements to help stop bacteria proliferate;
- give an overview of some of the different water systems components and their safe installation and operation;
- provide typical system layouts and individual component location;
- illustrate the importance of “safe” delivery of hot water;
- illustrate temperature regimes for sanitary outlets used in healthcare premises to reduce risk of occupant injury;
- identify key commissioning, testing and maintenance requirements for referral by designers, installers, operators and management.

## Recommendations of Part B

- The temperature control regimen is the preferred strategy for reducing the risk from *Legionella* and other waterborne organisms in water systems. This will require monitoring on a regular basis. The recommended test frequencies are listed below.

Frequency	Check	Cold water	Hot water	Notes
Monthly	Sentinel outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute	These measurements are applicable to non-mixed outlets only
Monthly	Inlets to sentinel TMVs	Temperatures as above	Temperatures as above	Measurements can be made by means of surface temperature probes
Monthly	Water leaving and returning to calorifier			Also to be monitored continuously by BMS
6-monthly	In-coming cold water at inlet to building – in the winter and in the summer	The water should be below 20°C		Also to be continuously monitored by BMS
Annually	Representative outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute	

**Note:** See [Table 1](#) on page 25 for definition of terms and explanatory notes

- Because of the complexity of hot and cold water systems found in healthcare facilities and the responsibility of maintaining a temperature control regimen at all times, this guidance suggests that chemical and other water treatments that have been shown to be capable of controlling and monitoring *Legionella* may also be considered (for example chlorine dioxide or silver/copper ionisation). Such measures should only be used in addition to maintaining temperature control of hot and cold water systems.



# Acknowledgements

The Department of Health would like to thank the Steering Group for their advice and support, and all those who contributed to the consultation phase of the document.

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# 1 Introduction

## Preamble

- 1.1 Health Technical Memorandum 2027 – ‘Hot and cold water supply, storage and mains services’ (NHS Estates, 1995) and Health Technical Memorandum 2040 – ‘The control of *Legionella* in healthcare premises: a code of practice’ (NHS Estates, 1994) have both been revised, and have, at the same time, been combined into this single document: Health Technical Memorandum 04 – ‘The control of *Legionella*, hygiene, “safe” hot water, cold water and drinking water systems’. The guidance has been revised in line with changes to relevant regulations, standards and other guidance and also technical developments.
- 1.2 Health Technical Memorandum 04 now supersedes Health Technical Memorandum 2027 and Health Technical Memorandum 2040.
- 1.3 This Health Technical Memorandum gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises. It is equally applicable to both new and existing sites.
- 1.4 In its new form, the document is divided in two parts. This part (Part B) covers operational management, including the control of *Legionella*. Part A outlines the principles involved in the design, installation and testing of the hot and cold water supply, and storage and distribution systems for healthcare premises. Some variation may be necessary to meet the differing requirements of the various water undertakers.

## General

- 1.5 Current statutory legislation requires both “management” and “staff” to be aware of their individual and collective responsibility for the provision of wholesome, safe hot and cold water

supplies, and storage and distribution systems in healthcare premises.

- 1.6 Healthcare premises are dependent upon water to maintain hygiene and a comfortable environment for patients and staff, and for clinical and surgical care.
- 1.7 The development, construction, installation and maintenance of hot and cold water supply systems are vital for public health.
- 1.8 Interruptions in water supply can disrupt healthcare activities. The design of systems must ensure that sufficient reserve water storage is available to minimise the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution systems.

## Exclusions

- 1.9 Although many of this Health Technical Memorandum’s recommendations will be applicable, it does not set out to cover water supply for fire-fighting services nor water supply for industrial or other specialist purposes, other than to indicate precautions that should be taken when these are used in association with “domestic” water services. The point at which a domestic activity becomes an industrial process, for example in food preparation, has not been defined, and the applicability will need to be considered in each case.
- 1.10 This Health Technical Memorandum does not cover wet cooling systems such as cooling towers. Guidance on these systems is given in the Health & Safety Commission’s Approved Code of Practice and guidance document L8.
- 1.11 While some guidance on other water-service applications is included, it is not intended to cover them fully. For:
  - laundry, see Health Building Note 25 – ‘Laundry’;

- sterile services departments, see Health Building Note 13 – ‘Sterile services department’;
- hydrotherapy pools, see the Public Health Laboratory Service’s ‘Hygiene for hydrotherapy pools’;
- spa pools, see the Public Health Laboratory Service’s ‘Hygiene for spa pools: guidelines for their safe operation. The report of a PHLS spa pools working party’;
- guidance on birthing pools, see Health Building Note 21 – ‘Maternity’.

## Definitions

- 1.12 Definition of terms is as those contained in the Water Supply (Water Fittings) Regulations 1999; BS 6100:1984-2000; BS 6700:1997; and BS EN 806-2:2005.

## 2 Management responsibility

- 2.1 Management has the overall responsibility for implementation procedures to ensure that safe, reliable hot and cold water supply, storage and distribution systems operate within the organisation. The Approved Code of Practice and guidance entitled 'Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8)' requires that there must be a written scheme in place in respect of controlling *Legionella* in water systems.
- 2.2 These procedures should demonstrate that any person on whom the statutory duty falls has fully appreciated the requirement to provide an adequate supply of hot and cold water of suitable quality. Though compliance with this guidance may be delegated to staff, or undertaken by contract, accountability cannot be delegated. The duty holder should appoint a person to take day-to-day responsibility for the control of the hot and cold water services and to be responsible for assessing and controlling any identified risks from *Legionella*.
- 2.3 A risk assessment for the water services will be necessary to identify potential problems in the system, for example excess storage capacity, temperature distribution problems, low water usage, inappropriate materials etc. The risk assessment should be carried out by a competent person. It is recommended that companies/ individuals who carry out risk assessments should be members of the Legionella Control Association. A standard specification for, and guidance on, water risk assessment can be found in BSRIA's (1999) FMS 4/99: 'Guidance and the standard specification for water services risk assessment'.
- 2.4 Management procedures must ensure that compliance is continuing and not notional. The prime purpose of the assessment is to be able to demonstrate that management has identified all the relevant factors, has instituted corrective or preventive action, and is monitoring the plans being implemented.
- 2.5 This guidance should be applied to all healthcare premises, however small, where there is a duty of care under the Health and Safety at Work etc Act 1974.
- 2.6 Where new healthcare premises are to be built in separate phases, the water storage, supply and distribution service for the whole premises should as far as possible be planned and evaluated at the design stage. This will enable the total water supply requirement to be assessed in the planning stages, and appropriate areas of accommodation to be allocated.
- 2.7 Management should also be aware of the legal duty to notify the water undertaker when it is proposed to carry out works on cold water distribution systems.
- 2.8 All regular tests and checks set out in this document should be carried out even if they cause minor disruption to hospital services, and comprehensive records should be maintained.

## 3 Statutory requirements

### General

- 3.1 It is the responsibility of management to ensure that their premises comply with all statutes.
- 3.2 Management (owners or occupiers) of healthcare premises have an overriding general duty of care under the Health and Safety at Work etc Act 1974. Therefore, they should ensure that the water supply, storage and distribution services are installed and operated within the terms of the following legislation.

### Health and Safety at Work etc Act 1974

- 3.3 Employers have a general duty under the Health and Safety at Work etc Act 1974 to ensure, so far as is reasonably practicable, the health, safety and welfare of their patients, staff and the public who may be affected by workplace activities.
- 3.4 These duties are legally enforceable, and the Health and Safety Executive has successfully prosecuted employers including health authorities and trusts under this statute. It falls upon owners and occupiers of premises to ensure that there is a management regime for the proper design, installation and maintenance of plant, equipment and systems. Failure to have a proper system of working and adequate control measures can also be an offence even if an outbreak of, for example, legionnaires' disease or other such incident has not occurred.

### The Management of Health and Safety at Work Regulations 1992

- 3.5 These regulations require every employer to make a suitable and sufficient assessment of all risks to health and safety of employees and the public caused by work activities. In addition to *Legionella*, other risks from a hot and cold water distribution system include deterioration of water quality, scalding at hot water outlets and danger due to pipe bursts at excessive pressures.

### Control of Substances Hazardous to Health (COSHH) Regulations 2002

- 3.6 These regulations apply to microorganisms such as *Legionella* and to the chemicals that may be used to control the growth of microorganisms in water supplies. Employers have a duty to assess the risks from exposure to these substances to ensure that they are adequately controlled.

### Public Health (Infectious Diseases) Regulations 1988

- 3.7 The Public Health (Infectious Diseases) Regulations 1988 require that a properly appointed officer shall inform the chief medical officer for England or for Wales, as the case may be, of any serious outbreak of any disease that to his/her knowledge has occurred in the district.

#### Note

The Health and Safety Commission's (2000) Approved Code of Practice L8 (see [paragraph 2.1](#)) contains further advice and guidance on communication and cooperation with the consultant in communicable disease control (CCDC), and arrangements for support of the CCDC and for him to have access to provider units, including NHS trusts.

### Water Supply (Water Quality) Regulations 2000

- 3.8 The Water Supply (Water Quality) Regulations 2000 apply to water supplied to any hospital which is used for domestic purposes such as drinking, washing or cooking. Two additional sources of advice on drinking water quality are:
  - a. the director of public health;
  - b. the World Health Organization's (1993) 'Guidelines for drinking water quality'.
- 3.9 The Private Water Supplies Regulations 1991 cover private water supplies such as boreholes and wells.



## Food Safety Act 1990

3.10 The Food Safety Act 1990 covers water used for food preparation or food manufacture and also includes water used for drinking. The Food Safety (Temperature Control) Regulations 1995 and the Food Safety (General Food Hygiene) Regulations 1995 are also relevant.

## The Health and Safety Commission's (2000) Approved Code of Practice L8

3.11 The Health and Safety Commission's (2000) Approved Code of Practice L8 came into effect on 8 January 2001 and replaced the earlier publication entitled 'The prevention or control of legionellosis (including legionnaires' disease) (L8 rev.)' and the technical guidance document HS(G)70 'The control of legionellosis including legionnaire's disease'. The onus is on management to demonstrate that procedures in place are as good as, or better than, those required by L8.

3.12 The Approved Code of Practice L8 has a special legal status. Health and safety inspectors seek to secure compliance with the law and may refer to L8 as an illustration of good practice.

3.13 Compliance with this guidance document will satisfy the Approved Code of Practice L8.

3.14 The health service, with responsibility for the wider aspects of public health and the operation of NHS premises, is expected to be particularly vigilant. The number of outbreaks of legionnaires' disease is relatively small, but outbreaks are considered to be avoidable. Management must also acknowledge that incidents or outbreaks cause widespread concern, especially if associated with healthcare premises. Investigation of these outbreaks has shown that they are generally related to a breakdown in management systems. Design flaws and defects, however, have also been implicated as the cause of some outbreaks, but by far the greatest contributor to outbreaks of *Legionella* is poor maintenance and control procedures.

3.15 Hence, managers need to satisfy themselves by monitoring that effective control procedures are being implemented. It is not sufficient merely to devise procedures.

## Water Supply (Water Fittings) Regulations 1999

3.16 The water undertaker responsible for water supply has a statutory duty to enforce the Regulations for the prevention of waste, undue consumption, misuse and contamination of water supplied in its area.

