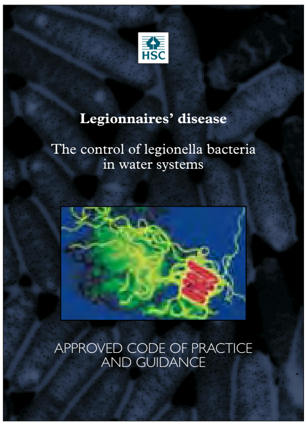
Health and Safety Executive

Legionnaires' disease

The control of legionella bacteria in water systems

Approved Code of Practice and guidance



This is a free-to-download, web-friendly version of L8, (Third edition, published 2000). This version has been adapted for online use from HSE's current printed version.

You can buy the book at www.hsebooks.co.uk and most good bookshops.

ISBN 978 0 7176 1772 2
Price £8.00

This book is written for dutyholders, including employers and those with health and safety responsibilities for others, to help them comply with their legal duties. These include identifying and assessing sources of risk, preparing a scheme to prevent or control risk, implementing, managing and monitoring precautions, keeping records of precautions and appointing a manager to be responsible for others.

The Approved Code of Practice and guidance give practical advice on the legal requirements concerning the risk from exposure to legionella bacteria. The Code also gives guidance on compliance with the relevant parts of the Management of Health and Safety at Work Regulations 1999.

First published 1991
Second edition 1995
Third edition 2000
Reprinted 2001 (twice), 2002, 2004, 2006, 2007, 2008

ISBN 978 0 7176 1771 2

This Code has been approved by the Health and Safety Commision, with the consent of the Secretary of State. It gives practical advice on how to comply with the law. If you follow the advice you will be doing enough to comply with the law in respect of those specific matters on which the Code gives advice. You may use alternative methods to those set out in the Code in order to comply with the law.

However, the Code has a special legal status. If you are prosecuted for breach of health and safety law, and it is proved that you did not follow the relevant provisions of the Code, you will need to show that you have complied with the law in some other way or a Court will find you at fault.

This document also contains guidance issued by the Health and Safety Commission and Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Contents

Notice of Approval

By virtue of section 16(4) of the Health and Safety at Work etc. Act 1974, and with the consent of the Secretary of State for the Environment, the Health and Safety Commission has on 23 November 1999 approved the Code of Practice entitled Legionnaires' disease: the control of legionella bacteria in water systems.

The Code of Practice gives practical guidance with respect to sections 2, 3, 4 and 6 of the Health and Safety at Work etc. Act 1974 and regulations 6, 7, 8, 9 and 12 of the Control of Substances Hazardous to Health Regulations 1999.

The Code of Practice comes into effect on 8 January 2001 and on that date the Code of Practice entitled *The prevention or control of legionellosis (including legionnaires' disease)* (L8rev) shall cease to have effect.

Signed

Avril Adams
Secretary to the Health and Safety Commisson

9th November 2000

The Health and Safety Commission (HSC) and the Health and Safety Executive (HSE) merged on 1 April 2008 to form a single national regulatory body. From that date, the Health and Safety Executive became responsible for approving Codes of Practice, with the consent of the Secretary of State.

Acknowledgements

HSE thanks the following organisations for providing representatives with technical expertise, which was used when preparing the guidance that appears in Part 2 of this publication: British Association for Chemical Specialities (John Lindemann); Building Services Research and Information Association (Reginald Brown); The Chartered Institution of Building Services Engineers (Geoffrey Brundrett); Department of Medical Microbiology, Royal Liverpool University Hospitals (Tom Makin); Environmental Services, Port and City of London (Roger Watson); NHS Estates (Ian Fraser); and The Water Management Society (Mike Iddon).

We also wish to acknowledge the contributions made by the following during the consultation: the City of Westminster; the Drinking Water Inspectorate; Group Investigating Legionnaires' Disease; the Scottish Centre for Infection and Environmental Health; and the Water and Environmental Microbiology Research Unit of the Public Health Laboratory Service.

Introduction

1 This Approved Code of Practice gives practical advice on the requirements of the Health and Safety at Work etc Act 1974 (HSWA) and the Control of Substances Hazardous to Health Regulations 1999 (COSHH) concerning the risk from exposure to legionella bacteria. In particular it gives guidance on sections 2, 3, 4 and 6 (as amended by the Consumer Protection Act 1987) of HSWA and regulations 6, 7,8, 9 and 12 of COSHH. The Code also gives guidance on compliance with the relevant parts of the Management of Health and Safety at Work Regulations 1999 (MHSWR).

2 This publication replaces two separate documents: the 1995 Approved Code of Practice and the technical guidance, HSG70. This has allowed information to be consolidated, with the aim of making it easier to read and understand the duties under the law. Since the last revision, the Health and Safety Executive (HSE) and others have funded research to assess the efficacy of new and alternative control strategies. This new document incorporates the findings of that research and explains how such strategies can be used safely and effectively.

3 This Code applies to the risk from legionella bacteria (the causative agent of legionellosis including Legionnaires' disease) in circumstances where the Health and Safety at Work etc Act 1974 applies.

4 To comply with their legal duties, employers and those with responsibilities for the control of premises should:

(a) identify and assess sources of risk - this includes checking whether conditions are present which will encourage bacteria to mulitply, eg is the water temperature between 20-45°C; there is a means of creating and disseminating breathable droplets, eg the aerosol created by a shower or cooling tower; and if there are susceptible people who may be exposed to the contaminated aerosols (see paragraphs 23-38);
(b) prepare a scheme for preventing or controlling the risk;
(c) implement, manage and monitor precautions - if control measures are to remain effective, then regular monitoring of the systems and the control measures is essential (see paragraphs 61-65). Monitoring of general bacterial numbers can indicate whether microbiological control is being achieved (see paragraphs 124-129 and 183-184). Sampling for legionella is another means of checking that a system is under control (see paragraphs 130-131 and 185-189);
(d) keep records of the precautions; and
(e) appoint a person to be managerially responsible.

5 The Code and guidance also set out the responsibilities of suppliers of services such as water treatment and maintenance as well as the responsibilities of manufacturers, importers, suppliers and installers.

Background to the disease and organisms

6 Legionnaires' disease is a potentially fatal form of pneumonia which can affect anybody, but which principally affects those who are susceptible because of age, illness, immunosuppression, smoking etc. It is caused by the bacterium *Legionella pneumophila* and related bacteria. Legionella bacteria can also cause less serious illnesses which are not fatal or permanently debilitating (see Box 1). The collective term used to cover the group of diseases caused by legionella bacteria is legionellosis.

7 On average there are approximately 200-250 reported cases of Legionnaires' disease each year in the United Kingdom (UK). It is thought, however, that the the total number of cases of the disease may be generally underestimated. About half of cases are associated with travel abroad. Infections which originate in the UK are often sporadic, for which no source of infection is traced. However, clusters of cases also occur and outbreaks have been associated with cooling tower systems and hot and cold water systems in factories, hotels, hospitals and other establishments.

Box 1: Legionellosis (including Legionnaires' disease)

- Legionnaires' disease was first identified following a large outbreak of pneumonia among people who attended an American Legion Convention in Philadelphia in 1976. A previously unrecognised bacterium was isolated from lung tissue samples which was subsequently named *Legionella pneumophila*.

- It is normally contracted by inhaling legionella bacteria, either in tiny droplets of water (aerosols), or in droplet nuclei (the particles left after the water has evaporated) contaminated with legionella, deep into the lungs. There is evidence that the disease may also be contracted by inhaling legionella bacteria following ingestion of contaminated water by susceptible individuals. Person-to-person spread of the disease has not been documented. Initial symptoms of Legionnaires' disease include high fever, chills, headache and muscle pain. Patients may develop a dry cough and most suffer difficulty with breathing. About one third of patients infected also develop diarrhoea or vomiting and about half become confused or delirious. Legionnaires' disease can be treated effectively with appropriate antibiotics.

- The incubation period is between 2-10 days (usually 3-6 days). Not everyone exposed will develop symptoms of the disease and those that do not develop the 'full blown' disease may only present with a mild flu-like infection.

- Infection with legionella bacteria can be fatal in approximately 12% of reported cases. This rate can be higher in a more susceptible population; for example, immunosuppressed patients or those with other underlying disease. Certain groups of people are known to be at higher risk of contracting Legionnaires' disease; for example, men appear more susceptible than women, as do those over 45 years of age, smokers, alcoholics, diabetics and those with cancer or chronic respiratory or kidney disease.

- The disease is usually diagnosed by a combination of tests. The organism may be cultured from the patient's sputum, bronchial washings or lung tissue. Alternatively, tests are used to measure the presence of antibodies in the blood and, increasingly, tests are available to measure specific antigens in the patient's urine.

- *L. pneumophila* is also responsible for a short feverish form of the illness without pneumonia, known as **Pontiac fever**. Its incubation period is typically between 2-3 days. Another species of legionella, *L. micdadei*, is responsible for a similar form of the illness without pneumonia called **Lochgoilhead fever** after an outbreak in Lochgoilhead, Scotland. The incubation period can be up to 9 days. A high percentage of those exposed to this agent tend to be affected. However, there have been no recorded deaths associated with either Pontiac or Lochgoilhead fevers.

- To date, approximately 40 species of the legionella bacterium have been identified. *L. pneumophila* causes about 90% of cases. Sixteen different serogroups of *L. pneumophila* have been described; however, *L. pneumophila* serogroup 1 is most commonly associated with cases of Legionnaires' disease in the UK.

- *L. pneumophila* serogroup 1 can be further sub-divided to distinguish between strains most commonly associated with Legionnaires' disease. Additionally, 'genetic fingerprinting' methods such as Restriction Fragment Length Polymorphism (RFLP) and Amplified Fragment Length Polymorphism (AFLP) can be valuable tools in the investigation of outbreaks. Such methods of typing can sometimes provide a means of linking the organisms isolated from patients to the sources of cases of outbreaks.

8 Cases of Legionnaires' disease have occurred among staff in the workplace (factories, offices, shops and hospitals); visitors (delivery drivers) and members of the public (patients, hotel guests or passers-by).

Natural history of the legionella bacterium

9 Legionella bacteria are common and can be found naturally in environmental water sources such as rivers, lakes and reservoirs, usually in low numbers. Legionella bacteria can survive under a wide variety of environmental conditions and have been found in water at temperatures between 6°C and 60°C. Water temperatures in the range 20°C to 45°C seem to favour growth. The organisms do not appear to multiply below 20°C and will not survive above 60°C. They may, however remain dormant in cool water and multiply only when water temperatures reach a suitable level. Temperatures may also influence virulence; legionella bacteria held at 37°C have greater virulence than the same legionella bacteria kept at a temperature below 25°C.

10 Legionella bacteria also require a supply of nutrients to multiply. Sources can include, for example, commonly encountered organisms within the water system itself such as algae, amoebae and other bacteria. The presence of sediment, sludge, scale and other material within the system, together with biofilms, are also thought to play an important role in harbouring and providing favourable conditions in which the legionella bacteria may grow. A biofilm is a thin layer of micro-organisms which may form a slime on the surfaces in contact with water. Such biofilms, sludge and scale can protect legionella bacteria from temperatures and concentrations of biocide that would otherwise kill or inhibit these organisms if they were freely suspended in the water.

11 As legionella bacteria are commonly encountered in environmental sources they may eventually colonise manufactured water systems and be found in cooling tower systems, hot and cold water systems and other plant which use or store water. To reduce the possibility of creating conditions in which the risk from exposure to legionella bacteria is increased, it is important to control the risk by introducing measures which:

(a) do not allow proliferation of the organisms in the water system; and
(b) reduce, so far as is reasonably practicable, exposure to water droplets and aerosol.

Legislation - health and safety law

12 Duties under the HSWA extend to risks from legionella bacteria which may arise from work activities. The MHSWR provide a broad framework for controlling health and safety at work. As well as requiring risk assessments, they also require employers to have access to competent help in applying the provisions of health and safety law; to establish procedures to be followed by any worker if situations presenting serious and imminent danger were to arise; and for co-operation and co-ordination where two or more employers or self-employed persons share a workplace.

13 Only the courts can give an authoritative interpretation of law in considering the application of these Regulations and guidance to people working under another's direction, the following should be considered: if people working under the control and direction of others are treated as self-employed for tax and national insurance purposes they may nevertheless be treated as their employees for health and safety purposes. It may therefore be necessary to take appropriate action to protect them. If any doubt exists about who is responsible for the health and safety of a worker this could be clarified and included in the terms of a contract. However, it should be remembered that a legal duty under section 3 of HSWA cannot be passed on by means of a contract and there will still be duties towards others under section 3 of HSWA. If such workers are employed on the basis that they are responsible for their own health and safety, legal advice should be sought before doing so.

14 More specifically the COSHH Regulations provide a framework of actions designed to control the risk from a range of hazardous substances including biological agents. The essential elements of COSHH are:

(a) risk assessment;
(b) prevention of exposure or substitution with a less hazardous substance if this is possible, or substitution of a process or method with a less hazardous one;
(c) control of exposure where prevention or substitution is not reasonably practicable;
(d) maintenance, examination and testing of control measures, eg automatic dosing equipment for delivery of biocides and other treatment chemicals;
(e) provision of information, instruction and training for employees; and
(f) health surveillance of employees (where appropriate, and if there are valid techniques for detecting indications of disease) where exposure may result in an identifiable disease or adverse health effect.

15 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) require employers and others, eg the person who has control of work premises, to report to HSE, accidents and some diseases that arise out of or in connection with work. Cases of legionellosis are reportable under RIDDOR if a doctor notifies the employer and if the employee's current job involves work on or near cooling systems that use water or hot water service systems in the workplace. Further details can be obtained in HSE guidance.[1]

16 Those who have, to any extent, control of premises, have a duty under the Notification of Cooling Towers and Evaporative Condensers Regulations 1992 to notify the local authority in writing with details of 'notifiable devices'. These consist of cooling towers and evaporative condensers, except when they contain water that is not exposed to the air and the water and electricity supply are not connected. Although the requirement is to notify the local authority, the Regulations are enforced by the relevant authority for the premises concerned. Forms are available from local authorities or the local HSE office. If a tower becomes redundant and is decommissioned or dismantled, this should also be notified. The

main purpose of these Regulations is to help in the investigation of outbreaks (see Appendix 2).

17 The Safety Representatives and Safety Committees Regulations 1977 and the Health and Safety (Consultation with Employees) Regulations 1996 require employers to consult trade union safety representatives, other employee representatives, or employees where there are no representatives, about health and safety matters. This includes changes to the work that may affect their health and safety at work, arrangements for getting competent help, information on the risks and controls, and the planning of health and safety training. Further information and details of additional guidance can be found in a free HSE leaflet.[2]

Part 1: The Approved Code of Practice

Scope and application

ACOP

18 This Approved Code of Practice applies to the control of legionella bacteria in any undertaking involving a work activity and to premises controlled in connection with a trade, business or other undertaking where water is used or stored and where there is a means of creating and transmitting water droplets which may be inhaled, thereby causing a reasonably foreseeable risk of exposure to legionella bacteria.

19 A reasonably foreseeable risk of exposure to legionella bacteria exists in:

(a) water systems incorporating a cooling tower;
(b) water systems incorporating an evaporative condenser;
(c) hot and cold water systems; and
(d) other plant and systems containing water which is likely to exceed 20°C and which may release a spray or aerosol (ie a cloud of droplets and/or droplet nuclei) during operation or when being maintained.

Guidance

20 Experience has shown that cooling towers, evaporative condensers and hot and cold water systems in a wide variety of workplaces present a risk of exposure to legionella bacteria. Further guidance on systems that may present a risk can be found in Part 2. Not all of the systems listed in paragraph 19 will require elaborate assessment and control measures. A simple risk assessment may show that the risks are low and in such case no further action will be necessary. Examples include small, domestic-type water systems where temperatures and turnover are high, or where instantaneous water heaters are used.

21 A water system includes all plant/equipment and components associated with that system, eg all associated pipe-work, pumps, feed tanks, valves, showers, heat exchangers, quench tanks, chillers etc. It is important that the system is considered as a whole and not, for example, the cooling tower in isolation. Deadlegs and parts of the system used intermittently, eg test loops in engineering factories and injection moulding machines, also need to be included as part of the system since they can create particular problems with microbial growth going unnoticed. Once brought back on-line they can cause heavy contamination, which could disrupt the efficacy of the water treatment regime.

22 For other systems, such as humidifiers and air washers, spa baths and pools, car/bus washes, wet scrubbers, indoor fountains and water features, advice on control measures is given in the text and in Table 3 of Appendix 1.

Identification and assessment of the risk

Regulation

Control of Substances Hazardous to Health Regulations 1999, Regulation 6
Management of Health and Safety at Work Regulations 1999, Regulation 3
Health and Safety at Work etc. Act 1974, Sections 2, 3 and 4.

ACOP

23 A suitable and sufficient assessment is required to identify and assess the risk of exposure to legionella bacteria from work activities and water systems on the premises and any necessary precautionary measures. The assessment is carried out by or on behalf of:

(a) the employer, where the risk from their undertaking is to their employees or to others; or
(b) a self-employed person, where there is a risk from their undertaking to themselves or to others; or

ACOP

(c) the person who is in control of premises or systems in connection with work where the risk is present from systems in the building (eg where a building is let to tenants but the landlord retains responsibility for its maintenance).

24 In conducting the assessment, the person on whom the statutory duty falls is required to have access to competent help to assess the risks of exposure to legionella bacteria in the water systems present in the premises and the necessary control measures.

25 The assessment should include identification and evaluation of potential sources of risk and:

(a) the particular means by which exposure to legionella bacteria is to be prevented; or
(b) if prevention is not reasonably practicable, the particular means by which the risk from exposure to legionella bacteria is to be controlled.

26 Where the assessment demonstrates that there is no reasonably foreseeable risk or that risks are insignificant and unlikely to increase, no further assessment or measures are necessary. However, should the situation change, the assessment needs to be reviewed and any necessary changes implemented.

27 The assessment needs to be reviewed regularly and, in any case, whenever there is reason to believe that the original assessment may no longer be valid.

Guidance

28 Before any formal health and safety management system for water systems can be implemented, a risk assessment has to be carried out to decide the possible risks. The purpose of the assessment is to enable a decision to decide:

(a) the risk to health, ie whether the potential for harm to health from exposure is reasonably foreseeable unless adequate precautionary measures are taken;
(b) the necessary measures to prevent, or adequately control, the risk from exposure to legionella bacteria.

29 The risk assessment also enables the person on whom the statutory duty falls to show that all the pertinent factors, and the steps needed to prevent or control the risk, have been considered.

30 In conducting the assessment, the person on whom the statutory duty falls needs to have access to competent help and advice. Further guidance on this is in paragraph 44. This source of advice may not necessarily be within the person's organisation but may be from a consultancy, water treatment company or a person experienced in carrying out risk assessments. Employers are required to consult employees or their representatives about the arrangements for getting competent help and advice (see paragraph 17).

31 It is the duty of the responsible person (see paragraph 39) to make reasonable enquiries to ensure that organisations such as water treatment companies or consultants, together with personnel from the occupier's organisation, are competent and suitably trained and have the necessary equipment to carry out their duties within the written scheme in a safe and adequate manner. Further guidance on this is in paragraphs 44-46 and 50.

Guidance

Carrying out a risk assessment

32 A number of factors are required to create a risk of acquiring legionellosis, such as:

(a) the presence of legionella bacteria;
(b) conditions suitable for multiplication of the organisms eg suitable temperature (20°C-45°C) and a source of nutrients eg sludge, scale, rust, algae and other organic matter;
(c) a means of creating and disseminating breathable droplets eg the aerosol generated by a cooling tower or shower; and
(d) the presence (and numbers) of people who may be exposed, especially in premises where occupants are particularly vulnerable, eg healthcare.

33 While there will inevitably be common factors associated with the many and varied types of premises being assessed, the individual nature of each site should be taken into account. In complex systems or premises, a site survey of all the water systems should be carried out and should include an asset register of all associated plant, pumps, strainers and other relevant items. This should include an up-to-date drawing/diagram showing the layout of the plant or system, including parts temporarily out of use. A schematic diagram would be sufficient. It should then be decided which parts of the water system, for example, which specific equipment and services, may pose a risk to those at work or other people.

34 The following list contains some of the factors which should be considered, as appropriate, when carrying out the assessment:

(a) the source of system supply water, for example, whether from a mains supply or not;
(b) possible sources of contamination of the supply water within the premises before it reaches the cold water storage cistern, calorifier, cooling tower or any other system using water that may present a risk of exposure to legionella bacteria;
(c) the normal plant operating characteristics; and
(d) unusual, but reasonably foreseeable operating conditions, for example breakdowns.

35 Where there is a risk, the significant findings of the assessment should be recorded (if there are five or more employees). In any case, it may be necessary to record sufficient details of the assessment to be able to show that it has been done. The record of the assessment should be linked to other relevant health and safety records and, in particular, to the written scheme referred to in paragraph 53.

36 Employers are required to consult employees or their representatives on the identified risks of exposure to legionella bacteria and on the measures and actions taken to control the risks. The employees should be given an opportunity to comment on the assessment and control measures and the employer has to take account of these views. It is therefore important for employers to publicise to employees that a legionella risk assessment has been performed and one means by which employers could ensure that employees are informed of the measures and actions taken to control risks, and have an opportunity to comment on the risk assessment, would be by displaying the appropriate parts of the risk assessment.

37 It is essential that the effectiveness of the control measures is monitored and decisions made on the frequency and manner of this monitoring.

38 The assessment should be reviewed regularly (at least every two years) and, whenever there is reason to suspect that it is no longer valid. An indication of when

Guidance

to review the assessment and what needs to be reviewed should be recorded. This may result from, for example:

(a) changes to the water system or its use;
(b) changes to the use of the building in which the water system is installed;
(c) the availability of new information about risks or control measures;
(d) the results of checks indicating that control measures are no longer effective;
(e) a case of Legionnaires' disease/legionellosis is associated with the system.

Managing the risk: management responsibilities, training and competence

Regulation

Control of Substances Hazardous to Health Regulations 1999, Regulations 8 and 12
Health and Safety at Work etc. Act 1974, Sections 2, 3 and 4
Management of Health and Safety at Work Regulations 1999, Regulation 5

ACOP

39 If the assessment shows that there is a reasonably foreseeable risk and it is reasonably practicable to prevent exposure or control the risk from exposure, the person on whom the statutory duty falls (see paragraph 23) should appoint a person or persons to take managerial responsibility and to provide supervision for the implementation of precautions.

40 Persons who carry out the assessment and who draw up and implement precautionary measures should have such ability, experience, instruction, information, training and resources to enable them to carry out their tasks competently and safely. In particular, they should know:

(a) potential sources and the risks they present;
(b) measures to be adopted, including precautions to be taken for the protection of people concerned, and their significance; and
(c) measures to be taken to ensure that controls remain effective, and their significance.

41 Where the above expertise is not possessed by the person or persons appointed under paragraph 39, it may be necessary to enlist help and support from outside the organisation. In such circumstances, the person or persons appointed under paragraph 39 should take all reasonable steps to ensure the competence of those carrying out work who are not under their direct control and that responsibilities and lines of communication are properly established and clearly laid down.

42 Management and communication procedures should be periodically reviewed as appropriate.

Guidance

43 Inadequate management, lack of training and poor communication have all been identified as contributory factors in outbreaks of Legionnaires' disease. It is therefore important that those people involved in assessing risk and applying precautions are competent, trained and aware of their responsibilities.

44 The duty holder (see paragraph 23) should appoint a person to take day-to-day responsibility for controlling any identified risk from legionella bacteria. The appointed 'responsible person' should be a manager, director, or have similar status and sufficient authority, competence and knowledge of the installation to ensure that all operational procedures are carried out in a timely and effective manner. If a duty-holder is self-employed or a member of a partnership, and is competent, they may appoint themselves. The responsible person should have a clear understanding of their duties and the overall health and safety management

Guidance

structure and policy in the organisation. Further guidance is given in *Successful health and safety management* HSG65.[3]

Competence

45 Those who are appointed to carry out the control measures and strategies should be suitably informed, instructed and trained and their suitability assessed. They should be properly trained to a standard which ensures that tasks are carried out in a safe, technically competent manner. Regular refresher training should be given and records of all initial and refresher training need to be maintained. Although training is an essential element of competence, it is not the only factor - it should be viewed as is a product of sufficient training, experience, knowledge and other personal qualities which are needed to undertake a job safely. Competence is dependent on the needs of the situation and the nature of the risks involved.

Implementation of the control scheme

46 The implementation of the system control scheme should be regularly and frequently monitored and everyone involved in any related operational procedure should be properly supervised. Staff responsibilities and lines of communication should be properly defined and clearly documented.

47 Arrangements should be made to ensure that appropriate staff levels are maintained during all hours that the water system is in operation. The precise requirements will depend on the nature and complexity of the water system. In some cases, for example where there is complex cooling plant, shift working and arrangements to cover for all absences from duty, for whatever reason, may be necessary. Appropriate arrangements should be made to ensure that the responsible person or an authorised deputy can be contacted at all times.

48 Call-out arrangements for people engaged in the management of water systems which operate automatically also need to be made. Details of the contact arrangements for emergency call-out personnel should be clearly displayed at access points to all automatically or remotely controlled water systems.

49 Communications and management procedures are particularly important where several people are responsible for different aspects of the operational procedures. For example, responsibility for applying precautions may change when shift-work is involved, or when the person who monitors the efficacy of a water treatment regime may not be the person who applies it. In such circumstances, responsibilities should be well defined in writing and understood by all concerned. Lines of communication should be clear, unambiguous and audited regularly to ensure they are effective. This also applies to outside companies and consultants who may be responsible for certain parts of the control regime.

50 The employment of contractors or consultants does not absolve the duty holder of responsibility for ensuring that control procedures are carried out to the standard required to prevent the proliferation of legionella bacteria. Organisations should make reasonable enquiries to satisfy themselves of the competence of contractors in the area of work before entering into contracts for the treatment, monitoring, and cleaning of the water system, and other aspects of water treatment and control. More general information on selecting a health and safety consultancy can be found in a free HSE leaflet.[4]

51 An illustration of the levels of service which should be expected from service providers can be found in the Code of Conduct developed jointly by the Water Management Society and the British Association for Chemical Specialities (WMS/BACS).[5] The Code of Conduct does not have any legal status under health and

Guidance

safety law, but should help occupiers choose a suitable service provider to help them control the risks from legionella bacteria.

Preventing or controlling the risk from exposure to legionella bacteria

Regulation

Control of Substances Hazardous to Health Regulations 1999, Regulation 7 and 9
Health and Safety at Work etc. Act 1974, Sections 2, 3 and 4

ACOP

52 Where the assessment shows that there is a reasonably foreseeable risk, the use of water systems, parts of water systems or systems of work that lead to exposure has to be avoided so far as is reasonably practicable.

53 Where this is not reasonably practicable, there should be a written scheme for controlling the risk from exposure which should be implemented and properly managed. The scheme should specify measures to be taken to ensure that it remains effective. The scheme should include:

(a) an up-to-date plan showing layout of the plant or system, including parts temporarily out of use (a schematic plan would suffice);
(b) a description of the correct and safe operation of the system;
(c) the precautions to be taken;
(d) checks to be carried out to ensure efficacy of scheme and the frequency of such checks; and
(e) remedial action to be taken in the event that the scheme is shown not to be effective.

54 The risk from exposure will normally be controlled by measures which do not allow the proliferation of legionella bacteria in the system and reduce exposure to water droplets and aerosol. Precautions should, where appropriate, include the following:

(a) controlling the release of water spray;
(b) avoidance of water temperatures and conditions that favour the proliferation of legionella bacteria and other micro-organisms;
(c) avoidance of water stagnation;
(d) avoidance of the use of materials that harbour bacteria and other micro-organisms, or provide nutrients for microbial growth;
(e) maintenance of the cleanliness of the system and the water in it;
(f) use of water treatment techniques; and
(g) action to ensure the correct and safe operation and maintenance of the water system.

Guidance

55 Once the risk has been identified and assessed, a written scheme should be prepared for preventing or controlling it. In particular, it should contain such information about the system as is necessary to control the risk from exposure.

56 The primary objective should be to avoid conditions which permit legionella bacteria to proliferate and to avoid creating a spray or aerosol. It may be possible to prevent the risk of exposure by, for example, using dry cooling plant, adiabatic cooling systems or point-of-use heaters (with minimal or no storage). Where this is impractical, the risk may be controlled by minimising the release of droplets and by ensuring water conditions which prevent the proliferation of legionella bacteria. This might include engineering controls, cleaning protocols and other control strategies. Decisions should be made about the maintenance procedures and intervals, where relevant, on equipment used for carrying out the control measures. Legionella bacteria may be present in very low numbers in many water systems but careful control will prevent them from multiplying.

Guidance

57 In general, proliferation of legionella bacteria may be prevented by:

(a) avoiding water temperatures between 20°C and 45°C - water temperature is a particularly important factor in controlling the risks;
(b) avoiding water stagnation, which may encourage the growth of biofilm;
(c) avoiding the use of materials in the system that can harbour or provide nutrients for bacteria and other organisms;
(d) keeping the system clean to avoid the build-up of sediments which may harbour bacteria (and also provide a nutrient source for them);
(e) the use of a suitable water treatment programme where it is appropriate and safe to do so; and
(f) ensuring that the system operates safely and correctly and is well maintained.

58 The scheme should give details on how to use and carry out the various control measures and water treatment regimes including:

(a) the physical treatment programme - for example, the use of temperature control for hot and cold water systems;
(b) the chemical treatment programme, including a description of the manufacturer's data on effectiveness, the concentrations and contact time required;
(c) health and safety information for storage, handling, use and disposal of chemicals;
(d) system control parameters (together with allowable tolerances); physical, chemical and biological parameters, together with measurement methods and sampling locations, test frequencies and procedures for maintaining consistency;
(e) remedial measures to be taken in case the control limits are exceeded, including lines of communication; and
(f) cleaning and disinfection procedures.

59 The scheme should also describe the correct operation of the water system plant including:

(a) commissioning and recommissioning procedures;
(b) shutdown procedures;
(c) checks of warning systems and diagnostic systems in case of the system malfunctions;
(d) maintenance requirements and frequencies; and
(e) operating cycles - including when the system plant is in use or idle.

60 Detailed guidance on how to effectively prevent or control exposure can be found in Part 2.

Review of control measures - monitoring and routine inspection

61 If precautions are to remain effective, the condition and performance of the system will need to be monitored. This should be the responsibility of the responsible person or, where appropriate, an external contractor or an independent third party and should involve:

(a) *checking* the performance of the system and its component parts;
(b) *inspecting* the accessible parts of the system for damage and signs of contamination; and
(c) *monitoring* to ensure that the treatment regime continues to control to the required standard.

Guidance

62 The frequency and extent of routine monitoring will depend on the operating characteristics of the system, but should be at least weekly.

63 Testing of water quality is an essential part of the treatment regime, particularly in cooling towers. It may be carried out by a service provider, such as a water treatment company or consultant, or by the operator, provided they have been trained to do so and are properly supervised. The type of tests required will depend on the nature of the system and further details are given in Part 2 for both cooling towers and hot and cold water systems.

64 The routine monitoring of general bacterial numbers (total viable count) is also appropriate as an indication of whether microbiological control is being achieved. This is generally only carried out for cooling towers, rather than hot and cold water systems. Periodic sampling and testing for the presence of legionella bacteria may also be relevant to show that adequate control is being achieved. However, reliably detecting the presence of legionella bacteria is technically difficult and requires specialist laboratory facilities. The interpretation of results is also difficult; a negative result is no guarantee that legionella bacteria are not present. Conversely, a positive result may not indicate a failure of controls as legionella are present in almost all natural water sources. Further guidance on bacteriological monitoring and interpretation of test results can be found in Part 2.

65 The results of monitoring and testing should be interpreted by a suitably experienced and competent person and any remedial measures, where necessary, should be carried out promptly.

Record keeping

Regulation

Control of Substances Hazardous to Health Regulations 1999, Regulations 6 and 9
Management of Health and Safety at Work Regulations 1999, Regulation 3 and 5
Health and Safety at Work etc. Act 1974, Sections 2, 3 and 4

ACOP

66 The person or persons appointed under paragraph 39 shall ensure that appropriate records are kept, including details of:

(a) the person or persons responsible for conducting the risk assessment, managing, and implementing the written scheme;
(b) the significant findings of the risk assessment;
(c) the written scheme required under paragraph 53 and details of its implementation; and
(d) the results of any monitoring, inspection, test or check carried out, and the dates. This should include details of the state of operation of the system, ie in use/not in use.

67 Records kept in accordance with paragraph 66 should be retained throughout the period for which they remain current and for at least two years after that period. Records kept in accordance with paragraph 66(d) should be retained for at least five years.

Guidance

68 To ensure that precautions continue to be carried out and that adequate information is available, a record of the assessment and precautionary measures and treatments should be kept. All records should be signed by those people performing the various tasks assigned to them.

69 The following items should normally be recorded:

(a) names and position of people responsible for carrying out the various tasks under the written scheme;

Guidance

(b) a risk assessment and a written scheme of actions and control measures;
(c) plans or schematic drawings of the systems;
(d) details of precautionary measures that have been carried out, including sufficient detail to show that they were carried out correctly and the dates on which they were carried out;
(e) remedial work required and carried out, and the date of completion;
(f) a log detailing visits by contractors, consultants and other personnel;
(g) cleaning and disinfection procedures and associated reports and certificates;
(h) results of the chemical analysis of the water;
(i) information on other hazards, eg treatment chemicals;
(j) cooling tower notification;
(k) training records of personnel;
(l) the name and position of the people or persons who have responsibilities for implementing the scheme, their respective responsibilities and their lines of communication;
(m) records showing the current state of operation of the system, eg when the system or plant is in use and, if not in use, whether it is drained down; and
(n) the signature of the person carrying out the work, or other form of authentication where appropriate.

Responsibilities of manufacturers, importers, suppliers and installers

Regulation

Health and Safety at Work etc. Act 1974, Section 3 and Section 6, as amended by the Consumer Protection Act 1987

ACOP

70 Whoever designs, manufactures, imports or supplies water systems that may create a risk of exposure to legionella bacteria should, so far as is reasonably practicable:

(a) ensure that the water system is so designed and constructed that it will be safe and without risks to health when used at work; and
(b) provide adequate information for the user about the risk and measures necessary to ensure that the water systems will be safe and without risks to health when used at work. This should be updated in the light of any new information about significant risks to health and safety that becomes available.

71 Suppliers of products and services, including consultancy and water treatment services, aimed at preventing or controlling the risk of exposure to legionella bacteria, should, so far as is reasonably practicable:

(a) ensure that measures intended to control the risk of exposure to legionella bacteria are so designed and implemented that they will be effective, safe and without risks to health when used at work;
(b) provide adequate information on the correct and safe use of products, taking into account the circumstances and conditions of their use;
(c) ensure that any limitations on their expertise or on the products or services they offer are clearly defined and made known to the person upon whom the statutory duty falls or the person(s) appointed to take managerial responsibility;
(d) ensure that any deficiencies or limitations which they identify in the occupier's systems or written scheme to control the risk of exposure to legionella bacteria are made known to the person upon whom the statutory duty falls or the person(s) appointed to take managerial responsibility; and
(e) ensure that their staff have the necessary ability, experience, instruction,

ACOP

information, training and resources to carry out their tasks competently and safely.