3.17 In 1999 the Water Supply (Water Fittings) Regulations came into effect. These Regulations are set out – along with the Department for Environment, Food and Rural Affairs' (Defra) guidance on the Regulations and the water industry's recommendations for fulfilling these provisions – in the 'Water Regulations Guide' published by the Water Regulations Advisory Scheme ('WRAS'). WRAS provides advice on water fittings regulations on a national basis and administers the scheme, which tests and lists water fittings and materials for compliance with the Regulations. The 'Water Fittings and Materials Directory' contains information on suitable fittings and materials and is updated every six months.

## British Standards

3.18 BS 6700:1997 is the British Standard specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilage.

3.19 BS 1710:1984 is the British Standard specification for identification of pipelines and services.

## 4 The control of *Legionella*

### Source of the bacteria

- 4.1 *Legionella* bacteria are ubiquitous, surviving and multiplying in water. It is widespread in natural fresh water including rivers, lakes, streams and ponds and may also be found in wet soil. Airborne dispersal may occur when water droplets are created. There is a strong likelihood of very low concentrations of the bacteria existing in all open water systems including those of building services.
- 4.2 The risk is related to the number and types of *Legionella* in the water at the point of use.

### Ecology

- 4.3 The following conditions have been found to influence the colonisation and growth rate of *Legionella*:
- water temperature between 20°C and 45°C is the range in which *Legionella* will proliferate most rapidly. The optimum laboratory temperature for the growth of the organism is 37°C. *Legionella* are killed within a few minutes at temperatures above 60°C.

#### Note

The death curve is logarithmic with time for a given temperature.

- poor water flow and areas within the water system where water is either stagnant (dead-legs) or is becoming stagnant because water temperature will rise or fall to within the optimum range for growth and the formation of biofilm is encouraged;
- biofilm plays an important role in harbouring and providing favourable conditions in which *Legionella* bacteria can grow by providing protection from the effects of heat and biocides, notably chlorine;

#### Note

Biofilm forms when bacteria adhere to surfaces in aqueous environments and begin to secrete a slimy, glue-like substance that can anchor them to many materials such as metals and plastics. A biofilm can be formed by a single bacterial species, but more often biofilms consist of many species of bacteria as well as fungi, algae, protozoa, debris and corrosion products. Essentially, biofilm may form on any wetted surface exposed to bacteria.

Biofilm develops where the temperature is right for growth and where there is a nutrient source. Nutrients can be scale, sediment, corrosion products, or trapped organic and inorganic molecules supplied by the flowing water.

- Legionella* have been shown to colonise certain types of water fitting, pipework and material used in the construction of water systems. Water quality can deteriorate in mixing valves, particularly when utilisation is low, because the mixed water can then become stagnant at a temperature favoured by pathogens such as *Legionella*;
- the presence of sediment, sludge, scale and organic material provides a good nutrient source for *Legionella*. Evidence suggests that the presence of iron oxide (rust) also favours the growth of the organism;
- commonly-encountered organisms in water systems such as algae, amoebae and other bacteria serve as an additional nutrient source for *Legionella* bacteria. Algal slime provides a stable habitat for multiplication and survival. Whilst exposure to direct sunlight may inhibit the growth of *Legionella* bacteria, it does stimulate growth of algae and the formation of slimes. *Legionella* bacteria have also been shown to proliferate rapidly in association with some water-borne amoebae;
- stagnant water encourages colonisation.

## Epidemiology

- 4.4 *Legionella pneumophila* serogroup 1 is the commonest cause of legionnaires' disease. *L. pneumophila* is also responsible for Pontiac fever. Another species, *L. micdadei*, is responsible for a similar illness called Lochgoilhead fever. To date, over 45 species of *Legionella* have been identified. The bacterium can be found naturally in many freshwater sources and can survive a variety of environmental conditions. Virulence may be enhanced when the bacteria have been exposed to temperatures around 37°C which are most favourable to its growth.
- 4.5 The risk of healthcare-associated legionellosis depends on a number of factors such as:
- the presence of *Legionella* in sufficient numbers;
  - conditions suitable for multiplication of the organisms (for example temperatures between 20°C and 45°C and stagnant water);
  - a source of nutrients (for example sludge, scale, rust, protozoa, algae and other organic matter);
  - a means of creating and disseminating respirable droplets (for example cooling towers, showers and most other water draw-offs that are capable of creating a spray or causing splashing); and
  - the presence of people who may be exposed to contaminated aerosols, especially those who are vulnerable to *Legionella* infection (for example those with compromised immune or respiratory systems, and transplant patients).
- 4.6 Many, if not all, of these factors are likely to be encountered in healthcare premises.

## Control measures

- 4.7 Original guidance on the control of *Legionella* in hot and cold water services relied on a temperature control regimen: that is, maintaining cold water below 20°C and hot water above 50°C. Because of the complexity of hot and cold water systems found in hospitals and the responsibility of maintaining a temperature control regimen at all times, chemical and other water treatments that have been shown to be capable of controlling *Legionella* may need to be considered to supplement a temperature control regimen.
- 4.8 Residual biocidal techniques such as chlorine dioxide and silver/copper ionisation (evaluated by BSRIA in TN 2/98: 'Chlorine dioxide water

treatment – for hot and cold water services'; and TN 6/96: 'Ionisation water treatment for hot and cold water services') are outlined in Chapter 15 and Appendix 4 of Part A. Due to their residual effect, these techniques can inhibit free-floating and attached bacteria with varying degrees of efficiency. Ozone and ultraviolet (UV) treatment are also mentioned; however, they have a limited effect as UV is non-dispersive, and ozone rapidly degrades and therefore has only a short-term residual effect. Ozone and UV are not effective at removing biofilm from hot and cold water distribution systems.

- 4.9 Monitoring to ensure that any of the control measures remain effective is essential. Monitoring and testing is covered in [chapters 9 and 10](#) of this document. Ionisation is pH-sensitive and there have been reports of a reaction between silver and calcium causing staining of sanitaryware. Control of water hardness will be necessary to avoid this, but softening should not be used for drinking water systems. In hot water systems, chlorine is rapidly lost, and maintaining temperature control of the calorifier/water heater and hot water circulating system is essential.

## Route of infection

- 4.10 The principal route of infection is through inhalation of the bacteria into the lungs. The risk rises with increasing numbers of inhaled bacteria. Aspiration of contaminated drinking water into the airways has also been described as a mode of transmission of legionnaires' disease. For some patients, there is the additional risk of *Legionella* infection from the use of nasogastric tubes.

## Aerosol generation

- 4.11 Contaminated water presents a risk when dispersed into the air as an aerosol. This risk increases with reduced droplet size, as smaller droplets remain airborne for longer, and aerosols (5 µm diameter or less) penetrate deeply into the lungs (alveoli) and cannot easily be expelled. However, larger droplets can evaporate and still contain the initial number of organisms. Amoebic vacuoles, typically 3 µm, may contain many *Legionella* and potentially provide an infectious dose.
- 4.12 In both a cooling tower and evaporative condenser, water is actively recirculated around these systems, which increases the opportunity for aerosols to be produced. Water services are also capable of

generating aerosols from the impaction of water onto hand-wash basins, sinks, baths and showers. In whirlpools and spas, the agitation of the water is achieved by the combination of air jets and pulsating water flow. Splashing water and air bubbles bursting as they break through the water surface create an aerosol immediately above the water surface. The risk of *Legionella* infection increases with the number of infective particles in the aerosol generated, especially if the size of the aerosol is less than 5 µm.

## Number of infectious bacteria

4.13 The number of organisms that cause infection has not been reliably determined and is likely to vary from person to person.

4.14 Two factors determine the number of bacteria deeply inhaled:

- a. the concentration of bacteria in the air:
  - (i) this is determined both by the concentration of bacteria in the water and by the amount of contaminated water dispersed into a given air volume. The concentration of live bacteria in the air falls rapidly with distance from the source. Where a cooling tower and the fresh-air inlet to a building are both at roof level, it may be possible for contamination from the tower to reach the air inlet and, hence, enter the building;
  - (ii) the quantity entering will depend primarily on the separation distance between the tower and the fresh-air inlet. Increasing this distance of separation and locating the air inlet upwind (prevailing wind) of the tower help to reduce the likelihood of water droplets containing *Legionella* entering the building;

- b. the duration of exposure to the contaminated air:
  - (i) exposure in a shower is usually limited to a few minutes, while exposure in a bath, particularly a spa, is much longer. Exposure to airborne *Legionella* distributed from a contaminated water-cooling system may take place whenever the tower is operating – this may be most of the day during the summer;
  - (ii) the risk increases with the number of *Legionella* in the air, the respiratory rate of the individual and the length of time the person is exposed. The chances of *Legionella* infections occurring increase with the number, and susceptibility, of people exposed.

## Susceptibility of individuals

- 4.15 While previously healthy people may develop legionnaires' disease, there are a number of factors that increase susceptibility:
- a. increasing age, particularly above 50 years (children are rarely infected);
  - b. sex: males are three times more likely to be infected than females (this may change with altered smoking habits);
  - c. existing respiratory disease that makes the lungs more vulnerable to infection;
  - d. illnesses and conditions such as cancer, diabetes, kidney disease or alcoholism, which weaken the natural defences;
  - e. smoking, particularly heavy cigarette smoking, because of the probability of impaired lung function;
  - f. patients on immunosuppressant drugs that inhibit the body's natural defences against infection.

# 5 Operational management

## General

- 5.1 Managers should ensure that an operational plan is in place for each site under their control. This document should comprise:
- up-to-date as-fitted drawings, schematic diagrams and descriptions of all the supply, storage and distribution systems within those premises;
  - step-by-step instructions to operate, maintain, control and shut down the water supply, storage and distribution systems within those premises;
  - a schedule of possible emergency incidents causing loss of the water supply from the water undertaker. Each item in the emergency incident schedule should include guidance on operational procedures to re-establish a stable wholesome water supply.

All premises are required to have a *Legionella* risk assessment and a written scheme for controlling any identified risks in accordance with the Health and Safety Commission's (2000) Approved Code of Practice L8.

## Competence

- 5.2 Management should implement a programme of staff training to ensure that those appointed to devise strategies and carry out control measures are appropriately informed, instructed and trained, and should be assessed as to their competency. It is also essential that they have an overall appreciation of the practices affecting water hygiene and safety, and that they can interpret the available guidance and perform their tasks in a safe and technically competent manner. The rate of change in building service technology is not great, but management should review the competence of staff on a regular basis, and refresher training should be given; records of training attendance would need to be maintained. Although training is an essential element of ensuring competence, it should be viewed within the context of experience, knowledge

and other personal qualities that are needed to work safely. Competence is dependent on specific needs of individual installations and the nature of risks involved.

## Safe hot water temperature and personal hygiene

- 5.3 See paragraphs 9.54–9.58 in Part A for guidance on safe water temperatures and delivery devices.
- 5.4 To reduce the risk of scalding, thermostatic mixing devices should be installed for many hot water outlets. A risk assessment will be necessary to establish the need and type of device to be installed.
- 5.5 As with any safety device, routine checks will be essential to ensure continued satisfactory operation. Such devices, however, should not be a substitute for caution, and there are circumstances where nursing staff should always use a thermometer. For example, when performing assisted bathing, it is often necessary to set the delivery temperature to a higher level than that normally considered “safe” to allow for the cooling affect of large baths that are required.
- 5.6 Before lowering or assisting patients into the bath, the water temperature should be checked with a thermometer to ensure that it has fallen to a “safe” level. Thermometers should also be used whenever children are being bathed.