72 All water systems should be properly installed, and commissioned as appropriate.

Guidance

73 Anyone involved in the supply of water systems (eg designers, manufacturers, importers or suppliers of water systems) has duties under health and safety legislation. They must, as far as reasonably practicable, ensure that the equipment is designed and constructed so that it is safe when used at work and enables safe and easy operation, cleaning and maintenance.

74 There are a number of key points to consider in the design and construction of water systems. Cooling systems should be designed and constructed so that they:

(a) comply with relevant British Standards or their European/International equivalents;
(b) control the release of drift by fitting effective drift eliminators (such devices do not eliminate but rather reduce drift). Spray from other parts of the system should also be controlled;
(c) aid safe operation - for example, water circuitry should be as simple as possible, ideally without deadlegs, or if this is not possible, with the length of deadlegs limited;
(d) aid cleaning and disinfection - for example, those parts of the system which need regular cleaning should be easily accessible, readily removable and easily dismantled; and
(e) be made of materials which can be easily disinfected and which do not support microbial growth.

Hot and cold water systems should be designed and constructed so that they:

(a) comply with the Water Regulations (1999) and with parallel provisions in Scotland;
(b) aid safe operation - for example, without deadlegs, or if this is not possible, with the length of deadlegs limited and non-essential standby plant disconnected or removed;
(c) reduce stored cold water to a minimum needed to meet peak needs;
(d) aid cleaning and disinfection - for example, by providing suitable access points within the system; and
(e) minimise heat gain/loss - for example, water pipes and storage tanks should be insulated.

Further detailed information can be found in Part 2.

75 Manufacturers and suppliers of water systems should provide adequate information and instructions on their safe use. This should include information about those aspects of operation and maintenance which have a bearing on the risk.

76 Those who supply services, such as water treatment or maintenance services, should also make clear to the responsible person any deficiencies in the water system or measures that may pose a significant risk of exposure to legionella bacteria. They should also make the owner or responsible person aware of any limitations in their own expertise, products or services so that they can make arrangements to ensure that these deficiencies or limitations are addressed.

77 Service providers should also ensure that their staff are competent to carry out the task safely. They should be properly trained to a standard appropriate

Guidance

to the various tasks they perform, such as risk assessment, advising on water treatment measures, sampling or cleaning and maintaining water systems. A Code of Conduct[5] for organisations providing services to occupiers/owners of water systems has been developed jointly by the Water Management Society and the British Association for Chemical Specialities (WMS/BACS). This Code of Conduct does not have any legal status, but may give guidance to occupiers about the standard of service they will receive from service providers who agree to abide by the Code.

78 All staff should be suitably trained, managed, supervised, and given appropriate resources or support. In particular, they should be aware of the action to take when confronted with situations outside of their knowledge or experience.

Guidance

Part 2: Guidance on the control of legionella in water systems

The following guidance on the design and management of cooling towers, evaporative condensers and hot and cold water systems is based on, and replaces, the 1993 guidance *The control of legionellosis (including Legionnaires' disease)* HSG70 and the 1998 supplement *The control of legionellosis in hot and cold water systems* MISC150.

This does not form part of the ACOP, but rather it gives practical guidance on how to comply with the requirements of the ACOP.

Cooling systems

79 There is a range of evaporative cooling systems available which vary considerably in size and type. These systems are designed to dissipate heat, using water as a heat exchange medium, from industrial processes and air-conditioning systems (see Box 2 for a description of process and types of system). However, such systems can provide an environment for the growth of many micro-organisms, including legionella, which can be spread widely by aerosol into the area around the cooling tower.

Alternative methods of cooling

80 In some circumstances it may be possible to use alternative methods of cooling. Dry cooling, for example using air blast coolers or air-cooled condensers, will avoid the risks presented by a wet cooling tower or evaporative condenser. The option of dry cooling should therefore be considered, particularly when cooling towers are due to be replaced or when new cooling systems are planned. Large dry cooling systems have some disadvantages as they are generally larger and heavier than cooling towers, so they may be impractical where space and load limitations are limited. They may also be noisier and, while running costs and energy use are comparable for small units, cooling towers are generally cheaper to run for larger systems. These drawbacks will be partially offset by reduced maintenance requirements and savings in the use of water treatment chemicals, cleaning and disinfection costs, regular monitoring and management costs. Adiabatic cooling systems are used increasingly but if used intermittently, they may pose problems associated with water stagnation; this may result in microbiological proliferation. In practice, each case should be considered on its individual merits.

Box 2: Processes and systems

Cooling towers/evaporative condensers

There are two main types of evaporative cooling towers: (a) mechanical draught; and (b) natural draught. **Mechanical draught towers** use fans to move the air through the tower. The air can be either forced or induced through the tower. The forced draught tower (see Figure 1a), with the fan located in the side, pushes the air through the tower and out at the top. Conversely the induced draught tower, with the fan located at the top, pulls air through the tower and out at the top (see Figure 1b). In **natural draught towers** the warm return water heats the internal air causing it to rise. Cooler air is drawn in at the tower base and passes through the falling water droplets, causing evaporation.

Guidance

Figure 1a Forced draft

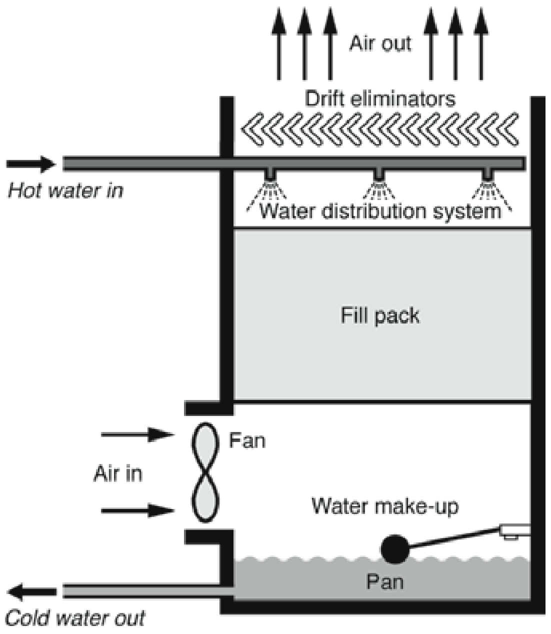
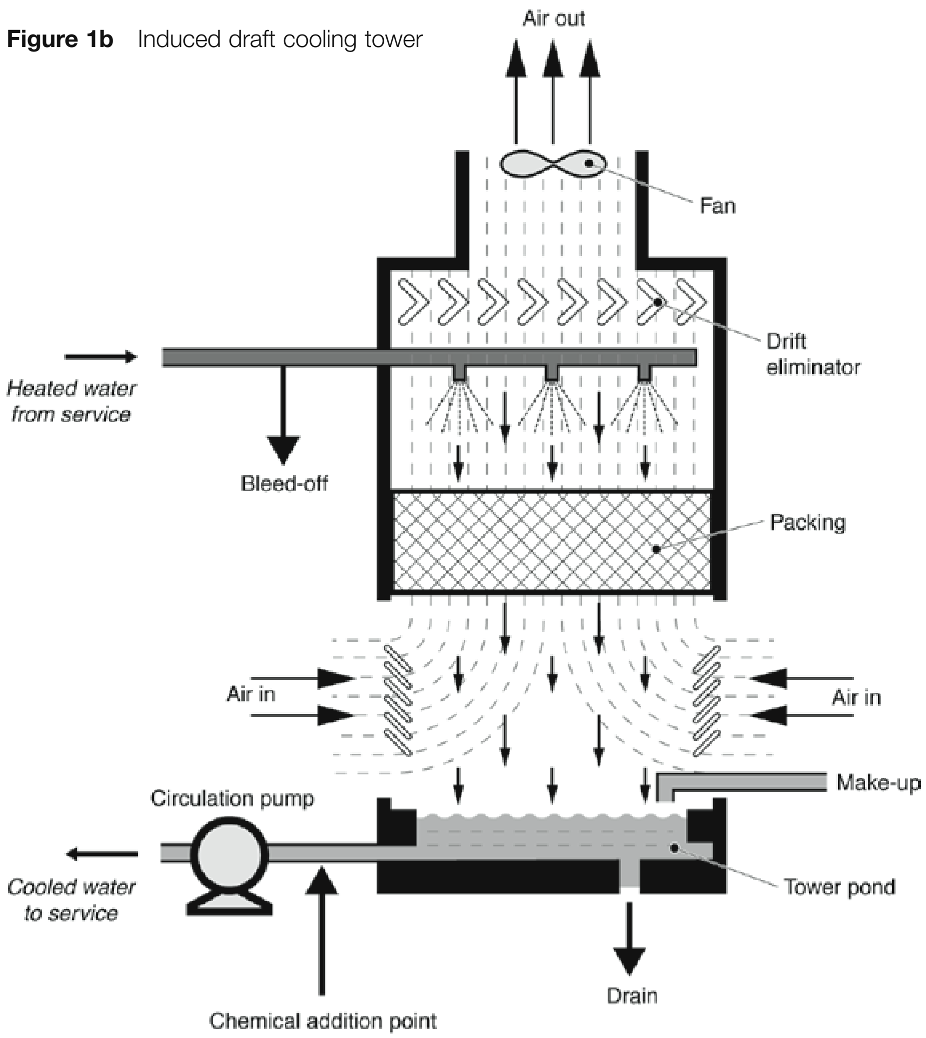


Figure 1b Induced draft cooling tower



Guidance

Heat removal and dissipation is achieved primarily by the evaporation of a portion of the recirculating cooling water. To optimise the cooling process there needs to be a large area of contact between the water and the air stream flowing through the cooling tower. This is achieved either by distributing the water over a system of splash bars or filming the water over a large surface area of packing.

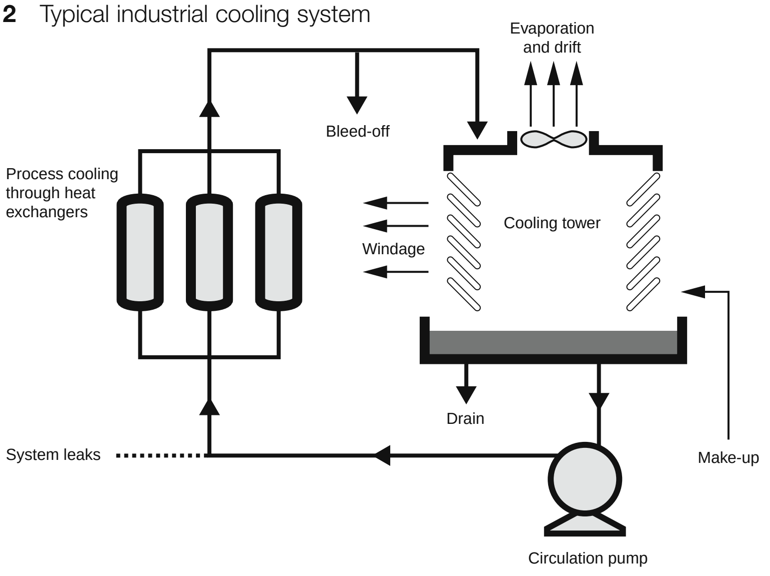
Different types of cooling towers and equipment are used because of the very wide range of cooling process applications. Open recirculating cooling systems are widely used in industry. Natural draught hyperbolic towers are commonly used in the power generation industry. Chemical, petro-chemical and steel industries may also use such towers but, more often, induced draught towers are used. Smaller industrial plants use forced or induced draught cooling towers and Figure 2 shows a typical industrial cooling system. The cooling tower used will depend on the nature of the system duty.

Evaporative condensers (see Figure 3) are sometimes used for air-conditioning or industrial cooling applications. The evaporative condenser combines the function of both the cooling tower and the conventional condenser, as water is sprayed directly over the cooling coils. The volume of water in the evaporative condenser is usually less than in a cooling system. However, cases of legionellosis have been attributed to evaporative condensers and they should therefore be regarded as presenting a similar risk and requiring similar precautions.

Air-conditioning systems

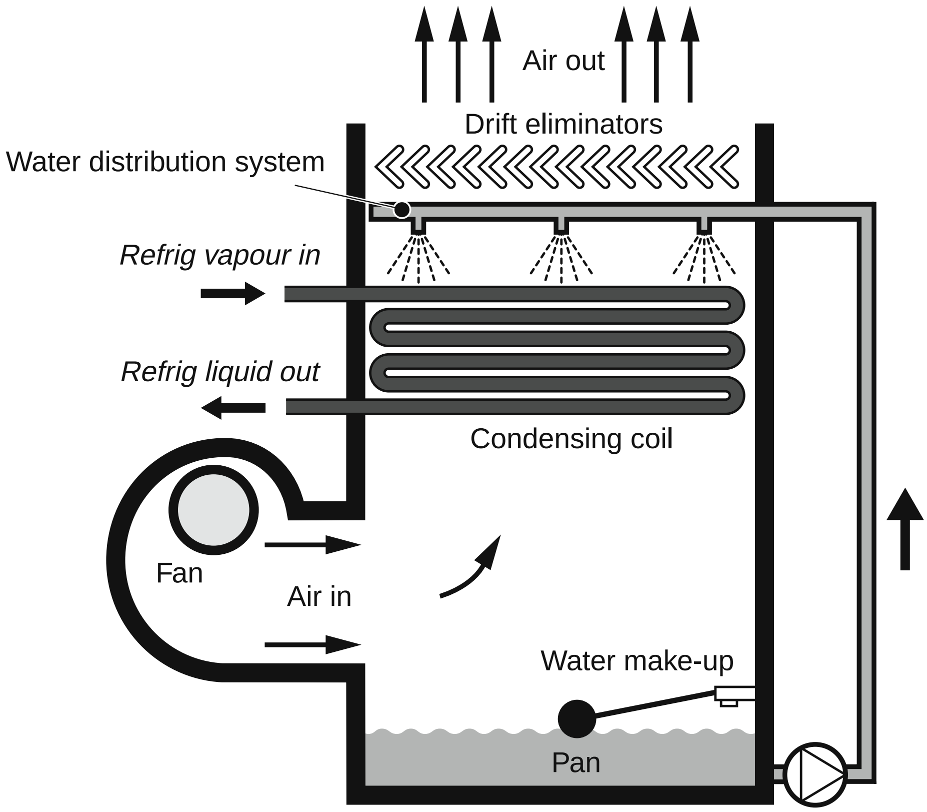
Air-conditioning is a process of treating air to control its temperature, humidity and cleanliness and distributing this air to meet the needs of the conditioned space. Since temperature and relative humidity are interdependent, typically control is established by passing the air over chilled or heated coils and this may include humidification. The air is cleaned by filtration and heat from the refrigeration cycle is removed by the condenser which is often cooled by water from a cooling tower. The cooling water is heated to around 30°C and with the potential for scale formation, corrosion and fouling this may provide an environment for the proliferation of legionella. Figure 4 shows a typical air-conditioning system.

Figure 2 Typical industrial cooling system



Guidance

Figure 3 Evaporative condenser



The ACOP says that plant or water systems should be designed and constructed to be safe and without risks to health when used at work. The following section on design and construction offers guidance on how to do this in cooling systems

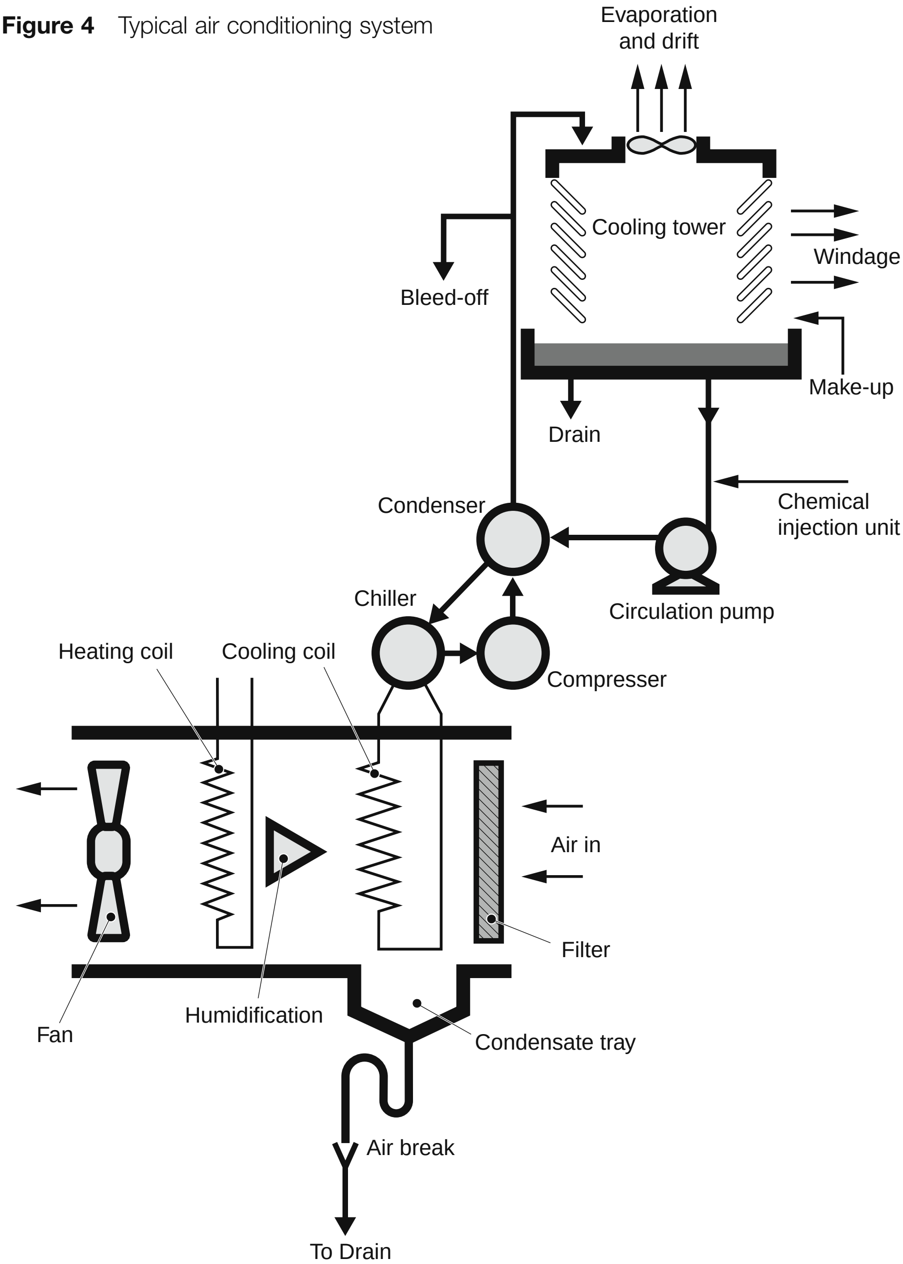
81 Cooling systems should be designed and constructed so as to control the release of drift, to aid safe operation, cleaning and disinfection (see BS 4485:Part 3: 1988 and BS 4485:Part 4: 1996).[6] In particular, the following points should be considered:

(a) Drift eliminators, usually made of plastic or metal, should be installed in all towers. In spite of the name, the function of a drift eliminator is to 'reduce' rather than actually 'eliminate' aerosol drift. Although some types are more effective than others, there is no industry standard. However, they should be well fitted and selected on the basis of their ability to reduce the release of small water droplets - there should be no visible drift released from the tower. Wooden slats do not control the small droplets and should be replaced. Operating conditions, especially the discharge air velocity, affect the efficiency of drift eliminators, for example, if the fan is not running. They are not always fitted on natural draught cooling towers because they may be ineffective.

(b) The area above the cooling tower pond should be as well enclosed as possible to reduce the effects of windage. Wind movements around the tower may cause spray to escape through the sides, especially if it is poorly enclosed. This is particularly significant when the tower runs with its fan off. It may also be necessary to screen the tower or its pond to prevent the entry of birds, vermin, leaves or other debris or contaminants and to reduce solar heat gain.

Guidance

Figure 4 Typical air conditioning system



(c) The water distribution system within the cooling tower should be designed to create as little aerosol (ie small water droplets) as possible. The water circuitry should be as simple as is practicable, with the avoidance of deadlegs and 'difficult to drain' loops and bends. Easily understood and accurate schematics of the various water circuits should be available, with any deadlegs or dead ends highlighted and redundant pipework removed. The absence of water circulation means that any microbial population can be left undisturbed for long periods, allowing growth and multiplication. Any subsequent disruption of the deadleg/dead end could lead to a rapid colonisation of the water system.

(d) Those parts of the tower which become wet should be accessible for cleaning; packs should be readily removable and easily dismantled. The wetted areas of the tower should, where possible, be shaded from direct sunlight to discourage the growth of algae. The pond should have a sloping bottom with a drain connection at the lowest point which is large enough to carry away water and slurry quickly and easily. A suitably-sized drain-down valve should be located at the lowest point of the system so that it can be

Guidance

conveniently and completely drained, including all pipework and items of equipment. It may be necessary to fit supplementary drain valves to the bottom of individual items of equipment.

(e) The tower should be constructed of materials which can be readily disinfected and which do not support microbial growth. Preserved (see BS5589:1989)[7] timber may be used for the manufacture of cooling towers and packs but it needs to be impervious and easy to clean and disinfect.

(f) Make-up water may not necessarily be mains-supplied (or from another treated water supply) - it may come from rivers, lakes, bore holes and other sources. It may therefore need pre-treatment to be of equivalent quality to the mains supply. If it does not come from a treated water supply, then the quality of water entering the make-up system may show considerable variation in both chemical composition and microbial activity. This may contribute to potential risk and a strategy is required to overcome any identified problems. Inclusion of a water meter in the tower supply pipeline both for the measurement of make-up rates and for the proportional dosage of treatment chemicals is recommended.

(g) A full water treatment programme should be integrated into the system design, with provision made for sample, injection, bleed and drain points and for the incorporation of dosing and bleed equipment; ideally this should be automated.

(h) Cooling towers should be positioned as far away as possible from air-conditioning and ventilation inlets, opening windows and occupied areas, taking note of the prevailing wind direction and the wind distribution over neighbouring buildings. This should also be considered when replacing old cooling towers as it may be possible to reposition them to a more suitable location.

Management of cooling towers

82 The cooling system may consist of a cooling tower, evaporative condenser or other cooling element, the recirculating pipework, the heat exchanger, pumps and ancillary items such as supply tanks and pre-treatment equipment. All of these items should be subject to the management and control system.

The ACOP says risks from legionella should be identified and managed. The following section on commissioning, operation and maintenance of cooling towers offers guidance on some of the issues which need to be addressed in order to do this.

Commissioning

83 Systems should be properly commissioned to ensure that they operate correctly and within the design parameters. It is essential that the commissioning process is carried out in a logical and defined manner. The responsibilities of the staff carrying out the commissioning process should be clearly defined with adequate time and resources allocated to allow the integrated parts of the installation to be commissioned correctly. The same precautions taken to prevent or control the risk of exposure to legionella during normal operation of cooling systems also apply to the commissioning process.

84 When commissioning (or recommissioning) a tower, the following points should be noted (see also paragraph 135).

(a) If a new system is not to be taken into immediate service, commissioning should not be carried out until the system is required for use and should not be filled until commissioning takes place (if filled for hydraulic testing, then the system should drained and not refilled until commissioning takes place).

Guidance

(b) If a new system is to be taken into use within a week, commissioning can be carried out and the system left charged with treated water which should include a biocide. This is equally important when recommissioning existing installations which have been substantially altered following a major design or modification.
(c) The results of the commissioning process should be included as a section in the operation and maintenance manual. The availability of such baseline data enables periodic checks to be made to show that the installation continues to operate as intended.
(d) Formal arrangements should be made to check that commissioning has been completed to the standard specified, eg an independent engineer witnesses the testing and countersigns the relevant documents.

Operation

85 Cooling systems and towers should be kept in regular use wherever possible. Where a system is used intermittently or is required at short notice, it should be run once a week and, at the same time, be dosed with water treatment chemicals and water quality monitored. The whole system should be run for long enough to thoroughly distribute treated water. If a system is out of use for a week or longer (up to a month), in addition to the above, the water should be treated with biocide immediately on reuse.

86 If it is out of use for longer than a month and there are continued management/monitoring arrangements in place, the system should be kept full of treated water which should be checked (for biocide levels and water quality) and circulated once a week (see also paragraph 135). If it is not possible to ensure regular monitoring and circulation (for example if a building falls out of use) the system should be drained and sealed, with a desiccant left in the system to reduce the effects of corrosion. Full recommissioning will be required before the system can be bought back into reuse. Cooling systems that do not operate continuously, such as cooling towers that cycle on and off automatically or those on regular standby duty, require particular attention with regard to the biocide programme to ensure that effective levels of biocide are maintained at all times.

87 Operation manuals should be available for each water system. These manuals should detail, in easily understood terms, operation and maintenance procedures which enable plant operators to carry out their duties safely and effectively.

88 The manuals should include equipment as fitted and represent the system as currently in operation, and include (also as fitted) system drawings and/or schematics, manufacturers' instructions for operation and system parameters such as capabilities, throughputs and design temperatures. The total volume of the entire water circuit, ie tower pond, recirculation pipework and heat exchange equipment, should be known and recorded.

89 Specific information on the water treatment programme in use should be included. Where automatic dosing equipment is used, there should be a means of confirming that treatment is being applied. Irrespective of the dosing method, both the quantity and frequency of chemical application should be recorded.

90 Such records should be expanded to:

(a) include the results of system monitoring; and
(b) show any action required and confirmation that this has been carried out.

Guidance

91 Manuals should include details of:

(a) normal control parameters;
(b) limits, with corrective actions, for out-of-specification situations, or where plant operating conditions or make-up water quality have changed; and
(c) cleaning and disinfection procedures.

92 Where automatic controls are employed, either for chemical addition or to allow system bleed-off, they should be checked over their full operating ranges. In the specific case of conductivity controlled bleed-off, regular calibration of the conductivity cell should be carried out.

93 Standby equipment, such as towers and recirculating pumps, should operate on a rota basis eg daily on/off, or otherwise isolated and held dry. If there are standby cooling towers, specific procedures will need to be adopted to bring them into operation safely.

94 When a biocide is added to a water system, all standby equipment or pipework should be brought into circulation so that the biocide is distributed throughout the entire system.

Maintenance

95 The operations manual should include a detailed maintenance schedule which should list the various time intervals when the system plant and water should be checked, inspected, overhauled or cleaned. Provision should be made for the completion of every task to be recorded by the plant operatives.

96 Drift eliminators require particular attention with regard to maintenance so that aerosol release continues to be controlled. They should be inspected, cleaned and maintained to ensure that they are free from biofouling, corrosion, scale and other deposits and are well seated and undamaged.

Treatment programmes

The ACOP says that the risk from exposure to legionella should be prevented or controlled; precautions should include the use of water treatment techniques. The following section on treatment programmes offers guidance on how to treat water in cooling systems.

97 A complete water treatment programme based on the physical and operating parameters for the cooling system and a thorough analysis of the make-up water should be established. The components of the water treatment programme should be environmentally acceptable and comply with any local discharge requirements.

98 It is important to ensure that water treatment programmes have sufficient range of adjustment to cope with any potential variations in make-up water supply quality. This enables control to be maintained. Failure to take account of variations in quality may lead to the rapid development of uncontrolled microbiological conditions within the cooling system.

99 There are a number of factors which will influence the effectiveness of any treatment programme:

(a) corrosion;
(b) scale formation;
(c) fouling; and
(d) microbiological activity.

Guidance

These are discussed in more detail in paragraph 101-121. They are interrelated and failure to control any one may lead to all occurring simultaneously, resulting in an environment that encourages the growth of legionella. In setting up an effective monitoring and control system, it should be remembered that corrosion, scale formation and fouling are continuous physico-chemical processes and inhibitors to control such processes should be added on a continuous basis.

100 All components of the treatment programme should be preferably be dosed by pump or eductor (sometimes referred to as an ejector) systems or by a suitable halogen dosing system such as a brominator. This will minimise health and safety risks to operators and ensure that frequencies and rates of application are maintained as recommended.

Corrosion

101 In many cooling systems a significant proportion of the construction material is mild steel which is susceptible to corrosion. Although heat transfer equipment may be made of more corrosion-resistant metals such as copper or copper alloys or stainless steel, these metals also need to be adequately protected. Corrosion of steel should be inhibited as it may lead to conditions which encourage the growth of legionella.

102 There are two types of corrosion inhibitors available; **anodic** and **cathodic** and a treatment programme would generally use both types for optimum protection. The actual inhibitors used will depend on the type of system and its operation, water quality, operating temperatures, construction materials and environmental constraints. In all cases, corrosion inhibitors need to be applied continuously since their effectiveness depends on the presence of clean metal surfaces. This highlights the need for pre-commissioning cleaning and subsequent passivation of the metal surfaces. Corrosion inhibitors are commonly applied at a point of good mixing such as the suction side of the recirculating pump.

Scale

103 Scale is the localised precipitation of normally water-soluble inorganic salts. Its formation is influenced by the concentration of calcium and magnesium salts, alkalinity and pH, surface and bulk water temperatures and the concentration of the total dissolved solids.

104 Scale formation results in loss of heat transfer, reduced flow rates, loss of efficiency and deposition/corrosion. Legionella can be associated with such deposits - the scale protects the bacteria and so reduces the effectiveness of biocidal treatment.

105 Chemicals used to control scale are known collectively as scale inhibitors. The specific chemicals used will depend upon the type of scale predicted from the water chemistry and system operating conditions. In systems which contain scale, or have had a history of scaling problems, chemical analysis of the scale will ensure that the most effective treatment programme is selected.

106 There are a number of other methods of scale control including:

(a) limiting the cycles of concentration by bleed-off/blow-down;
(b) conversion of calcium and magnesium hardness into more soluble salts - generally achieved by the controlled addition of a mineral acid to the cooling water, a method more applicable to large industrial systems; and
(c) prevention of scale formation by removing the calcium and magnesium hardness salts by ion-exchange softening; this is dependent on water quality

Guidance

and system characteristics. The use of a blend of untreated and softened water may be appropriate in some instances.

107 It is common practice to apply scale inhibitors to a point of good mixing such as the suction side of the recirculating pump.

Fouling

108 The term fouling is normally applied to deposition of particulate material and debris such as:

(a) insoluble corrosion products;
(b) scale deposits;
(c) mud, silt, clay;
(d) airborne dust and debris;
(f) process contaminants; and
(g) biological matter such as insects, pollen and plant material, including the formation of slimes. Settlement will occur in low-velocity areas of the system and can lead to loss of plant performance, corrosion under the deposits, increased microbiological activity and proliferation of legionella.

109 In systems using make-up water, which has a high concentration of suspended solids, pre-clarification may be necessary. Where this is not feasible, side-stream filtration can be used to remove particulate debris introduced into the cooling tower.

110 Fouling can be controlled or alleviated through:

(a) using dispersants to prevent agglomeration (and subsequent deposition) of the particles. Chemical methods are most effective if water velocities can be maintained at or above 1 m/s. Where oil contamination is a problem, surfactants may be used, as required, to emulsify and disperse the contamination;
(b) reversing water flow through heat exchangers, centrifugal strainers, 'air bumping' or temporarily increasing water velocity by the introduction of a high-pressure water supply. Such methods should always be used with care, as there is likely to be an increase in microbiological count in the recirculating water, caused by the disturbance of the deposits, so the bleed may need to be increased to flush micro-organisms from the system.

Microbiological activity

111 The operating conditions of a cooling system provide an environment in which micro-organisms can proliferate. The water temperatures, pH conditions, concentration of nutrients, presence of dissolved oxygen, carbon dioxide, sunlight, together with large surface areas all favour the growth of micro-organisms such protozoa, algae, fungi and bacteria, including legionella.

112 Problems arise when micro-organisms are allowed to grow or flourish to excess; this can result in the formation of biofilms on system surfaces. These can:

(a) cause a reduction in heat transfer;
(b) harbour legionella and provide an environment for their growth;
(c) induce highly localised microbial corrosion;
(d) interfere with the effectiveness of corrosion inhibitors;
(e) trap particulate matter, increasing the problem of fouling; and
(f) disrupt water distribution within the tower.

Guidance

Both surface-adhering (sessile) and free-flowing (planktonic) bacteria need to be controlled for a complete and effective programme.

113 Biocides are used to control microbiological activity. They should prevent the proliferation of micro-organisms but are not required to disinfect systems. Biocides can be oxidising or non-oxidising (see Box 3 for details of use). Control, ie the frequency and quantity of additions, will depend on the microbiological activity of the system.

114 Biocides, when correctly selected, applied and controlled, as part of a comprehensive water treatment programme, have been shown to be effective in preventing the proliferation of legionella. Many factors will influence the selection of chemicals required for the treatment programme. However, the success of the treatment programme is dependent on:

(a) compatibility of all chemical components used; and
(b) adherence at all times, to the recommended application, monitoring and control procedures.

115 Biocides are routinely applied at the tower sump or the suction side of the recirculating water pump but should be dosed so that the biocide will circulate throughout the cooling system. However, in air-conditioning systems where the tower can be bypassed, the biocide needs to be added to the suction side of the recirculating pump.

Box 3: Biocides

Oxidising biocides

The halogens are dosed to give a free chlorine or free bromine reserve. This is a measure of the free halogen, the hypochlorous/hypobromous acid (HOCl/HOBr) and the hypochlorite/hypobromite ion (OCl- /OBr-). In all cases the applied dosage should be sufficient to maintain a free reserve in the range of 0.5-1mg/l chlorine/chlorine dioxide and 1.0-2.0 mg/l bromine in the return water. Reserves consistently above 2mg/l free chlorine/bromine should be avoided (except in exceptional circumstances) as this may cause system corrosion. The activity (in terms of time taken to have an effect) of chlorine is significantly reduced at alkaline pH and additions of this biocide need to be adjusted to take account of this - it can be overcome by continuous dosing. It is, in any case, preferable to apply oxidising biocides on a continuous basis but if they are applied as a shot dose, the effective concentration should be present for at least 4 out of every 24 hours. In large industrial systems, the dosage is based on water recirculation rate. This has to be sustained for a period of time, ranging from a few minutes to several hours, or even continuously, dependent on the operating characteristics of the cooling system.

For small systems, such as air-conditioning installations, halogen addition would normally be based on system volume. The system and its water chemistry will influence the choice of the best method of addition to obtain effective microbiological control. Once halogenation is stopped, the free halogen reserve is quickly lost, leaving the system open to re-infection and re-population by micro-organisms.

Non-oxidising biocides

Such biocides are generally more stable and longer lasting than oxidising

Guidance

biocides but their concentration will reduce because of depletion via water losses from the system and by degradation of the active material.

To achieve the right non-oxidising biocide concentration to kill micro-organisms, it should be added as a shot dose but may sometimes be added continuously. The frequency and volume of applications are dependent on system volume, system half-life and the biocide contact time, typically four hours. These need to be considered to ensure that the biocide concentration necessary to kill the micro-organisms is achieved. In systems with smaller water volumes and high evaporation rates it is particularly important that the above parameters are accurately determined. In the case of systems which have long retention times, the half-life of the biocide is the controlling factor.