## Utilisation

- 5.7 One of the critical factors affecting the quality of water within hot and cold water distribution systems is the extent of utilisation.
- 5.8 Where stagnation occurs or utilisation is low, cold water temperature can increase significantly and approach the range that is conducive to the growth of a variety of water-borne pathogenic microorganisms such as *Legionella*. Where water is mixed, further opportunities arise for deterioration in water quality.

- 5.9 Particular problems occur where a separate thermostatic mixing device is used to provide a safe hot water supply to the inlet port of a second mixing outlet, or where there are separate hot and cold outlets. In this case, the pipe supplying the separate cold tap, or the cold supply to the inlet to the mixing tap, might not be used for periods of time; thus water will become stagnant. All mixing valves should therefore be easily accessible for routine cleaning and maintenance.
- 5.10 Management needs to ensure that there is good liaison between the estates officers/maintenance providers and clinicians to ensure that the water services are sufficiently used.
- 5.11 Showers are the most critical facilities because of their capacity to generate an aerosol and the potential under-utilisation; even when patients require assisted bathing, they are likely to use WCs and hand-wash basins, and water usage for these will be maintained. This may be less of a problem in multi-bed wards in which other patients are capable of using showers with or without assistance.
- 5.12 It will be essential to build into the management of the premises a mechanism to ensure that such facilities are routinely operated to draw off water. The Health and Safety Commission's (2000) Approved Code of Practice L8 recommends that, for sporadically used outlets, flushing is carried out once a week. In healthcare facilities, a higher frequency is recommended, and water draw-off should form part of the daily cleaning process. The procedure for such practice should be fully documented and covered by written instructions.

### Note

Regular flushing applies to all sporadically used outlets.

## Temporary closure of wards/ departments

- 5.13 During temporary closure of wards or departments, a procedure for flushing the hot and cold water service systems should be instituted. This should include opening all taps and showers for a period of three minutes and flushing WC cisterns etc on a twice-weekly cycle. Alternatively, when this is impracticable, the disinfection procedure recommended for new installations may be carried out immediately prior to occupation. This should be applied upstream of the closed area. Taps that include flow regulation may need to be flushed for longer than three minutes. In determining the flushing period, consideration should be given to the water pressure and length of dead-legs and spurs in the connecting pipework.
- ### High risk areas
- 5.14 In specialty departments where patients are particularly susceptible (such as renal wards, transplant units, cancer care areas), it may be preferable to provide separate small-scale systems. Such systems should have independent supply and local heating sources.
- 5.15 Additionally, local water treatment may be considered necessary. It is also vital that cold water should be maintained below 20°C.

### Note

Circulation of cold water and refrigeration should only be considered in specialist units where people are at particular risk as a result of immunological deficiency, for example transplant units. For other accommodation, the aim should be to promote turnover of cold water by means of the design of the distribution circuitry.

- 5.16 Cold water services should be sized to provide sufficient flow, and should be insulated and kept away from areas where they are prone to thermal gains. Stagnation should be avoided. Special attention should be given to the maintenance and monitoring of these systems.

## Water management policy

- 5.17 It is essential to regularly check systems and all components for signs of leakage; for example, a tap left dripping can waste in excess of 14,000 L of water each year.
- 5.18 Consumption should be monitored; if it increases for no apparent reason, this may indicate a leak. Wet or soggy patches of ground may identify underground leaks, for example areas of greenery that are more lush than their surroundings.
- 5.19 The Water Supply (Water Fittings) Regulations 1999 permit a maximum volume of 6 L per flush. (WC suites are available that use less than 4 L per flush.) Further savings can be achieved by the use of dual-flush systems.

## Water treatment policy

- 5.20 Local water undertakers are increasingly using chloramines in public water supplies on the grounds that they are more stable and more effective in the control of a variety of water-borne organisms. Chloramines can present problems for dialysis water systems (see Appendix 3 in Part A).

## Energy management policy

- 5.21 An energy management policy should be set up to define actions that should be taken to minimise energy consumption. An effective maintenance plan will also contribute to minimising energy consumption. Further guidance is given in Health Technical Memorandum 07-02 – ‘Encode’ and the Department of Health’s (2004) ‘Carbon/energy management in healthcare’.

## Maintenance policy

- 5.22 There are legal, operational and economic reasons for introducing a maintenance policy.
- 5.23 There is a legal requirement to protect and preserve the safety of staff, patients and the public. Complying with the law is generally given the highest priority, and is the minimum requirement that must be satisfied. **Chapter 3** lists specific statutes that must be complied with.
- 5.24 Maintenance will be required to achieve optimum economic life and maintain maximum operational efficiency of the plant.
- 5.25 To decide the appropriate level of maintenance (for example scheduled, corrective or condition-based) for the different items of plant, the following questions must be addressed:
- Would a breakdown of a particular service during working, or outside normal, hours prove critical?
  - How long can a breakdown of particular plant be tolerated?
  - What cost can be justified to avoid breakdown of particular plant such as stand-by pumps?
- 5.26 Resolving these issues will set objectives for the maintenance policy. If response to failure is critical for certain items of plant, the maintenance organisation will require a planned strategy of calling out skilled staff to achieve an agreed response time and to minimise the interval between

breakdown and the diagnosis and repair of the plant.

- 5.27 Management is ultimately responsible for the provision of a wholesome water supply in the premises under its authority.
- 5.28 The policy for healthcare premises should be based on that of planned preventative maintenance, as any failure in the water services would be seriously detrimental to the provision of healthcare.
- 5.29 Planned preventative maintenance involves a series of inspections at regular intervals and monitoring operating parameters to avoid failure by implementing timely remedial work.

## Maintenance responsibility

- 5.30 A maintenance manager must be given responsibility for implementation of the maintenance policy. These responsibilities will include:
- the provision of adequately trained and supervised manpower;
  - clear definitions of the equipment and services to be maintained, together with the procedures to be carried out on them;
  - monitoring of the quality of the work carried out to ensure that it is consistently acceptable;
  - the implementation of financial control procedures.

## Contract maintenance

- 5.31 The increasing complexity of building services equipment has resulted in a growing reliance on contractors for the provision of maintenance services. The decision to use either a contractor or in-house staff must be taken in the light of local circumstances.
- 5.32 Contracts between the hospital/healthcare premises and service providers should clearly define the responsibilities of both parties. BSRIA’s (1992) Application Guide AG 4/89.2: ‘Maintenance contracts for building engineering services’ provides advice on aspects to be considered when obtaining contract maintenance.
- 5.33 Reference should also be made to:
- Scottish Health Technical Note 2 – ‘Domestic hot and cold water systems for Scottish health care premises’;

- Scottish Health Technical Note 6 – ‘The safe operation and maintenance of thermostatic mixing valves’; and
- the Heating and Ventilating Contractors’ Association’s (HVCA) (2004) ‘Standard maintenance specification for mechanical services in buildings’.

5.34 When selecting subcontractors, particularly in relation to the control of *Legionella*, their competence should be established beforehand (for example companies/individuals who are members of the Legionella Control Association).

## Maintenance brief

5.35 The maintenance manager requires a brief from the management that sets out in a clear and unambiguous manner the following requirements:

- a. scope of work;
- b. budgeting – overall and single item limits;
- c. level of reliability;
- d. response time required to correct faults;
- e. criteria for quality of service;
- f. reporting procedure;
- g. accountability and responsibility;
- h. energy-saving policy;
- j. health and safety policy;
- k. environmental and sustainability factors.

5.36 The above requirements are necessary regardless of whether the work is carried out by contractors or in-house staff.

## Performance monitoring

5.37 This involves the regular inspection of systems and records, which should be in such detail as to enable management to form an opinion regarding compliance with the agreed criteria.

5.38 If a contractor is commissioned to carry out maintenance and in-house expertise is not available to monitor their performance, an independent professional adviser should be retained to carry out this function. Using another maintenance contractor in a monitoring role could lead to a conflict of interest.

5.39 Performance monitoring should establish that:

- a. the required level of service is met;

- b. all the required plant is being maintained;
- c. system performance is being maintained (where water treatment is provided as part of the control strategy, it will be necessary to test for *Legionella*);
- d. maintenance is being carried out to the agreed standard;
- e. correct replacement parts are being used;
- f. the agreed spares stocks are being held on site;
- g. records are being correctly maintained;
- h. the agreed standards, number of staff, and number of visits are being achieved;
- j. plant is being operated to achieve optimum energy usage;
- k. health and safety requirements are being complied with;
- m. only agreed subcontractors are being employed (see paragraph 5.34);
- n. the client and typical users of the building are satisfied;
- p. invoices accurately reflect the work carried out, including materials expended;
- q. breakdowns do not occur too often;
- r. adequate consideration is being given to the potential environmental impact of contractors’ action, for example disposal of lubricants, chemicals, worn parts etc that cannot be recycled.

## Emergency action

5.40 Contingency plans should be available in the event of the following:

- a. a power failure causing failure to maintain temperature in calorifiers or affecting distribution/circulating pumps (such action might require the removal of a calorifier from service for thermal disinfection, to be followed by thermal disinfection of the entire system);
- b. a mains water failure that could last beyond the period for which storage capacity has been designed (such action might entail advising clinical staff to restrict the amount of bathing/showering that takes place, temporary cessation of laundry and sterile supply activities; in extreme conditions, it may be necessary to resort to “tankered” water supplies).



- 5.41 Emergency action in an outbreak of healthcare-associated legionellosis is covered in [Appendix 1](#).

## Documentation

- 5.42 It is essential to have comprehensive operational manuals for all items of plant that include requirements for servicing, maintenance tasks and frequencies of inspection.
- 5.43 This information should be kept together with all commissioning data.
- 5.44 Documentation should also be drawn up as part of the health and safety file for the building or hospital (see Chapter 18, Part A).

## As-fitted drawings

- 5.45 The availability of accurate as-fitted drawings is essential for the safe operation of hot and cold water service systems. The drawings will be necessary to perform the temperature control checks on the systems and will assist in identifying any potential problems with poor hot water circulation and cold water dead-legs where flow to sporadically used outlets can be low. Such information should identify all key components in the installations, for example water meters, storage tanks (filtration equipment, where fitted), calorifiers, and the location of isolating valves in the systems. Separate schematic drawings should be prepared and displayed in plantrooms such that all plant items, control valves etc can be identified.
- 5.46 In addition to drawings, there should be comprehensive schedules of outlets, lists of sentinel taps (outlets), other outlets to be tested annually and other components in the system.

## Record-keeping

- 5.47 Management should ensure that an accurate record of all assets relating to the hot and cold water distribution systems is set up and regularly maintained. They must also ensure that records of all maintenance, inspection and testing activities are kept up-to-date and properly stored. Records should be kept for at least five years.
- 5.48 As a minimum, the following items should be recorded:
- the names and positions of those responsible for performing the various tasks under the written scheme;

- a *Legionella* risk assessment and a written scheme of actions and control measures;
  - details of precautionary measures that have been carried out, including sufficient detail to identify that the work was completed correctly and when the work was carried out.
- 5.49 Planned preventive maintenance will help to ensure that systems perform correctly, and an essential element of this process is the maintenance of accurate records.
- 5.50 Maintenance records are normally required for the following purposes:
- verification of maintenance for local accountability;
  - verification of maintenance for statutory obligations;
  - as a means of monitoring the maintenance policy and its effectiveness;
  - as a means of observing performance trends, initiating corrective action where necessary;
  - as an aid to financial planning.
- 5.51 Maintenance records should include the following:
- details of remedial work required and work carried out;
  - details of cleaning, disinfection procedures;
  - results of chemical and microbiological analysis of water.
- 5.52 When alterations to plant or systems are implemented, the record drawings should be updated to reflect the modifications carried out.
- 5.53 An asset register for the engineering services would provide a structure for recording, retrieving and analysing information.
- 5.54 The asset register should be designed to provide the following information:
- an inventory of plant;
  - a basis for identifying plant details;
  - a basis for recording the maintenance requirements;
  - a basis for recording and accessing information associated with maintenance;
  - a basis for accounting to establish depreciation and the provision needed for plant replacement;
  - information for insurance purposes.