A non-oxidising biocide programme should use two biocides on an alternating basis. Once the concentration of any biocide has been depleted to below its effective level, the system will be open to re-infection. The efficacy of non-oxidising biocides may be influenced by the pH of the water in the system and this should be taken into account to ensure that the biocide programme is effective. The following points are important in selecting a non-oxidising biocide programme:

- retention time and half-life of the system;
- microbiological populations;
- system contaminants;
- handling precautions; and
- effluent constraints.

116 Specific surfactants (biodispersants) which function by wetting biofilms and aiding penetration of the biocides into the films are often used to supplement oxidising biocide programmes. In microbiologically dirty systems which contain or readily grow biofilms, the use of biodispersants can improve the efficiency of oxidising biocides. Most non-oxidising biocide formulations already contain surfactants to improve performance.

117 Hazard data sheets should be available for all chemicals used in treatments applied to cooling towers and an assessment drawn up to ensure that those handling and applying them do so safely.

118 Where a biocide has been selected specifically for the control of legionella, the supplier should be able to present test data to demonstrate efficacy, which should include kill concentrations and contact times.

119 Regardless of the results of laboratory testing, to establish an effective biocide programme to control legionella, it should be remembered that an operating cooling system is subject to unpredictable recontamination both by legionella and sources of nutrients. Therefore regular microbiological testing needs to be carried out to ensure that the biocide programme remains effective.

120 A variety of other methods of water treatment is available. One approach relies on the electrolytic dissolution of metals such as copper and silver, thereby generating biocidal ions in solution. Another is the introduction of ozone, which produces an oxidising biocide in the water. Physical methods such as irradiation by ultraviolet (UV) light can also be used, although this is only effective when the water is clear, so it may be necessary to install a water filtration system too. Also, since UV irradiation is not a dispersive technique, additional biocides may be required to control biofilms.

Guidance

121 Each of the techniques described above has the potential advantage that they could replace the use of chemical biocides. However, they should only be used if they are capable of achieving at least the equivalent biocidal effect to those of the traditional methods.

Monitoring

The ACOP says that the risk from exposure to legionella should be prevented or controlled and that the precautions taken should be monitored to ensure that they remain effective. The following section on monitoring offers guidance on how to do this in cooling systems.

General Monitoring

122 The composition of the make-up and cooling water should be routinely monitored to ensure the continued effectiveness of the treatment programme. The frequency and extent will depend on the operating characteristics of the system, the minimum recommended frequency being once a week to ensure that dosage and bleed rates are correct (see Table 1).

Guidance

Table 1: Typical on-site monitoring checks recommended for good operating practice

Parameter	Timing	
	Make up-water	Cooling water
Calcium hardness as mg/l $CaCO_3$	Monthly	Monthly
Magnesium hardness as mg/l $CaCO_3$	Monthly	Monthly
Total hardness as mg/l $CaCO_3$	Monthly	Monthly
Total alkalinity as mg/l $CaCO_3$	Quarterly	Quarterly
Chloride as mg/l Cl	Monthly	Monthly
Sulphate as mg/l SO_4	Quarterly	Quarterly
Conductivity µs (Total dissolved solids)	Monthly	Weekly
Suspended solids mg/l	Quarterly	Quarterly
Inhibitor(s) level mg/l	-	Monthly
Oxidising biocide mg/l	-	Weekly
Temperature °C	-	Quarterly
pH	Quarterly	Weekly
Soluble iron as mg/l Fe	Quarterly	Quarterly
Total iron as mg/l Fe	Quarterly	Quarterly
Concentration factor	-	Monthly
Microbiological activity	Quarterly	Weekly
Legionella	-	Quarterly

123 The identification of changes in the water chemistry such as pH, dissolved and suspended solids, hardness, chloride and alkalinity allows any necessary corrective actions to be taken to the treatment programme or system operating conditions. In addition, chemical treatment reserves such as scale and corrosion inhibitors and oxidising biocides should be measured. Routine on-site determination of the concentration of non-oxidising biocides is not practical. The amount of non-oxidising biocide required is therefore calculated from the volume and half-life of the system. Other aspects of the treatment programme such as corrosion rates and microbiological activity will also need to be monitored.

124 The monitoring programme should also include the routine sampling and testing for the presence of bacteria, both general (aerobic) bacterial species and legionella bacteria. Since the detection of legionella bacteria requires specialist laboratory techniques, routine monitoring for aerobic bacteria is used as an indication of whether microbiological control is being achieved.

125 The most common method to measure microbiological activity within a cooling system is to use a dip slide. These are commercially available plastic slides which are coated with sterile nutrient agar - a medium on which many micro-organisms will grow, but not legionella. They are dipped into the water and incubated for 48

Guidance

hours. Any bacteria in the cooling water will grow and form colonies. Comparison with a chart will indicate the number of bacteria in the water. Dip slides should be dipped in the system water as near to the heat source as possible. If a drain cock is used it is important that any residual water is run off before the slide is dipped. The dip slide should then be replaced into its container and incubated for a minimum of 48 hours in an incubator, usually at 30°C. The incubation period and the temperature should be the same each time the test is performed.

126 Cooling tower water should be tested, using dip slides (or similar), on a weekly basis. The timing of dip slides and other microbiological sampling is important. Sampling should not be carried out if biocide has been recently added. Neither should the visible condition of the water be taken as a good indicator of the need for sampling; there are a number of chemical additions which render the water opaque. Conversely, relatively clear water may be heavily contaminated with bacteria.

127 Table 2 lists microbiological counts and the appropriate action that should be taken in response to them. While the number of micro-organisms is itself important, it is also necessary to monitor any changes from week-to-week, particularly if there are any increases in the numbers of micro-organisms detected. This should always result in a review of the system and the control strategies. A graphical representation of these data will often help to monitor any trends.

128 If the control strategy is effective, the dip slide counts should be consistently low. If an unusually high result is obtained, the test should be repeated immediately and, if confirmed, appropriate action taken (see Table 2). Consistently high microbiological counts using dip slides should be checked by laboratory-based total viable counts (TVC). The laboratory should be accredited by the United Kingdom Accreditation Service (UKAS).

Table 2: Action levels following microbial monitoring for cooling towers

AEROBIC COUNT cfu/ml at 30°C (minimum 48 hours incubation)	Legionella bacteria cfu/litre	ACTION REQUIRED
10 000 or less	100 or less	**System under control**
more than 10 000 and up to 100 000	more than 100 and up to 1000	**Review programme operation** - A review of the control measures and risk assessment should be carried out to identify any remedial actions and the count should be confirmed by immediate resampling.
more than 100 000	more than 1000	**Implement corrective action** - The system should immediately be re-sampled. It should then be ‘shot dosed’ with an appropriate biocide, as a precaution. The risk assessment and control measures should be reviewed to identify remedial actions.

Guidance

129 Alternative techniques for determining microbiological activity have been developed for on-site use. It is important that such methods can be clearly related to the results achieved by traditional counting methods and that appropriate action levels can be set to inform decisions on the necessary control measures.

Monitoring for legionella

130 In addition to the routine sampling for aerobic bacteria, the routine monitoring scheme should also include periodic sampling for the presence of legionella bacteria. This should be undertaken at least quarterly, unless sampling is necessary for other reasons, such as to help identify possible sources of the bacteria during outbreaks of Legionnaires' disease. More frequent sampling should be carried out when commissioning a system and establishing a treatment programme. Sampling should be carried out, on a monthly basis, until it can be shown that the system is under control. If a legionella-positive sample is found as a result of routine sampling, more frequent samples may be required as part of the review of the system/ risk assessment, to help establish when the system is back under control. The sampling method should be in accordance with ISO 11731:1998[8] and the biocide neutralised where possible. Samples should be taken as near to the heat source as possible. They should be tested by a UKAS accredited laboratory that takes part in the Public Health Laboratory Service Water Microbiology External Quality Assessment Scheme for the isolation of legionella from water. The laboratory should also apply a minimum theoretical mathematical detection limit of less than, or equal to, 100 legionella bacteria per litre of sample.

131 Legionella bacteria are commonly found in almost all natural water sources, so sampling of water systems and services may often yield positive results and the intererpretation of any results of sampling should be carried out by experienced microbiologists. Failure to detect legionella bacteria should not lead to the relaxation of control measures and monitoring. Neither should monitoring for the presence of legionella bacteria in a cooling system be used as a substitute in any way for vigilance with control strategies and those measures identified in the risk assessment.

Cleaning and disinfection

The ACOP says the risk from exposure to legionella should be prevented or controlled; precautions include maintaining the cleanliness of the system and the water in it. The following section on cleaning and disinfection offers guidance on how to do this in cooling systems.

132 The maintenance of an effective biocide regime will provide a hostile environment for microbial life (including legionella) and minimise biofouling. However, the use of biocides should not be considered in isolation but as part of the overall water treatment programme including the manual and chemical cleaning and disinfection of open cooling systems, and in particular the cooling tower.

133 Many cooling systems operate on a continuous basis where process conditions preclude total system shutdown except infrequently. Other measures, such as side-stream filtration, more frequent microbiological monitoring, continuous biocide addition etc, which are reasonably practicable, should be applied and monitored carefully.

134 Disinfection, cleaning and manual desludging of cooling towers should be undertaken at least twice a year, but more frequent cleaning may be necessary depending on local environmental conditions such as dirty atmospheres and the conclusions reached in the risk assessment. Cooling systems that have a short operating period may only need to be cleaned at the beginning and end of that

Guidance

period. If on inspection the system shows signs of a significant build-up of deposits or slime, then disinfection and cleaning should be carried out. The use of chlorine or other oxidising biocides to disinfect the tower is an effective approach, provided they are used correctly.

135 In addition to this regular disinfection, cooling towers should always be cleaned and disinfected before being put back into service:

(a) immediately before the system is first commissioned;
(b) after any prolonged shutdown of a month or longer (a risk assessment may indicate the need for cleaning and disinfection after a period of less than one month, especially in summer and for health care premises where shutdown is for more than five days);
(c) if the tower or any part of the cooling system has been mechanically altered;
(d) if the cleanliness of the tower or system is in any doubt; and
(e) if microbiological monitoring indicates that there is a problem.

Routine cleaning and disinfection

136 *Pre-cleaning disinfection* The system water should be disinfected using an oxidising biocide such as chlorine, bromine or chlorine dioxide to minimise health risks to the cleaning staff . This is done by adding either sodium hypochlorite solution or chloroisocyanurate compounds available as rapid-release tablets to achieve a measured residual of 5 mg/l free chlorine. Sodium hypochlorite solutions typically contain 10-12% available chlorine and rapid-release tablets contain 50-55% available chlorine. Such products should be handled with care and according to instructions given by the supplier. A biodispersant should also be used to enhance the effectiveness of the chlorination.

137 The chlorinated water containing 5 mg/l free chlorine should be circulated through the system for a period of 5 hours with the fan off, maintaining a minimum of 5 mg/l free chlorine at all times. However, if the system pH value is greater than 8.0, the measured residual will need to be in the range 15-20 mg/l free chlorine in order to achieve the required disinfection level. An alternative procedure to provide more effective use of chlorine is to introduce a heavy bleed-off for several hours to both reduce the pH of the system water and its chlorine demand, before carrying out disinfection. The system should then be de-chlorinated (see paragraph 144) and drained.

138 *Cleaning* Manual cleaning operations can then be carried out, with all accessible areas of the tower etc being adequately cleaned. Where practicable, the packs should be removed at least once a year and preferably every six months. If this is not practicable, it may be necessary to apply supplementary strategies such as side-stream filtration, increased monitoring etc. Accessible areas of the tower and its pack should be adequately washed but cleaning methods that create excessive spray, for example high-pressure water jetting, should be avoided. If this is not possible, the operation should be carried out when the building is unoccupied or, in the case of permanently occupied buildings, windows in the vicinity should be closed, air inlets blanked off and the area that is being water-jetted should be tented. The area should be isolated and consideration should also be given to other occupied premises in the immediate areas as well as members of the public who may in the vicinity during cleaning.

139 Cleaning staff who carry out water-jetting should wear suitable respiratory protective equipment such as a positive-pressure respirator with full facepiece or a hood and blouse. Staff who use this equipment should be adequately trained and the equipment properly maintained (see section on protection of personnel in paragraphs 199-202).

Guidance

140 Adherent scale or other deposits on the tower and distribution system that have not been removed by the above method can be dissolved using chemical descalents carefully chosen to avoid damage to the fabric of the system. If this is not possible, routine inspection and testing of water quality should be particularly thorough.

141 Finally, the system should be sluiced out until the water going to drain is clear.

142 *Post-cleaning disinfection* On completion of the cleaning operation, the system should be refilled and chlorinated to maintain a minimum level of 5 mg/l of free chlorine for a period of 5 hours with the fan off. This needs to be checked hourly to ensure that a concentration of 5 mg/l is present for the total period. Again, the use of a biodispersant will enhance the effectiveness of this chlorination. If the system volume is greater than $5m^3$, the water should be de-chlorinated, drained, flushed and refilled with fresh water and dosed with the appropriate start-up level of treatment chemicals, including the biocides.

143 While the maintenance of a continuous minimum residual of 5 mg/l of free chlorine for a minimum period of 5 hours is considered the best practice, if the downtime to conduct such a lengthy operation is not available, some compromise may be necessary. Under such circumstances it may be acceptable to shorten the pre- and post-chlorination times and to increase the free chlorine level, eg 50 mg/l for 1 hour or 25 mg/l for 2 hours. This should only be done if the operators are trained in this process because, at these levels, there is a greater risk of damaging the fabric of the system. The system should then be de-chlorinated, drained, flushed and refilled with fresh water and dosed with the appropriate start-up level of treatment chemicals, including the biocides.

144 Before water containing high-residual free chlorine is discharged to drain, it should be de-chlorinated. The usual procedure is to add sodium thiosulphate, sodium sulphite or sodium bisulphite as a neutraliser. The level of free chlorine is determined by testing and the quantity of sodium salt then is calculated.

Hot and cold water services

145 There is a variety of systems available to supply hot and cold water services (see Box 4 for description of types of system). In the past, hot and cold water systems were associated with more reported outbreaks of Legionnaires' disease than cooling towers. But in recent years there have been very few outbreaks - probably due to better maintenance and care. However, since such systems are widespread and can be complex in design they still present a foreseeable risk of exposure to legionella.

Box 4: Hot and cold water systems

Gravity system with recirculation

This is the type of system found in many commercial buildings (see Figure 5). Cold water enters the building from a rising main and is stored in an intermediate cold water tank. The cold water storage tank provides backflow protection to the mains supply and a stable pressure in the system. Cold water from this storage tank is fed to the calorifier where it is heated. There is a continuous circulation of hot water from the calorifier (storage heat exchanger) around the distribution circuit and back to the calorifier. The purpose of this is to ensure that hot water is quickly available at any of the taps, independent of

Guidance

their distance from the calorifier. The circulation pump is sized to compensate for the heat losses from the distribution circuit such that the return temperature to the calorifier is not less than 50°C. It does not depend on the projected hot water demand. The pump has little effect on the pressure at the tap which is determined by the relative height of the storage tank. If a heavy hot water demand occurs then water will flow directly to the point(s) of use via the non-return valve. The expansion of water as it is heated within the system is accommodated by a slight rise in the levels of the tank and vent pipe. Ideally the vent pipe should be linked to a separate tundish/drain or else to the cold water storage tank but it should not discharge water except under fault conditions. These design principles also apply where an electrically heated cylinder or direct fired storage water heater is used instead of a calorifier. In the cold water system, water is fed by gravity directly from the cold water storage tank to the points of use without recirculation.

Gravity system without recirculation

This system is generally found in most houses and small buildings. If temperature is being used as a means of controlling legionella then designers should be considering the requirement to achieve hot water of 50°C at all points of use within 1 minute. Where there are long pipe runs between the calorifier and the point of use this may not be possible without trace heating. Trace heating is usually applied in the form of a thermostatically controlled electric resistance tape in intimate contact with the pipe. It is then covered by a good thickness of insulation. In the cold water system, water is fed by gravity directly from the cold water storage tank to the points of use.

Pressurised systems

In a mains pressure hot water system there is no intermediate cold water storage tank. The rising main is connected directly to the calorifier, water heater or plate heat exchanger. Backflow protection is provided by a double non return valve on the cold feed to the water heater. Since the water in the system will expand with temperature, an expansion vessel and a safety temperature and pressure relief valve are required. Hot water distribution from pressurised systems can be used in both recirculation and non-recirculation systems. The latter is commonly found in houses with combination heating and hot water (combi) boilers. Cold water is fed directly from the mains to the points of use.

146 Hot water systems present the greatest risk in environments which allow the proliferation of legionella, for example:

(a) at the base of calorifiers where the incoming cold water merges with the existing hot water. This water collects sedimented organic and mineral deposits which support bacterial growth, including legionella - this can then be distributed throughout the system to colonise its periphery, especially where optimum temperatures and stagnation occur eg in infrequently used outlets.

(b) water held in pipes between a recirculating hot water supply and an outlet (eg tap or shower) particularly when not in use, as they may not be exposed to biocides and high temperatures.

147 Water systems may occasionally be contaminated with legionella (usually in small numbers) which enter cold water storage systems from the mains supply. This presents little risk under normal circumstances. Legionella will only grow

Guidance

in cold water systems and the distribution pipework when there are increased temperatures (eg due to heat gain), appropriate nutrients and stagnation.

148 Cases of legionellosis have been reported in hospitals where water systems have been colonised by legionella. In addition, there have also been reports of infection when tap water was used to fill personal humidifiers and to wash jet nebulisers and other respiratory equipment. This, together with the presence of susceptible individuals, means that there may be an increased risk in health care premises and additional precautions may be needed.[9]

Substitution

149 Some of the features of gravity hot water systems which influence the risk of exposure to legionella, such as having open tanks and relatively large storage volumes, can be eliminated by moving to mains pressure systems. This requires confidence in the reliability and continuity of the mains supply and may not be acceptable in all cases. Other problems, such as the maintenance of water temperatures throughout the distribution system and changes in demand, can be simplified by changing to point-of-use water heaters with minimal or no storage. Guidance on the general principles and limitations of instantaneous water heaters is given in BS6700:1997.[10]

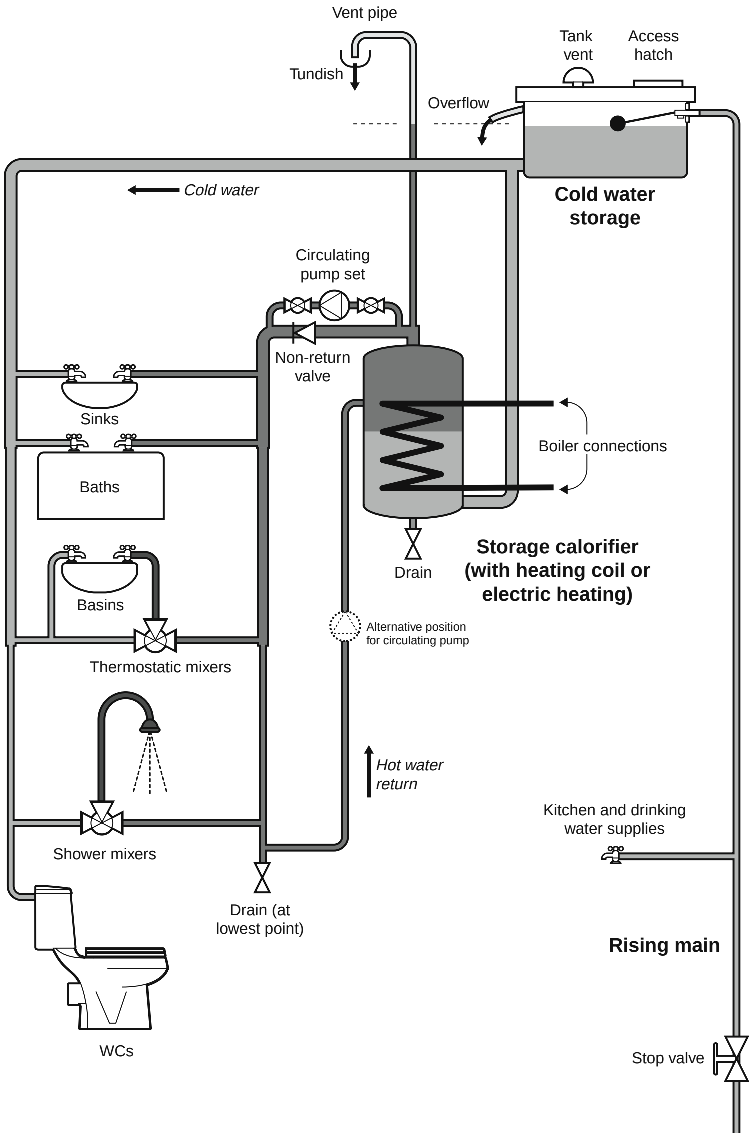
Design and construction

The ACOP says that plant or water systems should be designed and constructed to be safe and without risks to health when used at work.The following section on design and construction offers guidance on how to do this in hot and cold water systems.

150 The overall choice of system depends on the size and configuration of the building and the needs of the occupants. A key issue is whether cold water storage is required and how much. Some activities (health care, catering etc) rely on the continuous availability of hot and cold water but others would not be severely disadvantaged by a short-term loss of supply. Hot and cold water storage systems in commercial buildings are often over-sized in relation to the actual usage because of uncertainties in occupation at the design stage - this leads to excessive safety margins. If the design needs to allow for future growth in demand, this should be organised in a modular fashion. This enables additional plant to be added at a later stage if required (but see paragraph 152(d)).

Guidance

Figure 5 Typical gravity system with recirculation



151 Water service systems have to comply with the Water Supply (Water Fittings) Regulations 1999. This includes the prevention of backflow, the use of approved materials for pipework, water fittings and jointing materials. General issues of design, sizing, layout, construction and commissioning are discussed in BS6700:1997.[10] Certain aspects of the system will also have to comply with the appropriate buildings regulations.

152 Hot and cold water systems should be designed to aid safe operation by preventing or controlling conditions which permit the growth of legionella and to allow easy cleaning and disinfection. In particular, the following points should be considered.

(a) Materials such as natural rubber, hemp, linseed oil-based jointing compounds and fibre washers should not be used in domestic water systems. Materials and fittings acceptable for use in water systems are listed in the directory published by the Water Research Centre.[11]
(b) Low-corrosion materials (copper, plastic, stainless steel etc) should be used where possible.
(c) Water storage tanks should be fitted with covers which comply with the Water Regulations and insect screens fitted to any pipework open to the

Guidance

atmosphere, eg the overflow pipe and vent.

(d) Multiple linked storage tanks should be avoided because of operational difficulties due to possible unequal flow rates and possible stagnation.
(e) Accumulator vessels on pressure-boosted hot and cold water services should be fitted with diaphragms which are accessible for cleaning.
(f) The use of point-of-use hot water generators, with minimal or no storage for remote low-use outlets should be considered.
(g) Showers (excluding safety showers) should not be fitted where they are likely to be used less than once a week.
(h) Thermostatic mixing valves (TMVs) should be sited as close as possible to the point of use. Ideally, a single TMV should not serve multiple tap outlets but, if they are used, the mixed water pipework should be kept as short as possible. Where a single TMV serves multiple shower heads, it is important to ensure that these showers are flushed frequently (see paragraphs 164-7).
(i) TMVs should not be used with low-volume *spray* taps in buildings with susceptible populations.

Hot water systems

(a) The storage capacity and recovery rate of the calorifier should be selected to meet the normal daily fluctuations in hot water use without any drop in the supply temperature. The vent pipe from the calorifier which allows for the increase in volume of the water should be large enough and suitably sited on the water circuit, to prevent hot water being discharged. However, if discharged, the water should go to a tundish.
(b) Where more than one calorifier is used, they should be connected in parallel and if temperature is used as a means of control, each should deliver water at a temperature of at least 60°C. All calorifiers should have a drain valve located in an accessible position at the lowest point of the vessel so that accumulated sludge can be drained easily and the vessel emptied in a reasonable time. A separate drain should be provided for the hot water system vent (particularly if the feed to the calorifier incorporates a non-return valve).
(c) If temperature is used as the means of controlling legionella, the hot water circulating loop should be designed to give a return temperature to the calorifier of 50°C or above. The pipe branches to the individual hot taps should be of sufficient size to enable the water in each of the hot taps to reach 50°C within 1 minute of turning on the tap. Thermometer/immersion pockets should be fitted on the flow and return to the calorifier and in the base of the calorifier in addition to those required for control.
(d) In larger calorifiers, the fitting of time controlled shunt pumps should be considered to overcome temperature stratification of stored water (see paragraph 158).
(e) Hot water distribution pipes should be insulated.
(f) If temperature is used as a means of controlling legionella, trace heating should be provided on non-recirculatory hot water distribution pipework where the discharge temperature would not otherwise reach 50°C in 1 minute.

Cold water systems

(a) Low-use outlets should be installed upstream of higher use outlets to maintain frequent flow; eg a safety shower can be installed upstream of a WC. Access ports should be provided on cold water tanks for inlet valve maintenance, inspection and cleaning (more than one hatch may be needed on large tanks).
(b) The volume of cold water stored should be minimised; it should not normally be greater than one day's water use. Multiple cold water storage tanks require care in the connecting piping to ensure that the water flows through each of the tanks, so avoiding stagnation in any one tank.
(c) The cold water storage tank should be sited in a cool place and protected

Guidance

from extremes of temperature by thermal insulation. Piping should be insulated and kept away from hot ducting and other hot piping to prevent excessive temperature rises in the cold water supply; typically not more than 2°C increase should be allowed. The pipework should be easy to inspect so that the thermal insulation can be checked to see that it is in position and has remained undisturbed.

Management of hot and cold water systems

The ACOP says risks from legionella should be identified and managed. The following section on operation and maintenance of hot and cold water systems offers guidance on some of the issues which need to be addressed in order to do this.

Commissioning and recommissioning

153 Following the commissioning of a new hot water system, the water temperature should be measured continuously at the bottom and the outlet of the calorifier over a typical day. If the storage vessel is big enough to deal with the demand, the outlet temperature will be constant throughout the day. If the calorifier is too small, the outlet temperature will fall during use and remedial action may be required, particularly if temperature is used as a control method. If the system changes from the original specification, this procedure will need to be repeated.

154 If a calorifier or any substantial part of a hot water system is on standby use or has been taken out of service for longer than 1 week, the water in the calorifier should be brought up to 60°C for 1 hour before being used; this should be measured with normal circulating pumps operating and not with the system in a stagnant state. If there are standby recirculating pumps on the hot water circuits, they should be used at least once per week. If the system is to be treated with biocides as a means of controlling legionella, the biocide concentration in the system should reach normal operational levels for at least 3 hours, throughout the system, before being used.

Operation

155 *Cold water* Cold water from the water utility is usually delivered to consumer buildings with a trace of active chlorine disinfectant and fit for drinking. However, users should not rely on this to treat the hot water system. Where water comes from rivers, lakes, bore holes or other sources it needs to be pre-treated so that it is of the same quality as the mains supply. The Water Supply (Water Quality) Regulations require designers and maintainers of premises to maintain the wholesome nature of the water.

156 The Water Supply (Water Quality) Regulations permit water utilities to supply water to premises at temperatures up to 25°C. In practice, the water temperature is likely to be well below this maximum value (in the order of 5-10°C in winter and up to 20°C in summer). However, during a prolonged hot summer, the incoming water temperature at some sites can become abnormally warm. If the incoming water is above 20°C, the water undertaker should be advised to see if the cause of the high temperature can be found and removed. If this is not possible, the risk assessment should reflect this increased risk and appropriate action taken if necessary.

157 *Hot water* The water can be heated by hot water or steam from a boiler which is passed through a coiled heat exchanger sited inside the hot water storage vessel - the calorifier. Calorifiers heated directly by gas or oil flame have been shown to have the lowest incidence of colonisation by legionella. The calorifier can also be heated by electricity or by means of an electric immersion heater within the vessel.

Guidance

158 In a hot water system, cold water enters at the base of the calorifier with hot water being drawn off from the top for distribution to user points throughout the building. A control thermostat to regulate the supply of heat to the calorifier should be fitted to the calorifier near the top and adjusted so that the outlet water temperature is constant. The water temperature at the base of the calorifier (ie under the heating coil) will usually be much cooler than the water temperature at the top. Arrangements should therefore be made to heat the whole water content of the calorifier, including that at the base, to a temperature of 60°C for one hour each day. This period needs to coincide with the operation of boiler plant (or other calorifier heat source) and is usually arranged during a period of low demand eg during the early hours of the morning. A shunt pump to move hot water from the top of the calorifier to the base is one way of achieving this, however, it should not be used continuously except for about one hour each day (see above). In all cases the operation of the pump should be controlled by a time clock.

159 Alternatively, some calorifiers are fitted with coils extending to the base to promote convective mixing during heating. This mixing may not be required if using alternative treatment methodologies.

160 Ideally the calorifier will have specific connections for the shunt pump return, as low down on the calorifier as possible. For existing calorifiers without suitable connections, the drain point may sometimes be used (see Figure 6). This should not be done before cleaning and descaling of the calorifier otherwise the operation of the pump may disturb sludge or sediment.

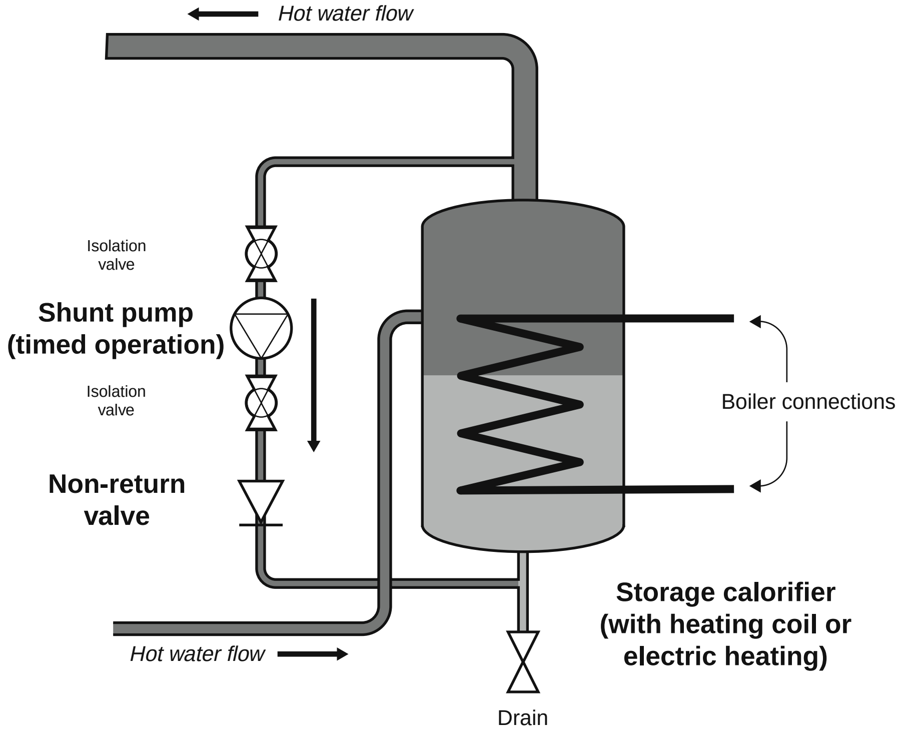
Maintenance

161 Some form of scale control is desirable in hard water areas. This is because there is a risk of calcium being deposited at the base of the calorifier at temperatures greater than 60°C. It is recommended that an inspection port is fitted in the side of the calorifier so that the cleanliness of the base can be checked and cleaned when needed. Where one has not been fitted, any debris in the water at the base of the calorifier should be purged to a suitable drain on an annual basis. The presence of scale makes it more difficult to generate hot water efficiently in the calorifier or water heater and reduces the effectiveness of any treatment or disinfection measures. Corrosion control may be required if low-corrosion materials (copper, plastic, stainless steel etc) have not been used in the system.

162 Whenever hot taps are no longer required for use they should be removed and cut back to the recirculating loop. Where standby units are provided, there should be procedures in place to enable these units to be incorporated into routine use. Standby pumps should be changed over and used each week to avoid water stagnation. Standby calorifiers should be emptied of water and there should be specified procedures in place to be followed before they are brought back into use.

Guidance

Figure 6 Shunt pump for calorifier mixing



163 Keeping water softeners and filters clean is important and best done by following the manufacturers' recommendations. Coarse filters and strainers should be checked and cleaned regularly to prevent the build-up of organic contaminants.

Regular flushing of showers and taps

164 Before carrying out the following procedures, consideration should be given to removing infrequently used showers and taps. If they are removed, the redundant supply pipework should be cut back, as far as possible, to a common supply, for example to the recirculating pipework or the pipework supplying a more frequently used upstream fitting.

165 The risk from legionella growing in peripheral parts of the domestic water system such as deadlegs off the recirculating hot water system may be minimised by regular use of these outlets. When outlets are not in regular use, weekly flushing of these devices for several minutes can significantly reduce the number of legionella discharged from the outlet. Once started, this procedure has to be sustained and logged, as lapses can result in a critical increase in legionella at the outlet. Risk assessment may indicate the need for more frequent flushing where there is a more susceptible population present, eg in hospitals, nursing homes etc.

166 Where it is difficult to carry out weekly flushing, the stagnant and potentially contaminated water from within the shower/tap and associated dead-leg needs to be purged to drain before the appliance is used. It is important that this procedure is carried out with minimum production of aerosols, eg additional piping may be used to purge contaminated water to drain.

167 Automatic drain valves fitted to showers to drain the mixer valve and shower hose after use, can produce conditions within the shower that support the growth of legionella, and are not recommended as a method for controlling the risk of exposure to legionella.

Guidance

Treatment and control programmes

The ACOP says that the risk from exposure to legionella should be prevented or controlled; precautions should include the use of water treatment techniques. The following section on treatment programmes offers advice on how to treat water in hot and cold water systems

168 It is essential that the system is kept clean (see section on cleaning and disinfection) because the efficacy of the control method (both temperature and biocide activity) may be reduced substantially in systems that are fouled with organic matter such as slimes or inorganic matter such as scale.

Temperature regime

169 This is the traditional approach to legionella control. It is recommended that hot water should be stored at 60°C and distributed so that it reaches a temperature of 50°C within one minute at outlets. Care is needed to avoid much higher temperatures because of the risk of scalding. At 50°C the risk of scalding is small for most people but the risk increases rapidly with higher temperatures and for longer exposure times. However the risk, particularly to young children, or the handicapped or elderly, and to those with sensory loss will be greater.[12,13 & 14] Where a significant scalding risk has been identified, the use of TMVs on baths and showers should be considered to reduce temperature. These need to be placed as close to the point of use as possible.

170 To ensure the correct function of fail-safe TMVs, there needs to be a minimum temperature differential between the hot and cold water supplies and the mixed water temperature. Users should refer to the manufacturers' operating instructions to ensure these devices are working safely and correctly.

Monitoring the temperature regime

171 As well as the routine monitoring and inspection outlined in paragraphs 180-182 when using temperature as a control regime, the checks in Table 3 should also be carried out and remedial action taken if necessary.

Biocide treatments

172 Where biocides are used to treat water systems they, like the temperature regime, will require meticulous control if they are to be equally effective. In such situations, if hot water is not needed for other reasons, eg for kitchens or laundries, there is no requirement to store hot water at 60°C (or distribute at 50°C) - although this is not currently permitted in NHS premises.[14] However, if water temperatures are reduced, any lapses in the biocide control regime would leave the system vulnerable. It is therefore recommended that the control system is checked at least weekly to ensure that it is operating correctly and so continuing to control legionella.