- 5.55 When completing records, it is essential that the individual concerned signs and dates the entries, and that there is an audit trail in place. Pro forma log sheets for temperature checks are included in [Appendix 2](#).
- 5.56 Further information on the monitoring of performance and effectiveness in carrying out maintenance tasks can be found in CIBSE's (2000) 'Guide to ownership, operation and maintenance of building services'.

## 6 Designated staff functions

### Management

- 6.1 Management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable, and on whom the duty falls, for the safe operation of healthcare premises.
- 6.2 A person intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to be able to perform safely the designated tasks.

### Infection control officer

- 6.3 The infection control officer, or consultant microbiologist if not the same person, is the person nominated by management to advise on infection control policy and to have responsibility for the maintenance of water quality.
- 6.4 The policy should be acceptable to the infection control team and they should agree any amendment to that policy.

### Responsible Person

- 6.5 A Responsible Person (water), possessing adequate professional knowledge and with appropriate training, should be appointed in writing by management to devise and manage the necessary procedures to ensure that the quality of water in healthcare premises is maintained. The Responsible Person should be a manager or director, or have similar status and sufficient authority to ensure that all operational procedures are carried out in an effective and timely manner. The Responsible Person will be required to liaise closely with other professionals in various disciplines. In addition, the Responsible Person should possess a thorough knowledge of the control of *Legionella* and would ideally be a chartered engineer, microbiologist or other professionally qualified person.
- 6.6 This role, in association with the infection control officer and maintenance staff, involves:

- a. advising on the potential areas of risk and identifying where systems do not adhere to this guidance;
  - b. liaising with the water undertakers and environmental health departments and advising on the continuing procedures necessary to ensure acceptable water quality;
  - c. monitoring the implementation and efficacy of those procedures;
  - d. approving and identifying any changes to those procedures;
  - e. ensuring equipment that is to be permanently connected to the water supply is properly installed;
  - f. ensuring adequate operating and maintenance instructions exist and adequate records are kept.
- 6.7 Implementation of an effective maintenance policy must incorporate the preparation of fully detailed operating and maintenance documentation and the introduction of a logbook system. The Responsible Person should appoint a deputy to whom delegated responsibilities may be given. The deputy should act for the Responsible Person on all occasions when the nominated person is unavailable.
- 6.8 The Responsible Person should be fully conversant with the design principles and requirements of water systems and should be fully briefed in respect of the cause and effect of water-borne organisms, for example *Legionella pneumophila*. The appointment of an engineer is appropriate in that the role can extend to the operation and maintenance of associated plant. It is recognised that the Responsible Person cannot be an expert on all matters and must be supported by specialists in specific subjects such as water treatment and microbiology, but he/she must undertake responsibility for calling upon and coordinating the activities of such specialists.
- 6.9 The Responsible Person should be aware that manufacturers, importers, suppliers, installers and

service providers have specific responsibilities that are set out in the Health and Safety Commission's (2000) Approved Code of Practice L8.

### **Maintenance technician**

- 6.10 A maintenance technician is someone who has sufficient technical knowledge and the experience necessary to carry out maintenance and routine testing of the water, storage and distribution system.

### **Tradesperson**

- 6.11 A tradesperson is someone who is appointed in writing by the Responsible Person to carry out, under the control of the maintenance technician, work on the water, storage and distribution system.

### **Installer**

- 6.12 An installer is the person or organisation responsible for the provision of the water, storage and distribution system.

### **Contractor**

- 6.13 A contractor is the person or organisation designated by management to be responsible for the supply, installation, validation and verification of hot and cold water services, and for the conduct of the installation checks and tests. In relation to the control of *Legionella*, it is essential to ensure that potential contractors have suitable qualifications (for example companies/individuals who are members of the Legionella Control Association).

### **Contract supervising officer**

- 6.14 The person nominated by the management to witness tests and checks under the terms of contract. He/she should have specialist knowledge, training and experience of hot and cold water supply, storage and mains services.

# 7 Description of systems, operational considerations and requirements

## Source of supply

- 7.1 See Chapter 2 in Part A for comprehensive guidance and information on sources of water supply.
- 7.2 If supplies are taken from local boreholes or wells etc, the water should be tested to comply with the requirements of the Private Water Supplies Regulations 1991. The results of all analyses should be kept and recorded.

## Water supply hygiene

- 7.3 Normally a supply from a water undertaker should not require disinfection, but all piping, fittings and associated services used for the conveyance of water for domestic purposes must be disinfected before being brought into use. Such piping, fittings and storage cisterns must also be disinfected on completion of works which have entailed “opening up” the system. Private water supplies must be disinfected before being used for domestic purposes. Disinfection is effected by chemical or physical agents – the method generally used is chlorination.
- 7.4 Despite disinfection of systems, some outbreaks of disease related to treated water supplies still occur. To reduce the risk of such outbreaks, the design should eliminate:
  - a. direct contact with the internal parts of water pipes and structures by people, animals or birds;
  - b. backflow (back-siphonage) of contaminated water into systems conveying potable water (mains and storage structures).
- 7.5 Measures to protect against back-siphonage are set out in the WRAS ‘Water Regulations Guide’. The principle is that the design of piped water systems should be carried out in a manner that minimises the likelihood of contaminated material, or water, gaining access to those parts of any water service conveying potable water. All water from non-potable sources (rain, surface run-off water, private

supplies, drainage of foul water etc) must be regarded as a potential source of pathogenic material.

## Chlorination

- 7.6 Disinfection using chlorine should be carried out in accordance with BS 6700:1997 (see also Chapter 17 in Part A) and under the direct supervision of a nominated person.
- 7.7 Contaminated water that is run to waste into a natural watercourse, or a drain leading to it, should be treated in accordance with the requirements of the authority responsible for land drainage and pollution control. The authority responsible for pollution control should be informed. Dechlorination can be achieved using either sulphite or bisulphite or meta-bisulphite.

## Thermal disinfection (of hot water service systems)

- 7.8 This process introduces a serious scalding risk, and it is essential that steps are in place to ensure that access is limited to authorised personnel only until such time that the system has returned to normal operating temperature; it is unlikely to be a practical alternative for a large system.
- 7.9 This process can be performed by raising the temperature of the entire contents of the calorifier, followed by circulating the water throughout the system for at least an hour. The process, however, is impractical for all but small systems. The calorifier temperature must be sufficiently high to ensure that the temperature in all parts of the circulating system, and at the calorifier return, does not fall below 60°C. After this period, each tap or outlet should be run sequentially, with the draw-off at the furthest tap or outlet being for a period of five minutes. Then each tap should be flushed back to source for the same period of time.
- 7.10 In the case of non-recirculating systems that have trace heating, the whole system should similarly be raised to 60°C for at least an hour before draw-off commences.

## Water treatment

- 7.11 *Legionella*, like other opportunist pathogens including *Aeromonas hydrophila* and *Pseudomonas aeruginosa*, are common in the environment and therefore can seed untreated water systems during construction and subsequent use. Contamination of water systems by microorganisms can also be introduced during refurbishment, repair and alteration, or during routine inspection and sampling.
- 7.12 The need for water treatment and the method of application depend on the purposes for which the water is to be used and the quantity required for each purpose.
- 7.13 In a properly installed and commissioned hot water system, it should be possible to maintain a temperature of at least 55°C at the furthest draw-off point in the circulating system, and 50°C in the circulating system's return connection to the calorifier. In older premises, however, this may not be possible, and in the case of cold water systems it is not always possible or practicable to maintain temperature below 20°C because of utilisation and complexity. It may therefore be necessary to apply additional residual biocidal water treatment that has been shown to destroy and remove biofilm. Information on these techniques can be found in paragraphs 7.18 and 7.30.
- 7.14 Where automatic equipment is used for disinfection, it should indicate any change in the amount or concentration of material injected into the water so that immediate action can be taken.
- 7.15 Continuous dosing with appropriate biocides that have proven efficacy should be considered during construction to prevent the accumulation of biofilm. A regular flushing programme for all outlets should also be implemented.
- 7.16 The continuous chlorination of hot and cold water service systems to control the growth of *Legionella* is not generally recommended. Treatment using chlorine dioxide or copper/silver ionisation can be used.
- 7.17 In defining their responsibilities, service providers should be asked to advise on test methods and anticipated concentrations of residual chemicals within the system. (See also Chapter 3 in Part A for more guidance on water treatment regimens.)

## Chlorine dioxide

- 7.18 Chlorine dioxide is an oxidising biocide that is capable of reacting with a wide range of organic

substances. Its effectiveness in the control of organisms in water systems has been demonstrated in a study carried out by BSRIA (see BSRIA's (1998) TN 2/98: 'Chlorine dioxide water treatment – for hot and cold water services').

- 7.19 In the inactivation of microorganisms, the chlorine dioxide molecule acts as a free radical (oxidising biocide) that readily bonds with the amino acids (the basic building blocks of proteins, which form the living cells). This results in their destruction.

### Chlorine dioxide as a control measure

- 7.20 The use of chlorine dioxide as a control measure will depend on the design of the systems in use and their operational history. (See also Appendix 4 in Part A.)
- 7.21 There are two aspects to be taken into consideration:
- in the cold water distribution system, chlorine dioxide will be injected into the system upstream of all parts of the distribution, storage and boosting equipment – that is, at the curtilage of the premises;

### Note

Backflow prevention is required if chlorine dioxide is injected into a pipe connected to the mains supply.

- in the case of hot water distribution systems with calorifiers/water heater operating conventionally (that is, at 60°C), there will be a tendency for chlorine dioxide to be lost by "gassing off", especially if the retention time in a vented calorifier/water heater is long. In most cases, however, some level of total oxidant should be found in the hot water, although at concentrations far less than the 0.5 mg/L injected. The calorifier/water heater should act as a barrier to dispersal of any pathogenic material by the hot water system (even if the cold water supply quality is not under control).

### Notes

Chlorine dioxide and its breakdown products chlorite and chlorate can be deleterious to neonates and renal dialysis patients, and should be removed from the water supply to these units.

For all practical purposes in water, ppm = mg/L.

## Maintenance of the control regimen

7.22 This depends on four separate aspects, as follows:

1. ensuring that the dosing equipment is operating satisfactorily;
2. ensuring that the limit for total oxidant in the system is not exceeded;
3. ensuring that all parts of cold and blended water systems are exposed to chlorine dioxide;
4. ensuring that a management system is in place to maintain these procedures, including communication between heads of department, to ensure that problems with the system, or changes in use, are brought to the attention of the responsible staff (see Health Technical Memorandum 00 – ‘Policies and principles’).

### *Ensuring that the dosing equipment is operating satisfactorily*

7.23 Generally this is the responsibility of the supplier of the dosing equipment, who will seek to achieve the maximum available chlorine dioxide from the generation process. (Systems are not 100% efficient, and the free available chlorine dioxide may be less than the permitted limit of total oxidant of 0.5 mg/L but should not be significantly less at the point of injection.) When chemical treatment is introduced as part of a programme of remedial action of a colonised system, as the system is brought under control, it should be possible to measure increasing concentrations of available (active) chlorine dioxide. With a newly installed dosing system, this may not be possible for several weeks. If chlorine dioxide cannot be identified, tests for total oxidant should be performed.