Chlorine dioxide

173 Chlorine dioxide is an oxidising biocide capable of reacting with a wide range of organic substances. Levels of 0.5 mg/l can, if properly managed, be effective against planktonic and sessile legionella in hot water systems. The Drinking Water Inspectorate prescribes a maximum value for total oxidants in drinking water supplies which is the combined chlorine dioxide, chlorite and chlorate concentration. This should not exceed 0.5 mg/l as chlorine dioxide. There are a number of commercial systems available that release chlorine dioxide into water systems and it may be necessary to contact the local water company in order to

Guidance

check that the installation complies with the requirements of the Water Regulations and, for Scotland, the Water Supply (Water Quality) (Scotland) Regulations and the Private Water Supplies (Scotland) Regulations 1992, as amended. It should be noted that maintaining total oxidant levels below 0.5 mg/l at outlets may be difficult in systems with a low turnover of water. Suppliers of commercial chlorine dioxide systems will need to consider these problems and when choosing a system these points should be checked to ensure that they have been addressed satisfactorily by the supplier.

Table 3: Monitoring the temperature control regime

Frequency	**Check**	**Standard to meet**		**Notes**
		Cold water	**Hot water**	
Monthly	Sentinel taps (see glossary)	The water temperature should be below 20°C after running the water for up to two minutes	The water temperature should be at least 50°C within a minute of running the water	This check makes sure that that the supply and return temperatures on each loop are unchanged, ie the loop is functioning as required
	If fitted, input to TMVs on a sentinel basis		The water supply to the TMV temperature should be at least 50°C within a minute of running the water	One way of measuring this is to use a surface temperature probe
	Water leaving and returning to calorifer		Outgoing water should be at least 60°C, return at least 50°C	If fitted, the thermometer pocket at the top of the calorifier and on the return leg are useful points for accurate temperature measurement. If installed, these measurements could be carried out and logged by a building management system
Six monthly	Incoming cold water inlet (at least once in the winter and once in summer)	The water should preferably be below 20°C at all times (but see paragraph 156)		The most convenient place to measure is usually at the ball valve outlet to the cold water storage tank
Annually	Representative number of taps on a rotational basis	The water temperature should be below 20°C after running the water for two minutes	The water temperature should be at least 50°C within a minute of running the water	This check makes sure that the whole system is reaching satisfactory temperatures for legionella control

Guidance

Monitoring the chlorine dioxide regime

174 For most systems, routine inspection and maintenance will usually be sufficient to ensure control (see paragraphs 180-182) if the following areas are checked at regular intervals and remedial action taken when necessary, with details of all actions being recorded (see also paragraph 172):

(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 - the concentration should be at least 0.1mg/l; and
(d) on an annual basis, the chlorine dioxide concentration at a representative number of outlets - the concentration should be at least 0.1mg/l.

Ionisation

175 Ionisation is the term given to the electrolytic generation of copper and silver ions for use as a water treatment. Copper and silver ion concentrations maintained at 400 µg/l and 40 µg/l respectively can, if properly managed, be effective against planktonic legionella in hot water systems. If however the water is softened, silver ion concentrations between 20-30 µg/l can also be effective, provided a minimum concentration of 20 µg/l is maintained. This level of silver still requires copper ions to complete the synergy.

176 The application of ionisation will need to be properly assessed, designed and maintained as part of an overall water treatment programme. The Water Supply (Water Quality) Regulations and Private Supply Regulations prescribe a maximum value for the level of copper and silver ions in drinking water supplies. It is important that installers of ionisation systems are aware of the need to avoid any breach of these Regulations and maintain copper and silver levels below the maximum allowable concentration. The local water company may need to be consulted to check that the installation complies with the requirements of the Water Regulations.

177 It should be noted that in hard water systems, silver ion concentrations can be difficult to maintain due to build-up of scale on the electrodes, and the high concentration of dissolved solids precipitating the silver ions out of solution. For both hard and soft water, the ionisation process is pH sensitive and it is difficult to maintain silver ion concentrations above pH 7.6. The build-up of scale and concentration of dissolved solids therefore needs to be carefully controlled so that suitable ion levels are consistently maintained throughout the system. This may need extra water treatments.

Monitoring the ionisation regime

178 For most systems, routine inspection and maintenance will usually be sufficient to ensure control (see paragraphs 180-182) if the following parameters are also monitored at regular intervals and remedial action taken when necessary, with details of all actions being recorded (see also paragraph 172):

(a) the rate of release of copper and silver ions into the water supply;
(b) the silver ion concentrations at sentinel outlets should be checked monthly - this should be at least 20µg/l at outlets;
(c) the measurement of silver ion concentrations at representative taps selected on a rotational basis once each year - this should be at least 20µg/l at outlets;
(d) the condition and cleanliness of the electrodes; and
(e) the pH of the water supply.

Guidance

Ozone and UV treatment

179 The strategies previously described are dispersive, ie they are directly effective throughout the water system downstream from the point of application. A number of other strategies are available, for example UV irradiation or ozone. These systems are not intended to be dispersive and are usually designed to have their effect at or very close to the point of application. This usually results in the active ingredient not being directly measurable in the circulating system. In large systems it may be necessary to use a number of point applications of these treatments and the system suppliers will be able to advise appropriately.

General monitoring

The ACOP says that the risk from exposure to legionella should be prevented or controlled and that the precautions taken should be monitored to ensure that they remain effective. The following section on monitoring offers guidance on how to achieve this in hot and cold waters systems.

180 All water services should be routinely checked for temperature, water demand and inspected for cleanliness and use. Ideally, the key control parameters should be monitored by a building management system if one is present. This will allow early detection of problems in maintaining the control regime.

181 The frequency of inspection and maintenance will depend on the system and the risks it presents. All the inspections and measurements should be recorded and should include:

(a) the name of the person undertaking the survey, signature or other identifying code, and the date on which it was made (computer records are acceptable); and
(b) a simple description and plan of the system and its location within and around the building. This should identify piping routes, storage and header tanks, calorifiers and relevant items of plant, especially water softeners, filters, strainers, pumps and all water outlets.

Annual check

182 This should comprise the following.

(a) Visual inspection of the cold water storage tank to check the condition of the inside of the tank and the water within it. The lid should be in good condition and fit closely. The insect screen on the water overflow pipe should be intact and in good condition. The thermal insulation on the cold water storage tank should be in good condition so that it protects it from extremes of temperature. The water surface should be clean and shiny and the water should not contain any debris or contamination. The cold water storage tank should be cleaned, disinfected and faults rectified, if considered necessary. If debris or traces of vermin are found then the inspection should be carried out more frequently.
(b) Making a record of the total cold water consumption over a typical day to establish that there is reasonable flow through the tank and that water is not stagnating. This can be done by fitting a temporary water flow meter over the outlet pipe and recording the consumption. It can also be measured by holding the ball valve supplying the water in the closed position and measuring the rate of water level drop within the vessel. Whenever the building use pattern changes, this measurement should be repeated.
(c) Draining the calorifier and checking for debris in the base of the vessel. The calorifier should then be cleaned if considered necessary.

Guidance

(d) Checking the plans for both the hot and cold water circuits to make sure they are correct and up to date - this should be done by physical examination of the circuits, if possible. Plans should be updated if necessary.
(e) Ensuring that the operation and maintenance schedules of the hot and cold water systems are readily available and up to date with named and dated actions throughout the previous year.
(f) Checking the existence of all water connections to outside services; kitchens, fire hydrants and chemical wash units. Any insulation should be checked to ensure that it remains intact. Any water outlets that are no longer used should be removed.

Microbiological monitoring

183 Routine microbiological monitoring of hot and cold water systems using dip slides or TVCs is not necessary since systems will be supplied with water that is fit to drink. Also, these systems should be totally enclosed, ie they are not open to the elements and to significant external contamination (in the same way as cooling towers).

184 However, there is the potential for micro-organisms to proliferate in various parts of hot and cold water systems. This could manifest itself in taste and odour problems and microbiological investigation should then be carried out. The conditions that supported this microbiological growth could also support legionella growth and so the system should be investigated fully.

Monitoring for legionella

185 It is recommended that this should be carried out:

(a) in water systems treated with biocides where storage and distribution temperatures are reduced from those recommended in the section on the use of temperature to control legionella. This should be carried out on a monthly basis. The frequency of testing should be reviewed after a year and may be reduced when confidence in the efficacy of the biocide regime has been established;
(b) in systems where control levels of the treatment regime (eg temperature, biocide levels) are not being consistently achieved. As well as carrying out a thorough review of the system and treatment regime, frequent samples eg weekly, should be taken until the system is brought back under control;
(c) when an outbreak is suspected or has been identified (see section in Appendix 2 on action in the event of an outbreak); or
(d) testing for legionella may also be required in hospital wards with 'at risk' patients - eg those immunologically compromised.

186 Samples should be taken as follows:

(a) *cold water system* - from the cold water storage tank and the furthest outlet from the tank. Samples may also be required from outlets in areas of particular concern, eg in hospital wards with 'at risk' patients;
(b) *hot water system* - from the calorifier outlet or the nearest tap to the calorifier outlet plus the return supply to the calorifier or nearest tap to that return supply. Samples should also be taken from the base of the calorifier where drain valves have been fitted. The furthest outlet from the calorifer should also be sampled. Samples may also be required from outlets in areas of particular concern, eg in hospital wards with 'at risk' patients.

187 The complexity of the system will need to be taken into account in determining the appropriate number of samples to take. For example, if there is more than one

Guidance

ring main present in the building, taps on each ring (as described in paragraph 186) will need to be sampled. In order to be representative of the system as a whole, samples should be of treated, circulating water and not taken from temporarily stored water, eg at TMV-controlled taps and showers. These may require sampling but this should be determined by risk assessment, eg where such fittings are used in areas where susceptible individuals may be exposed (see paragraphs 164-166 for advice on flushing of such fittings).

188 Analysis of water samples for legionella should be carried out by a UKAS accredited laboratory which takes part in the PHLS Water Microbiology External Quality Assessment Scheme for the Isolation of Legionella from Water. The interpretation of any results should be carried out by experienced microbiologists.

189 Table 4 gives guidance on action to be taken if legionella is found in the water system.

Table 4: Action levels following legionella sampling in hot and cold water systems

Legionella bacteria (cfu/litre)	**Action required**
More than 100 but less than 1000	Either: (a) 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 actions (b) If the majority of samples are positive, the system may be colonised, albeit at a low level, with legionella. 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.
More than 1000	The system should be resampled and an immediate review of the control measures and risk assessment carried out to identify any remedial actions, including possible disinfection of the system.

Cleaning and disinfection

The ACOP says the risk from exposure to legionella should be prevented or controlled; precautions include keeping the system and the water in it clean. The following section on cleaning and disinfection offers guidance on how to do this in hot and cold water systems.

190 Hot water services and, exceptionally, cold water services, should be cleaned and disinfected in the following situations:

(a) if routine inspection shows it to be necessary (see paragraphs 180-182);
(b) if the system or part of it has been substantially altered or entered for maintenance purposes in a manner which may lead to contamination; or
(c) during or following an outbreak or suspected outbreak of legionellosis.

191 Disinfection of the water services may be carried out in two ways:

(a) by the use of suitable chemical disinfectants, eg by chlorination (see BS6700:1997)[10] when it is necessary to disinfect the whole system including storage tanks; or

Guidance

(b) by thermal disinfection, ie by raising water temperature to a level at which legionella will not survive.

Chemical disinfection

192 Before chemical disinfection is carried out it is essential that the system is clean and it is important to ensure that all parts of the system are disinfected, not just those which are readily accessible. Chemical disinfection is usually carried out by chlorinating the water in the cold water storage tank to 20-50 mg/litre free residual chlorine. It is then allowed to flow to all parts of the system by successively opening the outlets in the system such as taps and showers (until there is a smell of chlorine), then closing them and leaving it to stand for an appropriate period. This depends on chlorine concentration (from at least one hour at 50 mg/l to at least two hours at 20 mg/l). The required concentration should be maintained in the header tank throughout the chlorination procedure and chlorine concentration needs to be monitored throughout disinfection to ensure that there is a sufficient residual chlorine level. The system should be thoroughly flushed following chlorination. Appropriate concentrations of chlorine dioxide, as recommended by the manufacturers, may also be used as a disinfectant.

193 This treatment should not be carried out by untrained personnel and should be closely supervised. Building occupants should be warned that the water is heavily chlorinated. If tanks and calorifiers are heavily contaminated by organic materials, the system should be disinfected before cleaning to reduce risks to cleaning staff and also after cleaning. It may be necessary to add chemical dispersants to remove organic fouling from pipework etc and chemical descaling may also be necessary. Where possible, cleaning methods should not create an aerosol.

Thermal disinfection

194 Thermal disinfection can be carried out by raising the temperature of the whole of the contents of the calorifier then circulating this water throughout the system for at least an hour. To be effective, the temperature at the calorifier should be high enough to ensure that the temperatures at the taps and appliances do not fall below 60°C. Each tap and appliance should be run sequentially for at least five minutes at the full temperature, and this should be measured. For effective thermal disinfection the water system needs to be well insulated.

195 Alternatively, the circulating pipework and deadlegs/ends may be thermally disinfected by means of trace heating. As before, the system should be capable of raising temperatures of the whole distribution system to 60°C or more for at least an hour.

196 The risk of scalding should be considered and particular care taken to ensure that water services are not used, other than by authorised personnel, until water temperatures have dropped to their normal operating levels.

Other risk systems

197 There are a number of other systems (which produce aerosols) which may pose a risk of exposure to legionella. These include:

Spas and whirlpool baths - a spa is a bath or a small pool where warm water is constantly recirculated, often through high-velocity jets or with the injection of air to agitate the water. The water is not changed after each user; instead it is filtered and chemically treated. The water temperature is normally greater that 30°C and the deliberate agitation creates a spray or aerosol above the

Guidance

surface of the water. They therefore present a foreseeable risk of exposure to legionella. Careful attention to design, maintenance and cleaning of equipment such as filters, and regular water treatment to prevent/control the risk from legionella is required[15]. Spa baths can be a risk even when not being used by bathers, for example when being run for display purposes. Whirlpool baths (baths fitted with high-velocity water jets and/or air injection but without water recirculation) do not present the same risk as spas because the water is discharged after each use.

Humidifiers and air washers - atomising humidifiers and spray-type air washers may use water from reservoirs or tanks where the water temperature exceeds 20°C. Unless they are regularly cleaned and maintained, they can become heavily contaminated, especially in industrial environments. The risk can be prevented by using humidifiers which do not create a spray, ie steam humidifiers. 'Portable' or 'room' humidifiers of the type that have a water supply that is sprayed or atomised into the room are not recommended for use in NHS premises.

198 The actions that need to be taken with regard to the systems outlined in paragraph 197 and for some other recognised risk systems are detailed in Appendix 1 (Checklist 3). In general, these systems and any others found to present a risk should be maintained in a clean state, will often require regular disinfection and should be monitored on a regular basis where appropriate. There is also a duty to carry out a risk assessment and to maintain records of all maintenance that is carried out together with monitoring results. Great care needs to be taken during installation and commissioning to ensure that cross connections do not occur between different water systems, eg fire mains and the cold water system.

Protection of personnel

199 Maintenance, cleaning, testing and operating procedures should all be designed to control the risks to staff and others who may be affected.

200 Cooling towers and evaporative condensers should be treated as described in the section on cleaning and disinfection and in particular, the requirement for pre-cleaning disinfection should be observed. This will only have a transient effect on legionella, but it will reduce the chance of engineering staff being exposed while working on the tower. Where possible, cleaning methods which create spray (for example, high pressure water jetting) should be avoided. If this is not possible, the operation should be carried out when nearby buildings are unoccupied or in the case of permanently occupied buildings, windows in the vicinity should be closed and air inlets temporarily blanked off.

201 As systems requiring cleaning may have been contaminated, the operator and others closely involved in the work should wear suitable respiratory protective equipment. This can be a powered filter and hood, European Class TH3 (assigned protection factor of 40) or a power-assisted filter and close-fitting full-face mask, TM3 (assigned protection factor 40). It should be borne in mind that the filter on these systems is liable to get wet, and so resistance to air can increase, causing discomfort to the operator.

202 Alternatively, a hood or full face mask fed with breathing quality compressed air may be used. The preferred equipment is a full-face close-fitting airline mask with a positive pressure demand valve, under a hood or helmet protecting the rest of the head. The air supply should come from an oil-free compressor drawing air through a filter from a location well upwind of any jetting operation or using cylinder supplies of compressed air. Further information on respiratory protective equipment

Guidance

can be obtained from *The Selection, Use and Maintenance of Respiratory Protective Equipment: a Practical Guide*.[16]

Use of treatment chemicals

203 Many water treatment chemicals, including chlorine-containing chemicals and solutions, are often hazardous and need to be used with care. The COSHH assessment and any manufacturers' recommendations need to be followed to ensure that the chemicals do not endanger the users or other people. Proprietary biocides, other than those permitted by the Water Regulations, should never be used in drinking water or in hot or cold water services and should not be discharged into sewers, storm water drains or natural watercourses without the prior permission of the relevant water company (or authority in Scotland). Contact may also need to be made with the Environment Agency in England and Wales and the Scottish Environment Protection Agency In Scotland, who may have responsibility for direct discharges into watercourses. Water treatment chemicals are not recommended for use in humidifiers and airwashers when buildings are occupied.

204 The handling of these water treatment chemicals should be carried out by trained operators under the direction of people who are suitably qualified, experienced and trained.