7.24 It will be the healthcare facility’s responsibility to check that the equipment is operating, and this should include routine checking of available “active” chlorine dioxide.

7.25 Tests for total oxidant are most easily accomplished by DPD1<sup>1</sup> tablets. The oxidising effect of chlorine can be removed by first adding glycine, and the remaining total oxidants (including chlorine dioxide, chlorite and chlorate) can then be measured using the DPD1 tablets, following suppliers’ instructions.

### *Ensuring that the limit for total oxidant in the system is not exceeded*

7.26 Feedback control to maintain chlorine dioxide levels at the most distant draw-off positions cannot be used since this would result in the limit of 0.5 mg/L being exceeded at draw-offs close to the point of injection.

7.27 The available chlorine dioxide and total oxidant, therefore, will be the result of the disinfection process, general state of the system and water usage levels. Performance of the dosing equipment is the responsibility of the supplier/service provider. (Water quality overall is ultimately the responsibility of the owners of the system.)

7.28 A representative number of outlets should be tested for total oxidant to ensure that the limits are not being exceeded. These should include proximal outlets and some distal outlets. (It is not necessary to check the hot water service.)

### *Ensuring that all parts of cold and blended water systems are exposed to chlorine dioxide*

7.29 In addition to the above, it will be necessary to monitor the following:

- a. the quantity of chemicals in the reservoir;
- b. the rate of addition of chlorine dioxide to the water supply;
- c. on a monthly basis, the concentration of chlorine dioxide should be measured at the sentinel taps and should be at least 0.1 mg/L;
- d. on an annual basis, the chlorine dioxide should be measured at a representative number of outlets and should be at least 0.1 mg/L.

## Silver/copper ionisation

7.30 Ionisation systems release copper and silver ions into the water stream by means of electrolytic action (see also Appendix 5 in Part A). Ionisation as a water treatment method is covered in BSRIA’s (1994) Technical Note TN 6/96: ‘Ionisation water treatment for hot and cold water services’ following a study in which it was shown that copper and silver ion concentrations maintained at 400 µg/L and 40 µg/L respectively can be effective against planktonic *Legionella* in hot water systems. In soft waters, a silver level as low as 20 µg/L can be effective.

<sup>1</sup> DPD is an abbreviation for diethyl-p-phenylene diamine. DPD1 tablets are used for detecting oxidants in water.

## Maintenance of the control regimen

- 7.31 Stable and consistent emission of ions is essential. Manual setting is not recommended, since changes in water quality (conductivity) wear the electrodes, and the insulation of scale formation will affect the level of dosing.
- 7.32 As ions are released in direct proportion to the current flowing between the electrodes, irrespective of voltage, control systems having a constant current arrangement that automatically increase (or decrease) voltage are likely to be the most satisfactory.
- 7.33 It is also possible to control the dosing equipment by metering the in-coming flow to the system or its individual sections.

### Note

Continuous dosing of drinking water with silver ions is contraindicated (see the Drinking Water Inspectorate's recommendations at <http://www.dwi.gov.uk>).

- 7.34 For testing on site, two separate tests are required for each of the elements:
- silver is usually measured by means of a dip slide typically of sensitivity 5 µg/L to 1 mg/L. Prior to measurement, chlorine is neutralised by means of aminoacetic acid and the wetted dip slides are compared with a colour chart;
  - copper is tested by means of a titration test whereby reagents are added to water that is then similarly compared with a colour chart. The concentration sensitivity is typically between 0.05 and 1.0 mg/L.
- 7.35 The tests are not as accurate as atomic absorption. It is generally advised that, on initial introduction of ionisation, test kits are employed for the first few weeks, and when levels are thought to be under control, confirmation is obtained by atomic absorption. After this, test kits can then be used routinely.

## Monitoring silver/copper ions

- 7.36 In addition to the above, the following should be monitored:
- a. on a weekly basis, the rate of release of copper and silver ions into the water supply;

- b. on a monthly basis, the silver ion concentration at sentinel outlets should be measured – this should be at least 20 µg/L;
- c. on an annual basis, the concentration of silver ions should be measured at representative outlets – this should be at least 20 µg/L;
- d. on a weekly basis, the condition and cleanliness of the electrodes;
- e. on a weekly basis, the pH of the water supply – any significant change should be drawn to the attention of the supplier of the equipment.

## Purging the systems

- 7.37 Where chemical treatment is introduced, it is essential to ensure that all parts of the system are purged so that adequate concentrations are achieved.
- 7.38 As temperature monitoring is performed on sentinel and representative outlets on a rolling basis only, additional draw-off will be required at all points on a regular basis.

## Ozone and ultraviolet treatment

- 7.39 Whereas the previous treatments are intended to be dispersive (that is, they result in a residual agent within the system), ozone and ultraviolet are intended to be effective close to the point of application. They are not, therefore, necessarily effective in hot and cold water service systems (see Chapter 15, Part A).

## Metal contamination

- 7.40 See Chapter 6 in Part A.

## Filtration

- 7.41 Filtration of potable water to a particle size of 0.2 µm is not uncommon, typically using “dead-end” filters or cross-flow membrane filters.
- 7.42 In all cases it is feasible for bacteria to colonise or “grow through” the filter material even where backwashing is a feature.
- 7.43 It is essential for filter cartridge elements to be changed at appropriate intervals in accordance with the manufacturer's recommendations, taking into account local conditions.
- 7.44 Filter membranes should also be chemically cleaned or replaced at the recommended periods, and care



must be taken to ensure that the “vessel” or “housing” containing the filter assembly is also disinfected appropriately during filter or membrane maintenance.

## Water softening

- 7.45 Base-exchange softening removes permanent and temporary hardness from water. The technique uses an ion exchange process in which the calcium and magnesium ions in solution are removed and replaced by an equivalent number of sodium ions.
- 7.46 Daily or frequent backwashing and periodic cleaning and disinfection (six-monthly) must be undertaken in accordance with the manufacturer’s/supplier’s instructions. Other proprietary cleaning agents are not recommended, particularly if the softened supply water serves apparatus such as dialysis machines.
- 7.47 Other water softening methods include physical water conditioning and magnetic water conditioning. The operation and maintenance of these systems should be in accordance with manufacturers’ instructions. The efficacy of these water-conditioning measures needs to be considered.
- 7.48 Further information on water softening can be found in BSRIA’s Applications Guide AG 2/93: ‘Water treatment for building services systems’. See also Chapter 4 in Part A, which classifies the levels of water hardness.

## Metering

- 7.49 Where water meters are installed in below-ground meter chambers, the chambers should be kept clean of debris and water; this will enable quick and accurate reading of the meters.
- 7.50 Meters should be periodically checked to ensure that they are operating and providing accurate readings.
- 7.51 Meters, other than the water undertaker’s meter, should be removed at such intervals as recommended by the manufacturers for cleaning and renewal of worn parts and should be tested for accuracy prior to replacement.
- 7.52 Meters should be read on a regular basis (monthly) and consumption monitored. A bar graph will highlight unusually large consumption, which can then be investigated.

- 7.53 Consumption should be checked against the utility bill and any discrepancies investigated.

## Water storage

- 7.54 For general information on water storage, see paragraphs 7.1 –7.2 in Part A.
- 7.55 The Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS 6700:1997 specify minimum standards for cold water storage cisterns to ensure that the stored water is retained at a potable standard suitable for domestic use. It is necessary to minimise stagnation and stratification of the stored water. A nominal 12 hours’ total on-site storage capacity is recommended. The quantity of the water stored should be carefully assessed in relation to the daily requirement so that a reasonable rate of turnover is achieved. The storage capacity should be reduced where it is known or established that it is excessive and where it is practicable to do so.
- 7.56 All cold water storage cisterns and cold feed cisterns must be examined at least annually, paying particular attention to the presence of foreign objects, biological material and excessive corrosion. On completion of the examinations, the cisterns should be cleaned, if required, and any remedial work carried out. Before the cisterns and system are put back into use, they should be disinfected in accordance with the procedure detailed in Chapter 17 of Part A.
- 7.57 Any chemicals used in the cleaning or maintenance of cisterns must be listed in the ‘Water Fittings and Materials Directory’.
- 7.58 Cistern insulation should be checked to ensure that it is adequately positioned and in good condition.
- 7.59 Float-operated valves should be checked to ensure that they are securely fixed and set to achieve a correct water level in accordance with the Water Supply (Water Fittings) Regulations 1999.
- 7.60 Overflow/warning pipes should be checked to ensure that they do not rise in level and they are clear and correctly routed to give an obvious visual alarm of an overflow condition. A weatherproof label fixed adjacent to the warning pipe, identifying the tank and its location together with the person/department to be contacted in the event of a discharge, would contribute to a quick and accurate defect report which could then be acted upon, so minimising water wastage.

7.61 A schematic drawing, illustrating piping and valve arrangements for break-tank operation during normal running and maintenance periods, is shown in Figure 2 of Part A.

### Pressurisation/supply pumps

7.62 Where two or more pumps are installed for pressurising systems, automatic control should be provided to cyclically and sequentially operate the pumps to minimise any danger of stagnation.

7.63 The maintenance carried out on this type of equipment should be in accordance with the manufacturer's recommendations. Secondary recirculation pumps should be manually inspected at least monthly to ensure that they are operating effectively.

### Cold water distribution system

7.64 The design and installation of the cold water distribution system should comply with the Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS 6700:1997 and BS EN 806-2:2005. (See Chapter 8 of Part A for further information.)

7.65 The control of water temperature in the cold water service will essentially rely on good insulation and water turnover. Cold water services should be sized to provide sufficient flow and should be insulated and kept away from areas where they are prone to thermal gains. Stagnation must be avoided. Special attention should be given to the maintenance and monitoring of these systems.

#### Note

Automatic flushing of urinals can also be used to assist in water turnover.

7.66 Schematic drawings of the system with numbered and labelled valves will reduce confusion and save time in trying to identify appropriate isolating valves and other system components.

7.67 Checks and actions should be carried out to show that:

- the system components show no sign of leakage or corrosion;
- the system insulation is in good condition;
- the system filters have been changed and/or cleaned in accordance with manufacturer's

recommendations. Regularly check and clean strainers;

- all isolating valves have periodically been worked through their full range of travel;
- every water outlet complies with the backflow protection requirements of the Water Supply (Water Fittings) Regulations 1999.

### Drinking water

7.68 Current guidance does not draw a distinction between drinking and general cold water services; both are considered to be "domestic".

7.69 The installation of separate drinking water supplies has been standard policy. But in many cases where such systems have been installed, the quality of drinking water (particularly at sporadically used draw-offs, for example washrooms) has generally been inferior to that of the general cold water supply.

7.70 If separate drinking water supplies are provided, reference should be made to paragraphs 8.13 and 8.14 in Part A.

### Hot water storage and distribution

7.71 Hot water services should be designed and installed in accordance with the Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS 6700:1997 and BS EN 806-2:2005. The hot water system may be of either the vented or the unvented type. (See Chapter 9 of Part A for further information.)

7.72 To control possible colonisation by *Legionella*, it is essential to maintain the temperature within the hot water circulating system. To some extent, if properly maintained, the calorifier/water heater will provide a form of barrier to *Legionella* and other water-borne organisms. The minimum flow temperature of water leaving the calorifier/water heater should be 60°C at all times, and 55°C at the supply to the furthestmost draw-off point in the circulating system.

#### Notes

A minimum of 55°C may be required for the operation of suitable mixing devices to provide "safe" hot water at the upper limit of the recommended range.

In large, non-recirculating systems, the minimum of 55°C should be maintained by electric trace heating.

7.73 The minimum water temperature at the connection of the return to the calorifier/water heater should be 50°C. To achieve the required circulating temperatures, it will be necessary to maintain the balance of flows to individual pipe branches and draw-off points.

7.74 Calorifiers should be subjected to regular procedures that include the following:

- cleaning and maintenance;
- quarterly draining to minimise the accumulation of sludge. This may be extended to annual draining if, during inspection, it is found that there is little accumulation of debris;
- whenever dismantled, for statutory inspection, or every year in the case of indirect calorifiers, calorifiers should be thoroughly cleaned to remove sludge, loose debris and scale;
- whenever a calorifier is taken out of service, it should be refilled, drained, refilled again and the entire contents brought up to, and held at, the nominal operating temperature of 60°C for at least an hour;
- a calorifier shunt pump will reduce the heat-up time. The calorifier should remain isolated until the procedure is completed. When bringing calorifiers back on line, it is important that service valves are opened slowly to avoid any disturbance of sediment debris. Calorifiers that are to be taken out of service for more than a few days should be drained and should not be refilled until ready for return to service. The drain valve should be left open while the calorifier is out of use;
- users are reminded that if a calorifier is colonised by *Legionella* and is then drained and opened for maintenance purposes, there can be a risk of infection to maintenance personnel and personal protective equipment will be necessary;
- where it is known, or established, that gross over-capacity exists in a calorifier, and where it is practicable to do so, it should be removed;
- approximate calorifier emptying times are shown in Table 3 (Part A).

7.75 Hot water circulating pumps should be of adequate performance to ensure a minimum available temperature at draw-off points of 55°C and an absolute minimum of 50°C at the return connection to the calorifier. In some circumstances it may be preferable to have a stand-by pump

permanently installed for operational reasons. In such circumstances the pumps should be automatically controlled so that each is regularly brought into operation (every three hours).

### Notes

Ball-type valves should be specified to avoid clogging. The drain from the gully should be of sufficient size to take the flow from the calorifier drain.

7.76 It is not permissible to shut down the pumped circulation. To do so will lead to the loss of the required system temperatures.

### Instantaneous water heaters for single or multi-point outlets

7.77 These devices usually serve one draw-off only and are either electrically or gas-heated. The general principles and limitations of instantaneous water heaters are given in BS 6700:1997. In essence:

- a. the flow rate is limited and is dependent upon the heater's hot water power rating;
- b. where restricted rates of delivery are acceptable, the heater can deliver continuous hot water without requiring time to reheat;
- c. they are susceptible to scale formation in hard water areas, where they will require frequent maintenance;
- d. this form of hot water heating should only be considered for smaller premises or where it is not economically viable to run hot water distribution to a remote outlet.

7.78 Where electrical trace heating is used, it should be checked routinely (at least monthly) to ensure that it maintains the water temperature above 55°C. Care should be taken to ensure there are no cool spots. Consideration should be given to monitoring the temperatures by means of a building management system (BMS) (sensors should be located at the most distal points).

### Safe hot water delivery devices

7.79 Thermostatic mixing valves for baths, showers and taps should comply with the standards of the Model Engineering Specification D08 – 'Thermostatic mixing valves (healthcare premises)'.

7.80 The types of mixing device are specified in Table 4 of Part A.

- 7.81 It is essential to check the temperature settings and operation of all water mixing devices regularly (six-monthly, provided that there is no “drift” in excess of 1°C). The method of testing should be in accordance with Model Engineering Specification D08. Other maintenance should be strictly in accordance with the manufacturer’s instructions. The local water quality will influence the maintenance frequency for any installation. A relatively small piece of debris may restrict the operation of the temperature control and fail-safe mechanisms.
- 7.82 The recommendations regarding safe water temperature apply to all ward accommodation, residents’ rooms and those areas to which patients, residents and visitors have free access (including public areas). Until the recommended precautions are put into effect, staff should be made aware of the potential danger and take the necessary steps to protect patients, residents and visitors. Areas that do not meet these recommendations should be identified, and plans to comply as soon as reasonably practicable should be devised.

## Materials of construction

- 7.83 Systems should comply with the requirements of the Water Supply (Water Fittings) Regulations 1999. Materials used in contact with water that is for drinking etc should comply with BS 6920-1: 2000 and be listed in the latest edition of the ‘Water Fittings and Materials Directory’ published by WRAS.

## Temperature control regimen

- 7.84 Temperature control regimen is the preferred strategy to maintain systems free from *Legionella* and other waterborne organisms. This will require monitoring on a regular basis. The test frequencies are listed in Table 1. (See also BSRIA’s Application Guide AG 4/94: ‘Guide to legionellosis – temperature measurements for hot and cold water services’.)
- 7.85 Whereas many of the checks will, of necessity, require the use of separate thermometric equipment, some of the temperature checks can be carried out by continuous monitoring by a BMS. Where a BMS is used, it will be essential to ensure that regular calibration and physical tests are performed in accordance with the manufacturer’s instructions.

- 7.86 More extensive use of BMS should be considered: hot water service flow and return temperatures should be monitored at the entry to individual wards, and cold water service(s) at the most distal point(s). In other departments where bathing/showering is less likely, monitoring should be provided on branches serving up to 50 outlets. The BMS can also be used to monitor the temperature in non-recirculating systems that have trace heating – the alarm level should be 50°C.

## Showers

- 7.87 Hyper-chlorination of showerheads and angle valve strainers has only a short-lived effect on *Legionella*. Manual cleaning to remove scale and other deposits should be carried out at least quarterly, and more frequently if required. Automatic drain valves are ineffective in maintaining a reduction in the number of *Legionella* in shower water, and they should not be installed (see the Health and Safety Commission’s (2000) Approved Code of Practice L8). Regular flushing of showers reduces *Legionella*, but *Legionella* can significantly increase in number if regular flushing should cease. The most effective management of showers will be achieved by the removal of unnecessary ones and the regular use of others. Where showers are removed, it is important to cut back all the associated pipework to avoid creating dead-legs.
- 7.88 Where it is difficult to carry out flushing to the recommended frequency, stagnant and potentially contaminated water from within the shower and associated dead-leg should be purged to drain immediately before the appliance is used. This procedure must be carried out with minimum production of aerosols. It is important to note the distinction between self-purging and self-draining showers. Self-purging showers can be an effective *Legionella* control procedure, while self-draining showers can support the proliferation of *Legionella*.

## Point-of-use filtration

- 7.89 Point-of-use filters must be changed in accordance with the manufacturers’ recommendations, typically at least once a month. When changing filters, it is recommended that sampling of water quality take place at outlets identified as sentinel points, before refitting a replacement filter. Except where taking samples as above, once point-of-use filtration has been introduced, taps or showers must not be used without a filter in place.

7.90 Where point-of-use filters are no longer required, the outlet and associated pipework must be disinfected to remove any accumulated biofilm before the system is returned to service (see also paragraph 5.16 in Part A).

## Summary checklist

7.91 A summary checklist for hot and cold water services showing recommended frequency of activity is given in [Table 2](#).

**Table 1 Tests for temperature performance**

Frequency	Check	Cold water	Hot water	Notes
Monthly	†Sentinel outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes <sup>1,2</sup>	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute <sup>3</sup>	These measurements are applicable to non-mixed outlets only
Monthly	Inlets to sentinel TMVs	Temperatures as above	Temperatures as above	Measurements can be made by means of surface temperature probes
Monthly	Water leaving and returning to calorifier			Also to be monitored continuously by BMS
6-monthly	In-coming cold water at inlet to building – in the winter and in the summer	The water should be below 20°C <sup>2</sup>		Also to be continuously monitored by BMS
Annually	‡Representative outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes <sup>1,2</sup>	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute <sup>3</sup>	

† Sentinel outlets are normally those that – on a hot water service – are the first and last outlets on a recirculating system. On cold water systems (or non-recirculating hot water systems), they are the closest and furthest from the storage tank (or water heater). The choice of sentinel taps should also include other outlets that are considered to represent a particular risk, for example those installed in accommodation in which particularly susceptible patients are treated, or others identified in the risk assessment and temperature mapping exercise as having the least satisfactory temperature performance.

‡ Representative outlets include conventional and mixed-temperature taps; 20% of the total number installed throughout the premises would be tested annually on a rotational basis: that is, all taps checked every five years.

### Notes:

1. The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of two minutes to achieve an equilibrium temperature below 20°C. Achieving this minimum requirement would be indicative of an exceptionally under-utilised water system. (At a typical flow to a hand-wash basin of 4.5 L/m, 2 minutes to achieve temperature would indicate a 50 m dead-leg of 15 mm pipe.)
2. The Water Supply (Water Quality) Regulations 2000 permit water undertakers to supply water to premises at temperatures up to 25°C. In practice, the water temperature is likely to be below this maximum value, typically below 10°C in winter and 20°C in summer. If, during prolonged periods of high environmental temperature, the water temperature starts to exceed 20°C, the water undertaker should be asked to see whether remedial action could be undertaken. Within the curtilage of the premises, the aim should be to ensure that the temperature difference between the in-coming supply and most distal parts of the distribution system is below 2°C.
3. The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of 1 minute to achieve an equilibrium temperature of 50°C. A minimum of 55°C may be required for the operation of suitable mixing devices required to provide "safe" hot water at the upper limit of the recommended range. Hot water at 55°C is required in many cases for reasons of food hygiene or decontamination requirements, for example in kitchens and sluice rooms etc. In a properly balanced hot water circulating system, with the circulation taken close to the draw-off point, achieving temperature should be virtually instantaneous. (At a typical flow to a hand-wash basin of 4.5 L/m, 1 minute to achieve temperature would indicate a 25 m dead-leg of 15 mm pipe.)

**Table 2 Summary checklist for hot and cold water services**

Service	Task*	Frequency
Hot water services	Arrange for samples to be taken from hot water calorifiers/water heaters in order to note condition of drain water	Annually
	Check temperatures in flow and return at calorifiers/water heaters	Monthly <sup>4</sup>
	Check water temperature after draw-off from outlets for 1 minute to ensure that 50°C has been achieved in sentinel outlets <sup>1,2,5</sup>	Monthly <sup>4</sup>
	Visually check internal surfaces of calorifiers/water heaters for scale and sludge. <sup>5</sup> Check representative taps for temperature as above on a rotational basis	Annually
	Manual check to confirm secondary hot water recirculation pumps are operating effectively	Monthly
Cold water services	Check tank water temperature remote from in-coming ball valve and mains temperatures. Note maximum temperatures recorded by fixed max/min thermometers, where fitted	6-monthly <sup>4</sup>
	Check temperature in sentinel outlets after draw-off for 2 minutes to establish that it is below 20°C <sup>2,3</sup>	Monthly
	Visually inspect cold water storage tanks and carry out remedial work where necessary. Check representative taps for temperature, as above, on a rotational basis	Annually
Mixed-temperature outlets	Check delivery temperature in accordance with D08	6-monthly
Showerheads	Dismantle, clean and descale showerheads and hoses	Quarterly, or as necessary
Sporadically-used outlets	Flush through and purge to drain, or purge to drain immediately before use without release of aerosols	At least twice weekly <sup>6</sup>

**Notes:**

\* See paragraph 182 in the Health & Safety Commission's Approved Code of Practice L8 for further guidance on tasks that should be undertaken.