Appendix 1 Recommended inspection frequencies for risk systems

Checklist 1: Cooling water installations

System/service	Task	Frequency
Cooling towers and evaporative condensers	Monitor water quality, water use and biocide/chemical use to assess and ensure effectiveness of water treatment regime, including key chemical and microbiological parameters, and observations of internal condition of pond, pack and water	See Table 1
	Central control function, conductivity sensor calibration, blowdown function, uniformity of water distribution, condition of sprays/troughs, eliminators, pack, pond, immersion heater, fans and sound attenuators	Monthly to three monthly, according to risk (See Table 1)
	Clean and disinfect cooling towers/evaporative condensers, make-up tanks and associated systems, including all wetted surfaces, descaling as necessary. Packs should be removed and cleaned where practicable	Six monthly

Checklist 2: Hot and cold water services

Service	Task	Frequency
Hot water services	Arrange for samples to be taken from hot water calorifiers, in order to note condition of drain water	Annually
	Check temperatures in flow and return at calorifiers	Monthly
	Check water temperature up to one minute to see if it has reached 50°C in the sentinel taps	Monthly
	Visual check on internal surfaces of calorifiers for scale and sludge. Check representative taps for temperature as above on a rotational basis	Annually
Cold water services	Check tank water temperature remote from ball valve and mains temperature at ball valve. Note maximum temperatures recorded by fixed max/min thermometers where fitted	Six monthly
	Check that temperature is below 20°C after running the water for up to two minutes in the sentinel taps	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
Shower heads	Dismantle, clean and descale shower heads and hoses	Quarterly or as necessary
Little-used outlets	Flush through and purge to drain, or purge to drain immediately before use, without release of aerosols	Weekly

Checklist 3: Other risk systems

System/service	Task	Frequency
Ultrasonic humidifiers/foggers and water misting systems	If equipment fitted with UV lights, check to ensure effectiveness of lamp (check to see if within working life) and clean filters	Six monthly or according to manufacturer's instructions
	Ensure automatic purge of residual water is functioning	As part of machinery shut down
	Clean and disinfect all wetted parts	As indicated by risk assessment
	Sampling for legionella	As indicated by risk assessment
Spray humidifiers, air washers and wet scrubbers	Clean and disinfect spray humidifiers/air washers and make-up tanks including all wetted surfaces, descaling as necessary	Six monthly
	Confirm the operation of non-chemical water treatment (if present)	Weekly
Water softeners	Clean and disinfect resin and brine tank - check with manufacturer what chemicals can be used to disinfect resin bed	As recommended by manufacturer
Emergency showers and eye wash sprays	Flush through and purge to drain	Six monthly or more frequently if recommended by manufacturers
Sprinkler and hose reel systems	When witnessing tests of sprinkler blow-down and hose reels ensure that there is minimum risk of exposure to aerosols	As directed
Lathe and machine tool coolant systems	Clean and disinfect storage and distribution system	Six monthly
Spa baths	Check filters - sand filters should be backwashed daily	Daily
	Check water treatment - pools should be continuously treated with an oxidising biocide	Three times daily
	Clean and disinfect entire system	Weekly
Horticultural misting systems	Clean and disinfect distribution pipework, spray heads and make-up tanks including all wetted surfaces, descaling as necessary	Annually
Dental equipment	Drain down and clean	At the end of each working day
Car/bus washes	Check filtration and treatment system, clean and disinfect system	See manufacturers' instructions
Indoor fountains and water features	Clean and disinfect ponds, spray heads and make-up tanks including all wetted surfaces, descaling as necessary	Interval depending on condition

Appendix 2 Action in the event of an outbreak

1 Legionnaires' disease is not notifiable under public health legislation in England and Wales but, in Scotland, legionellosis (ie all diseases caused by legionella) is notifiable under the Public Health (Notification of Infectious Disease) (Scotland) Regulations 1988.

2 An outbreak is defined by the Public Health Laboratory Service (PHLS) 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). In Scotland, it is the Consultant in Public Health Medicine (CPHM) employed by the Health Board and acting as Designated Medical Officer for the local authority.

3 Local authorities will have established incident plans to investigate major outbreaks of infectious disease including legionellosis. These are activated by the Proper Officer who invokes an Outbreak Committee, whose primary purpose is to protect public health and prevent further infection. This will normally be set up to manage the incident and will involve representatives of all the agencies involved. HSE or the local authority 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 site visit.

5 As part of the outbreak investigation and control, the following requests and recommendations may be made by the enforcing authority.

(a) To shut down any processes which are capable of generating and disseminating airborne 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 (see paragraphs 124-131, Part 2) from the system before any emergency disinfection being undertaken. This will help the investigation of the cause of the illness. The investigating officers from the local authority/ies may take samples or require them to be taken.
(c) To provide staff health records to discern whether there are any further undiagnosed cases of illness, and to help prepare case histories of the people affected.
(d) To co-operate fully in an investigation of any plant that may be suspected of being 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.

6 Any infringements of relevant legislation, may be subject to a formal investigation by the appropriate enforcing authority.

Emergency cleaning and disinfection procedure for cooling towers

7 If a cooling water system has been implicated in an outbreak of Legionnaires' disease emergency cleaning of that system has to take place as soon as possible. The following actions should be taken, where appropriate:

(a) switch off the fan immediately;
(b) take samples for laboratory investigation before any further action;
(c) switch off the circulation pump as soon as is practicable and the system decommissioned;
(d) consult the enforcing authority before proceeding further;
(e) keep all personnel clear of the tower area;
(f) when cleared by the enforcing authority, add sodium hypochlorite to the system water to obtain a measured concentration of 50 mg/l of free chlorine;
(g) circulate the system water with the fans off for a period of at least six hours;
(h) maintain the free chlorine level at an absolute minimum of 20 mg/l at all times;
(i) use a suitable biodispersant;
(j) after six hours, de-chlorinate and drain the system;
(k) undertake manual cleaning of the tower, sump, and distribution system with cleaning staff wearing fully pressurised respirators;
(l) refill with fresh water, add sodium hypochlorite;
(m) recirculate without using the fan, at 20 mg/l of free available chlorine for six hours;
(n) de-chlorinate and drain the system;
(o) refill, recirculate and take samples for testing:
(p) re-commission system when test results detect no legionella and/or permission is granted by the enforcing authority.

8 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 usually involve the processes in paragraphs 192-196.

Glossary

Aerosol	A suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having negligible falling velocity.
Algae	A small, usually aquatic, plant which requires light to grow, often found on exposed areas of **cooling towers**.
Air-conditioning	A form of air treatment whereby temperature humidity and air cleanliness are all controlled within limits determined by the requirements of the air-conditioned enclosure.
Antibodies	Substances in the blood which destroy or neutralise various toxins or **components of bacteria** known generally as antigens. The antibodies are formed as a result of the introduction into the body of the antigen to which they are antagonistic as in all infectious diseases.
Bacteria	(singular bacterium) a microscopic, unicellular (or more rarely multicellular) organism.
Biocide	A substance which kills **micro-organisms.**
Biofilm	A community of **bacteria** and other **micro-organisms,** embedded in a protective layer with entrained debris, attached to a surface.
Blow-down/bleed-off	Water discharged from the system to control the concentration of salts or other impurities in the circulating water; usually expressed as a percentage of recirculating water flow.
Calorifier	An apparatus used for the transfer of heat to water in a vessel by indirect means, the source of heat being contained within a pipe or coil immersed in the water.
Chlorine	An element used in **disinfection.**
Cold water service (CWS)	Installation of plant, pipes and fitting in which cold water is stored, distributed and subsequently discharged.
Cooling tower	An apparatus through which warm water is discharged against an air stream; in doing so part of the water is evaporated to saturate the air and this cools the water. The cooler water is usually pumped to a heat exchanger to be reheated and recycled through the tower.
Concentration factor	Compares the level of dissolved solids in the cooling water with that dissolved in the **make-up water** (also known as cycle of concentration). Usually determined by comparison of either the chloride or magnesium hardness concentration.

Corrosion inhibitors	Chemicals which protect metals by: (a) passivating the metal by the promotion of a thin metal oxide film (anodic inhibitors); or (b) physically forming a thin barrier film by controlled deposition (cathodic inhibitors).
Dead end/blind end	A length of pipe closed at one end through which no water passes.
Deadleg	Pipes leading to a fitting through which water only passes when there is draw-off from the fitting.
Dip slide(s)	A dip slide is a means of testing the microbial content of liquids. It consists of a plastic carrier bearing a sterile culture medium which can be dipped in the liquid to be sampled. It is then incubated to allow microbial growth. The resulting microbial colonies are estimated by reference to a chart.
Disinfection	A process which destroys or irreversibly inactivates **micro-organisms** and reduces their number to a non-hazardous level.
Distribution circuit	Pipework which distributes water from hot or cold water plant to one or more fittings/appliances.
Domestic water services	Hot and cold water intended for personal hygiene, culinary, drinking water or other domestic purposes.
Drift	Circulating water lost from the tower as liquid droplets entrained in the exhaust air stream; usually expressed as a percentage of circulating water flow but for more precise work it is parts of water per million by weight of air for a given liquid to gas ratio.
Drift eliminator	More correctly referred to as drift reducers or minimisers - equipment containing a complex system of baffles designed to remove water droplets from **cooling tower** air passing through it.
Evaporative condenser	A heat exchanger in which refrigerant is condensed by a combination of air movement and water sprays overs its surface.
Evaporative cooling	A process by which a small portion of a circulating body of water is caused to evaporate thereby taking the required latent heat of vaporisation from the remainder of the water and cooling it.
Fill/Packing	That portion of a **cooling tower** which constitutes its primary heat transfer surface; sometimes called **'packing' or 'pack'**.
Fouling	Organic growth or other deposits on heat transfer surfaces causing loss in efficiency.
Half-life	Ratio of system volume to purge rate.

Hot water service (HWS)	Installation of plant, pipes and fittings in which water is heated, distributed and subsequently discharged (not including cold water feed tank or cistern).
Legionnaires' disease	A form of pneumonia caused by **legionella** bacteria.
Legionellae	The genus **legionella** belongs to the family legionellaceae which has over 40 species. These are ubiquitous in the environment and found in a wide spectrum of natural and artificial collections of water.
Legionella	Type of aerobic **bacterium** which is found predominantly in warm water environments. (singular of **legionellae**).
L. pneumophila	One of the causative organisms of **Legionnaires' disease.**
Legionellosis	Any illness caused by exposure to **legionella**.
Pontiac fever	A disease caused by species of legionella, an upper respiratory illness less severe than **Legionnaires' disease.**
Make-up water	Water which is added to a cooling water system to compensate for wastage (eg via system leaks), evaporative loss and bleed.
Micro-organism	An organism of microscopic size including **bacteria**, fungi and viruses.
Non-oxidising biocide	A non-oxidising biocide is one that functions by mechanisms other than oxidation, including interference with cell metabolism and structure.
Nutrient	A food source for **micro-organisms**.
Oxidising biocide	Agents capable of oxidising organic matter, eg cell material, enzymes or proteins which are associated with microbiological populations resulting in death of the micro-organisms. The most commonly used oxidising biocides are based on chlorine or bromine (halogens) which liberate hypochlorous or hypobromous acids on hydrolysis in water. The exception is chlorine dioxide, a gas which does not hydrolyse but which functions in the same way.
Pasteurisation	Heat treatment to destroy **micro-organism** usually at high temperature.
Planktonic	Free floating micro-organisms in an aquatic system.
ppm	Parts per million: a measure of dissolved substances given as the number of parts there are in a million parts of solvent. It is numerically equivalent to milligrams per litre mg/l with respect to water.

Pond/Sump	Collection of cooling water at the base of a cooling tower.
Retention time	Time a chemical is retained in the system.
Scale inhibitors	Chemicals used to control scale. They function by holding up the precipitation process and/or distorting the crystal shape, thus preventing the build-up of a hard adherent scale.
Sero-group	A sub-group of the main species.
Sentinel taps	For a hot water services - the first and last taps on a recirculating system. For cold water systems (or non-recirculating hot water systems), the nearest and furthest taps from the storage tank. The choice of sentinel taps may also include other taps which are considered to represent a particular risk.
Sessile	Aquatic micro-organisms adhering to a surface normally as part of a biofilm.
Sludge	A general term for soft mud-like deposits found on heat transfer surfaces or other important sections of a cooling system. Also found at the base of calorifiers and cold water storage tanks.
Shunt pump	A circulation pump fitted to hot water service/plant to overcome the temperature stratification of the stored water.
Slime	A mucus-like exudate which covers a surface produced by some **micro-organisms**.
Stagnation	The condition where water ceases to flow and is therefore liable to microbiological growth.
Strainers	A coarse filter usually positioned upstream of a sensitive component such as a pump control valve or heat exchanger to protect it from debris.
Thermal disinfection	Heat treatment to disinfect a system.
Thermostatic mixing valve	Mixing valve in which the temperature at the outlet is pre-selected and controlled automatically by the valve.
Total viable counts (TVC)	The total number of culturable **bacteria** (per volume or area) in a given sample (does not include legionella).
Risk assessment	Indentifying and assessing the risk from **legionellosis** from work activities and water sources on premises and determining any necessary precautionary measures.
Windage	Physical loss of water from a **cooling tower** caused by draught of air or wind - water is lost around the base of the cooling tower as a result of cross winds as opposed to **drift**.

References and further reading

References

Some of the references in this list have been updated at reprint to take account of new legislation.

1 *A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995* L73 (Second edition) HSE Books 1999 ISBN 0 7176 2431 5

2 *Consulting employees on health and safety: A guide to the law* Leaflet INDG232 HSE Books 1996 (single copy free or priced packs of 15 ISBN 0 7176 1615 0) Web version: www.hse.gov.uk/pubns/indg232.pdf

3 *Successful health and safety management* HSG65 (Second edition) HSE Books 1997 ISBN 0 7176 1276 7

4 *Getting specialist help with health and safety* Pocket card INDG420 HSE Books 2008 (single copy free or priced packs of 10 ISBN 987 0 7176 6274 6) www.hse.gov.uk/pubns/indg420.pdf

5 *The control of legionellosis: A recommended code of conduct for service providers* Water Management Society/British Association for Chemical Specialities, 1999

6 BS 4485 Part 3:1988 *Water cooling towers. Code of Practice for thermal and functional design* British Standards Institution
BS 4485 Part 4 1996 *Water cooling towers. Code of Practice for structural design and construction* British Standards Institution

7 BS 5589:1989 *Code of Practice for preservation of timber* British Standards Institution

8 BS ISO 11731-2:2004 *Water quality. Detection and enumeration of Legionella. Direct membrane filtration methods for waters with low bacterial counts* British Standards Institution

9 *The control of legionellae in health care premises. A Code of Practice: Management policy* Part 1 HTM2040 NHS Estates 1993 ISBN 0 1132 1680 7

The control of legionellae in health care premises. A Code of Practice: Design considerations Part 2 HTM2040 NHS Estates 1993 ISBN 0 1132 1679 3

The control of legionellae in health care premises. A Code of Practice: Operational management Part 3 HTM2040 NHS Estates 1993 ISBN 0 1132 1682 3

The control of legionellae in health care premises. A Code of Practice: Validation and verification Part 4 HTM2040 NHS Estates 1993 ISBN 0 1132 1681 5

The control of legionellae in health care premises. A Code of Practice: Good practice guide Part 5 HTM2040 NHS Estates 1993 ISBN 0 1132 1683 1

This Code of Practice gives day-to-day guidance on the management of hot and cold water systems and other systems where there is a risk of proliferation of legionella bacteria. It also deals with engineering and design aspects of these systems.

10 BS 6700:2006 *Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages* British Standards Institution

11 *Water fittings and materials directory* Water Regulations Advisory Service 1999 ISBN 1 8726 9956 1

12 *Health and safety in care homes* HSG220 HSE Books 2001 ISBN 0 7176 2082 4

13 *Safe hot water and surface temperatures* NHS Estates 1998 ISBN 0 1132 2158 4

14 *Hot and cold water supply, storage and mains services: Management policy* Part 1 HTM2027 NHS Estates 1995 ISBN 0 1132 2176 2

Hot and cold water supply, storage and mains services: Design considerations Part 2 HTM2027 NHS Estates 1995 ISBN 0 1132 2177 0

Hot and cold water supply, storage and mains services: Operational management Part 3 HTM2027 NHS Estates 1995 ISBN 0 1132 2179 7

Hot and cold water supply, storage and mains services: Validation and verification Part 4 HTM2027 NHS Estates 1995 ISBN 0 1132 2178 9

15 *Hygiene for spa pools* Public Health Laboratory Service 1994 ISBN 0 901144 37 1

16 *The selection, use and maintenance of respiratory protective equipment: A practical guide* HSG53 (Second edition) HSE Books 1998 ISBN 0 7176 1537 5

Further reading

A Code of Practice: The control of legionellae by the safe operation of cooling systems British Association for Chemical Specialities 1989 ISBN 0 9514950 0 3 (Some sections updated in 1995)

Cooling water treatment: *A Code of Practice* 1998 Water Management Society

Both of the above Codes of Practice give practical guidance on the day-to-day management of evaporative cooling systems.

Minimising the risk of Legionnaires' disease TM13 2000 The Chartered Institution of Building Services Engineers 2002 ISBN 1 903287 23 5

This guidance gives details of engineering and design criteria together with day-to-day management and running of hot and cold water systems.

Water Supply Regulations Guide published by and available from Water Research Centre, Oakdale, Gwent.

This guide comprises the Regulations, the DETR guidance on the regulations and supplementary guidance by the Water Regulations Advisory Scheme.

Swimming pool water: Treatment and quality standards Pool Water Treatment Advisory Group 1999 ISBN 0 951 70076 6

Further information

For information about health and safety ring HSE's Infoline Tel: 0845 345 0055 Fax: 0845 408 9566 Textphone: 0845 408 9577 e-mail: hse.infoline@natbrit.com or write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

HSE priced and free publications can be viewed online or ordered from www.hse.gov.uk or contact HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165 Fax: 01787 313995. HSE priced publications are also available from bookshops.