1. For effective operation of hot water services, the minimum equilibrium temperature should be 55°C and be achieved within seconds.
2. For thermostatic mixing devices, temperatures should be measured at the inlet.
3. For satisfactory operation of cold water services, temperature equilibrium to below 20°C should be achieved well within one minute.
4. Temperatures should be continuously monitored by the BMS.
5. Additional checks should be made on the hot water circulating system and systems using trace heating at distal points.
6. Risk assessment may indicate the need for more frequent flushing of outlets. It is preferable that this form part of the daily cleaning routine where appropriate. Alternatively, self-purging showers that discharge water to a drain prior to use and without the release of aerosols can be considered.

## 8 Other operational considerations

### General

8.1 *Legionella* may colonise other areas where droplets of contaminated water of a size suitable for deep inhalation are generated. Such aerosol-generating plant and equipment should not be installed next to patient accommodation. Some patients may be particularly susceptible to infection.

### Hydrotherapy pools, spa pools and whirlpool baths

- 8.2 Hydrotherapy pools, spa pools and whirlpool baths provide conditions that potentially favour the growth of *Legionella*. While there have been no reported cases of *Legionella* infections associated with hydrotherapy pools, there have been several outbreaks associated with spa pools or whirlpools. These types of pool are ideally suited to the proliferation and dissemination of *Legionella*. In addition, because of the small volume of water in circulation and the number of bathers (typically three to six people), spa pools can become a source of infection. Careful maintenance and chemical treatment is essential to maintain water quality. A log must be kept of water treatment and filter cleaning, and the results of tests for pH, free residual halogen and other treatment parameters. (For further guidance on hydrotherapy pools, see the Health Protection Agency's 'Hygiene for hydrotherapy pools'. For further guidance on spa pools, see the Health Protection Agency's 'Management of spa pools: controlling the risks of infection'.)
- 8.3 Spa pools and whirlpool baths which provide a single fill for each individual use do not appear to present the same hazard. There remains concern, however, about retention of water in these systems.
- 8.4 Regular cleaning and disinfection after each use in accordance with manufacturer's instructions is recommended.
- 8.5 The Swimming Pool and Allied Trades Association (SPATA) and the Pool Water Treatment Advisory

Group (PWTAG) provide advice on the operation of whirlpool baths.

- 8.6 All staff operating/maintaining this type of equipment should receive adequate training to ensure that appropriate safety procedures and effective water treatment regimes are adopted.
- 8.7 Maintenance for this equipment should be carried out in accordance with the manufacturer's recommendations.

### Vending, chilled water and ice-making machines

- 8.8 See paragraphs 8.26–8.28 in Part A for guidance on installation of this equipment.
- 8.9 Where equipment is hand-filled, there should be clear instructions on the water used; it should be hygienically collected and decanted into the equipment from a clean vessel.

### Notes

Proprietary water containers for water dispensing machines should be returned to the supplier.

- 8.10 Chilled-water drinking fountains normally include a reservoir to assist in the cooling cycle; if machines are turned off, water quality can deteriorate.
- 8.11 Ice should not be allowed to stagnate in an ice-making machine's storage bin, but should be changed frequently.
- 8.12 For guidance on infection-control precautions with regard to ice-making machines, see Health Facilities Note 30 – 'Infection control in the built environment'.
- 8.13 Maintenance for ice-making machines should be carried out in accordance with the manufacturer's recommendations. Care should be taken to ensure that the water supply to the ice-making machine is not subjected to heat gain.

## Portable/room humidifiers

- 8.14 Designs should not include the use of “portable” or “room” self-contained humidifiers (having a water supply that is sprayed/atomised into the room space). In clinical/patient areas the decision to use this type of humidifier must rest with the infection control team. See Safety Notice NHSE SN(96)06: ‘Evaporative type cooling fan’.

## Non-potable water storage

- 8.15 Non-potable water is sometimes stored for emergency use (for example for fire-fighting purposes). These systems should be kept isolated from others by appropriate means that prevent back-siphonage and microbial contamination. They should be treated regularly using chlorine tablets or other form of treatment to ensure that water quality is maintained. This should be checked by total viable counts (TVC) sampling.

## Deluge showers

- 8.16 Deluge showers are intended for use in an emergency where a staff member or a patient has suffered external chemical contamination. Similarly, there may be other special outlets used for personal emergencies, for example eyebaths. These should not be installed on the end of lines and should be flushed in accordance with the recommendations in L8.

## Trolley wash procedures

- 8.17 Trolley washing using high-pressure hoses is known to result in the generation of aerosols. The water supply should be taken from the potable system via a suitable air gap to prevent backflow contamination.

## Lawn sprinklers and garden (or similar) hoses

- 8.18 In certain conditions, lawn sprinklers may retain stagnant water in the pipework/hose supplying the sprinkler head; they may also produce an aerosol spray. The pipework may be installed underground or via a flexible hose over ground. In either case it is very unlikely that they can be completely drained down after use or when not required; at certain times in the year the retained water may be at temperatures suitable for the colonisation by, and multiplication of, *Legionella*. There are evidence-linking cases of legionnaires’ disease with

permanently installed systems using underground supply plumbing.

## Vehicle washing plant

- 8.19 Vehicle washing is carried out either using a hand-held pressure spray or by a “frame wash” that consists of a bay containing a rectangular pipework frame fitted with several high-pressure sprays. In the latter case, this equipment should be flushed regularly.
- 8.20 Permanent hard-standing areas for vehicle-washing purposes should have an even surface to avoid ponding and have a slope or dish to a suitable drain.

## Ornamental fountains

- 8.21 Ornamental fountains have been implicated in cases of legionellosis. They should not be situated under trees where fallen leaves or bird droppings may contaminate the water. Exposure to high winds should be avoided as they can disperse spray beyond the immediate confines of the basin/pond. The apex of the water column/jet should not exceed the distance to the nearest edge of the basin/pond, for the same reason. An overflow/outlet to a suitable drain should be provided for easy emptying and cleaning. Where possible, a permanently installed freshwater supply pipe with topping-up device should be provided. Their provision should be subject to a risk assessment, and appropriate action is required to minimise the risk. Any connection from a potable supply should be via adequate backflow protection.
- 8.22 The installation of an ornamental fountain inside a healthcare building (for example a main entrance hall) is not recommended.

## Sanitary assemblies

- 8.23 Hoses used with sanitary assemblies such as variable-height baths should be provided with quick connectors to permit their removal for draining.

## Wet fire systems

- 8.24 Wet fire protection systems have been implicated in outbreaks of legionellosis. All hose reels, sprinkler systems and wet risers should be isolated from the potable water supply by a method permitted by the Water Supply (Water Fittings) Regulations 1999. Many fire authorities are not in



favour of local fire-fighting, preferring early professional intervention. It may, therefore, be possible to remove hose reels, thus avoiding their hazards. (Any redundant pipework should be cut back as close to the main as possible.)

### **Respiratory nebulisers**

- 8.25 Respiratory nebulisers are intended for the delivery of a variety of medicinal products. They should be used strictly in accordance with the manufacturer's recommendations, and in no circumstances should they be used in association with domestic water supplies.

### **Flowers and plants**

- 8.26 Consideration should be given to providing facilities for regularly disposing of wastewater and compost outside ward areas. This should not be provided in sluice rooms.

### **Summary checklist**

- 8.27 A summary checklist for the systems covered in this chapter, showing recommended frequency of activity, is given in L8.

## 9 Microbiological monitoring

- 9.1 Apart from situations where there are taste or odour problems, microbiological monitoring for TVCs is not considered to be necessary.
- 9.2 If performed for these purposes, the detection of low TVCs is not necessarily an indication of the absence of *Legionella*, but are an indication of the overall water quality and signify a generally unfavourable environment for bacteria.
- 9.3 All microbiological measurements should be by approved methods and/or be carried out by United Kingdom Accreditation Service (UKAS)-accredited laboratories. Dip slides are not acceptable.

## 10 Testing for *Legionella*

10.1 *Legionella* can exist within many systems at extremely low levels or below the threshold of detection (100 cfu/L). Up to now, in the absence of evidence of healthcare-associated infection, testing (which is complex and expensive) has not been considered necessary.

10.2 The infection control team, however, will need to consider the level of risk before deciding that *Legionella* testing is indicated. For example, testing may be required:

- a. when storage and distribution temperatures do not achieve those recommended under the temperature control regimen and systems are treated with a biocide regimen, a monthly frequency of testing for *Legionella* is recommended. This may be reduced as confidence in the efficacy of the treatment regimen is established;
- b. in systems where the control regimens are not consistently achieved, for example temperature or biocide levels (weekly checks are recommended until the system is brought under control);
- c. when an outbreak is suspected or has been identified;
- d. on hospital wards with at-risk patients – for example those who are immuno-compromised.

10.3 As a minimum, samples should be taken as follows:

- from the cold water storage and the furthest outlet from the tank;
- from the calorifier flow, or the closest tap to the calorifier, and the furthest tap on the hot water service circulating system;
- additional samples should be taken from the base of the calorifier where drain valves have been fitted;

- additional random samples may also be considered appropriate where systems are known to be susceptible to colonisation.

10.4 The sampling method for *Legionella* should be in accordance with ISO 11731:2004. A UKAS-accredited laboratory that takes part in the Health Protection Agency's water external quality assessment (EQA) scheme for the isolation of *Legionella* from water should test samples (visit <http://www.hpaweqa.org.uk> for further information). The laboratory should also apply a minimum theoretical mathematical detection limit of  $\leq 100$  *Legionella* bacteria/litre sample.

10.5 Action following *Legionella* sampling in hot and cold water systems:

Legionella bacteria (cfu/L)	Action required
>100 but <1000	<p>Either:</p> <p>If only one or two samples are positive, system should be resampled. If a similar count is found again, a review of the control measures and risk assessment should be carried out to identify any remedial action to be taken.</p> <p>Or:</p> <p>If the majority of the samples are positive, the system may be colonised with <i>Legionella</i>. Disinfection of the system should be considered, but an immediate review of control measures and risk assessment should be carried out to identify any other remedial action required.</p>
>1000	<p>The system should be resampled and an immediate review of the control measures and risk assessment should be carried out to identify any remedial action, including disinfection of the system. Retesting should take place a few days after disinfection and at frequent intervals thereafter until a satisfactory level of control has been achieved.</p>

## Appendix 1 Action in the event of an outbreak of legionellosis

1. Legionnaires' disease is not notifiable under public health legislation in England and Wales.
  2. The Public Health Laboratory Service (PHLS) (now subsumed under the Health Protection Agency) defined an outbreak as two or more confirmed cases of legionellosis occurring in the same locality within a six-month period. Location is defined in terms of the geographical proximity of the cases, and requires a degree of judgement. It is the responsibility of the "proper officer" for the declaration of an outbreak. The proper officer is appointed by the local authority under public health legislation and is usually a consultant in communicable disease control (CCDC).
  3. Local authorities will have established incident plans to investigate major outbreaks of infectious diseases such as legionellosis. These are activated by the proper officer, who evokes an outbreak committee, whose primary purpose is to protect public health and prevent further infection. This will normally be convened to manage the incident and will involve representatives of the agencies involved. The Health & Safety Executive (HSE) or the local EHO may be involved in the investigation of outbreaks, their aim being to pursue compliance with health and safety legislation.
  4. The local authority, CCDC or EHO acting on their behalf (often with the relevant officer from the enforcing authorities – either HSE or the local authority) may make a visit.
  5. As part of the outbreak investigation and control, the enforcing authority may make the following requests and recommendations:
    - a. to shut down any processors that are capable of generating and disseminating air-borne water droplets and keep them shut down until sampling procedures and any remedial cleaning or other work has been done. Final clearance to restart the system may be required;
    - b. to take water samples from the system before any emergency disinfection is undertaken. This will help the investigation of the cause of illness. The investigating officers from the local authority/authorities may take samples, or require them to be taken;
    - c. to provide staff records to discern whether there are any further undiagnosed cases of illness, and to help prepare case histories of the people affected;
    - d. to cooperate fully in an investigation of any plant that may be involved in the cause of the outbreak. This may involve, for example:
      - (i) tracing of all pipework runs;
      - (ii) detailed scrutiny of all operational records;
      - (iii) statements from plant operatives and managers;
      - (iv) statements from water treatment contractors or consultants.
- Any infringements of relevant legislation may be subject to a formal investigation by the appropriate enforcing authority.

### Emergency cleaning and disinfection of water systems

6. If a water system, other than a cooling system, is implicated in an outbreak of legionnaires' disease, emergency treatment of that system should be carried out as soon as possible. This will involve disinfection as set out in Chapter 17 of Part A.

## Appendix 2 Exemplar temperature test sheets

Hospital/site:				Parameters:				
Building:				Sentinel outlets				
Department/ward:				Cold water equilibrium <20°C within 2 minutes (see notes below)				
				Hot water equilibrium >50°C within 1 minute (measured at outlet or inlet of blended temperature device) (see notes below)				
Room N°.	Room name	Mixing device type	Mixed temp. (°C)	Hot (°C)	Cold (°C)	Comments	Date	Initial
101	Main bathroom							
	– Bath		43	55	18	C. Initially rose to 25°C	D/M/Y	ABC
	– WHB		41	55	18	– Ditto –		

A unique identification is required for each mixing device as well as identification of its type. Hot and cold water pressures also need to be measured and recorded for each mixing device together with all the test parameters from the in-service tests in Model Engineering Specification D08.

### Note

The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of 1 minute to achieve an equilibrium temperature of 50°C. A minimum of 55°C may be required for the operation of suitable mixing devices required to provide "safe" hot water at the upper limit of the recommended range. Hot water at 55°C is required in many cases for reasons of food hygiene or decontamination requirements, for example in kitchens and sluice rooms etc. In a properly balanced hot water circulating system, with the circulation taken close to the draw-off point, achieving temperature should be virtually instantaneous. (At a typical flow to a hand-wash basin of 4.5 L/m, 1 minute to achieve temperature would indicate a 25 m dead-leg of 15 mm pipe.)

### Note

The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of 2 minutes to achieve an equilibrium temperature below 20°C. Achieving this minimum requirement would be indicative of an exceptionally under-utilised water system. (At a typical flow to a hand-wash basin of 4.5 L/m, 2 minutes to achieve temperature would indicate a 50 m dead-leg of 15 mm pipe.)

Hospital/site:				Parameters:				
Building:				Year 1 test outlets				
Department/ward:				Cold water equilibrium <20°C within 2 minutes (see notes below)				
				Hot water equilibrium >50°C within 1 minute (measured at outlet or inlet of blended temperature device) (see notes below)				
Room N°.	Room name	Mixing device type	Mixed temp. (°C)	Hot (°C)	Cold (°C)	Comments	Date	Initial
120	Ward 4							
	Shower		41	57	17		D/M/Y	ABC
	Hand-wash basin		41	57	17			
124	Kitchen							
	– Sink		–	57	12			
	– WHB		41	57	12			

A unique identification is required for each mixing device as well as identification of its type. Hot and cold water pressures also need to be measured and recorded for each mixing device together with all the test parameters from the in-service tests in Model Engineering Specification D08.

**Note**

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# References

## Acts and regulations

**(The) Control of Substances Hazardous to Health Regulations 2002, SI 2002 No 2677.** HMSO, 2002.  
<http://www.opsi.gov.uk/si/si2002/20022677.htm>

**(The) Food Safety Act 1990.** HMSO, 1990.  
[http://www.opsi.gov.uk/acts/acts1990/Ukpga\\_19900016\\_en\\_1.htm](http://www.opsi.gov.uk/acts/acts1990/Ukpga_19900016_en_1.htm)

**(The) Food Safety (General Food Hygiene) Regulations 1995, SI 1995 No 1763.** HMSO, 1995.  
[http://www.opsi.gov.uk/si/si1995/Uksi\\_19951763\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1995/Uksi_19951763_en_1.htm)

**(The) Food Safety (Temperature Control) Regulations 1995, SI 1995 No 2200.** HMSO, 1995.  
[http://www.opsi.gov.uk/si/si1995/Uksi\\_19952200\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1995/Uksi_19952200_en_1.htm)

**(The) Health and Safety at Work etc Act 1974.** HMSO, 1974.

**The Management of Health and Safety at Work Regulations 1992. SI 1992 No 2051.** HMSO, 1992.  
[http://www.opsi.gov.uk/si/si1992/Uksi\\_19922051\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1992/Uksi_19922051_en_1.htm)

**(The) Private Water Supplies Regulations 1991, SI 1991 No 2790.** HMSO, 1991.  
[http://www.opsi.gov.uk/si/si1991/Uksi\\_19912790\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1991/Uksi_19912790_en_1.htm)

**The Public Health (Infectious Diseases) Regulations 1988. SI 1988 No 1546.** HMSO, 1988.  
[http://www.opsi.gov.uk/si/si1988/Uksi\\_19881546\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1988/Uksi_19881546_en_1.htm)

**(The) Water Supply (Water Fittings) Regulations 1999, SI 1999 No 1148.** HMSO, 1999.  
<http://www.opsi.gov.uk/si/si1999/19991148.htm>

**(The) Water Supply (Water Quality) Regulations 2000, SI 2000 No 3184.** HMSO, 2000.  
<http://www.opsi.gov.uk/si/si2000/20003184.htm>

## Department of Health publications

**Safety Notice NHSE SN(96)06: Evaporative type cooling fan.** 15 August 1996.

<http://www.dh.gov.uk/assetRoot/04/12/08/02/04120802.pdf>

## Health Building Notes

**Health Building Note 13 – Sterile services department.** The Stationery Office, 2004.

**Health Building Note 21 – Maternity** (forthcoming).

**Health Building Note 25 – Laundry.** HMSO, 1997.

**Health Building Note 53 – Facilities for renal services. Volume 1, Satellite dialysis unit.** The Stationery Office, 2004.

## Health Facilities Notes

**Health Facilities Note 30 – Infection control in the built environment.** The Stationery Office, 2002.

## Health Technical Memoranda

**Health Technical Memorandum 07-02 – Encode.** The Stationery Office, 2006.

**Health Technical Memorandum 64 – Sanitary assemblies.** The Stationery Office, 2006.

**Health Technical Memorandum 2011 – Emergency electrical services** (to be replaced by Health Technical Memorandum 06-01 – ‘Electrical services supply and distribution’, forthcoming).

## Model Engineering Specifications

**MES D08 – Thermostatic mixing valves (healthcare premises).** HMSO, 1997.

## Other Government publications

Department for Environment, Food & Rural Affairs (Defra) (1999). **Water Supply (Water Fittings) Regulations 1999 guidance document relating to Schedule 1: Fluid Categories and Schedule 2: Requirements for Water Fittings** [See Regulation 4(3)].

<http://www.defra.gov.uk/environment/water/industry/wsregs99/guide/index.htm>

## British Standards

**BS 1212-1:1990** Float operated valves. Specification for piston type float operated valves (copper alloy body) (excluding floats). British Standards Institution, 1990.

**BS 6100:1984–2000** Glossary of building and civil engineering terms. British Standards Institution, 1984–2000.

**BS 6700:1997** Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. British Standards Institution, 1997.

**BS 6920-1:2000** Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water. Specification. British Standards Institution, 2000.

**BS 1710:1984** Specification for identification of pipelines and services. British Standards Institution, 1984.

**BS EN 806-2:2005** Specifications for installations inside buildings conveying water for human consumption. Design. British Standards Institution, 2005.

**ISO 11731:2004.** Water quality. Microbiological methods. Detection and enumeration of *Legionella*. International Standards Organisation, 2004.

## Other publications

BSRIA (1993). **Application Guide 2/93: Water treatment for building services systems.** BSRIA, 1993.

BSRIA (1992). **Application Guide AG 4/89.2 Maintenance contracts for building engineering services.** BSRIA, 1992.

BSRIA (1994). **Application Guide AG 4/94: Guide to legionellosis – temperature measurements for hot and cold water services.** BSRIA, 1994.

BSRIA (1999). **FMS 4/99: Guidance and the standard specification for water services risk assessment.** BSRIA, 1999.

BSRIA (1998). **Technical Note TN 2/98: Chlorine dioxide water treatment – for hot and cold water services.** BSRIA, 1998.

BSRIA (1996). **Technical Note TN 6/96: Ionisation water treatment for hot and cold water services.** BSRIA, 1996.

CIBSE (2000). **Guide to ownership, operation and maintenance of building services.** CIBSE, 2000.

European Pharmacopoeia 3rd Edition 1997 (Supplement) (2000). **Water for diluting concentrated haemodialysis solutions.** European Directorate for the Quality of Medicines, Council of Europe, Strasbourg, France.

Health Protection Agency (1999). **Hygiene for hydrotherapy pools.** HPA, 1999.  
<http://www.hpa.org.uk>

Health Protection Agency (2006). **Management of spa pools: controlling the risks of infection.** HPA, 2006.  
<http://www.hpa.org.uk/publications/2006/spa-pools/default.htm>

Health and Safety Commission (2000). **Approved Code of Practice, Legionnaires' disease: the control of legionella bacteria in water systems (L8).** Health and Safety Executive, 2000.

Heating and Ventilating Contractors' Association (HVCA) (2004). **SFG20: Standard maintenance specification for mechanical services in buildings.**  
<http://www.hvca.org.uk/publications.html>

NHSScotland Property & Environment Forum Executive (1994). **SHTN 2: Domestic hot and cold water systems for Scottish health care premises.** Property & Environment Forum Executive, 1994.

NHSScotland Property & Environment Forum Executive (2001). **SHTN 6: The safe operation and maintenance of thermostatic mixing valves.** Property & Environment Forum Executive, 2001.

The Renal Association (2002). **Treatment of adults and children with renal failure: standards and audit measures.** The Renal Association and the Royal College of Physicians, London.  
[http://www.renal.org/Standards/RenalStandards\\_2002b.pdf](http://www.renal.org/Standards/RenalStandards_2002b.pdf)

Water Regulations Advisory Scheme (WRAS) (2004). **Water Regulations Guide.** WRAS, 2004.  
<http://www.wras.co.uk>

Water Regulations Advisory Scheme (WRAS) (2005). **Water Fittings and Materials Directory.** WRAS, 2005.  
<http://www.wras.co.uk>

World Health Organization (WHO) (1993) **Guidelines for drinking water quality.** WHO, 1993.  
[http://www.who.int/water\\_sanitation\\_health/dwq/guidelines/en/](http://www.who.int/water_sanitation_health/dwq/guidelines/en/)