European Guidelines for Control and Prevention of Travel Associated Legionnaires' Disease

Produced by members of the European Surveillance Scheme for Travel Associated Legionnaires' Disease and the European Working Group for Legionella Infections

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The complete guidelines can be found at http://www.ewgli.org/guidelinedownload

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Executive Summary

About these Guidelines

This guidance document describes the updated procedures for control and prevention of travel associated legionnaires' disease for participants in the European Surveillance Scheme for Travel Associated Legionnaires' Disease (EWGLINET). It has been produced by a small team from the surveillance scheme and the European Working Group for Legionella Infections (EWGLI). Drafts of the guidelines were submitted to the European Network Committee for the Epidemiological Surveillance and Control of Communicable Diseases in the Community, that operates under Decisions 2119/98/EC(2) and 2000/96/EC(3). After discussion of detailed written comments on the guidelines at their meeting in April 2002, the Committee supported the document. The guidelines have now been produced incorporating these comments and additional final comments from EWGLI members following their annual scientific meeting in Malta in May 2002.

EWGLINET is supported by European Commission funding from DG-SANCO. However, the status of these guidelines under the Commission is yet to be determined. Countries using the guidelines do so because they support and agree their contents.

The guidelines offer a standardised approach to procedures for preventing, detecting, reporting and responding to legionella infections associated with travel; and as such, also provide an additional source of guidance for countries that have already produced their own national guidelines. *National laws apply where advice on specific aspects of control and prevention differs between the European guidelines and those produced in some member state countries.*

Legionnaires' disease is a serious pneumonia infection caused by inhaling the bacteria *Legionella pneumophilia* or other *Legionella* species. This bacterium is frequently found in domestic, hotel and other water systems and in water used for air conditioning or air cooling systems. After the first recognition of the disease in people attending a hotel conference in the USA in 1976 (4), national surveillance for the condition began in several countries. The European Working Group for Legionella Infections (EWGLI) was formed in 1986 and members of this group established a European surveillance scheme for travel associated infections in 1987 (5). Sixteen years later, EWGLI remains a voluntary group of international scientists who share a common goal of furthering the microbiological and epidemiological understanding of legionella infections. The surveillance scheme however, which was named EWGLINET in 2002, has grown in size and complexity since 1987, and now functions under an official EU Control of Communicable Disease programme.

Legionnaires' disease principally affects adults and around 10% to 15% of otherwise healthy individuals with the disease are reported to die each year, despite the availability of appropriate antibiotic treatment. Hence the main intervention against the condition is prevention, through control of the organism in water systems. For a number of reasons people travelling to holiday destinations, especially in warm climates are especially at risk and such cases account for up to half of the cases reported from some European countries. Through extensive media coverage the public has become increasingly aware of legionnaires' disease, the specific risks associated with travel and hotel stays and a view that early pan-European action should protect them against the risks of infection.

Part 1

Introduction to legionnaires' disease and travel

This section provides information on the nature of legionnaires' disease, how it is caught, the type of symptoms with which it is associated and the current known sources of infection. It also describes the systems in place in Europe to monitor the infection at the international level and some results from the European surveillance scheme.

Part 2

Procedures for reporting and responding to cases of travel associated legionnaires' disease

These define the roles and responsibilities in response to reports of single cases and clusters for the Scheme's co-ordinating centre in London, the national government authorities with responsibility for public health in the collaborating countries, and the scheme's national collaborators nominated by their governments. It outlines the important stages and deadlines required of collaborators in the country of infection to inform the co-ordinating centre in London of the steps taken to investigate and control reported clusters. There is also information in this section on how the public is informed of these procedures.

Part 3

Procedures for the risk assessment, environmental investigation and control and prevention of legionella in water systems

This section summarises the factors to be considered in the risk assessment which include: the responsibilities of the individuals concerned, measurement of competence, their training requirements; management structure; the factors promoting the growth of legionella bacteria; the types of water systems to be considered and the documentation of the risk assessment; the systems for implementing and monitoring the control scheme. It details the items that should be included in the written scheme for the control of the risk and the need for regular review of the control measures, including the role of microbiological sampling. The responsibilities of manufacturers, importers, suppliers and installers are also detailed.

Part 4

Methods for the investigation and control of an outbreak of legionnaires' disease in an hotel or other accommodation site

This section briefly outlines the procedures for investigating an outbreak, with an emphasis on sampling for legionella and consideration of the emergency and long-term remedial measures for control.

Supplement 1 Part A

Technical guidelines for the control and prevention of legionella in water systems

This document provides the technical background to the control measures commonly applied to hot and cold water systems and cooling systems, including features of the design and construction; management of the systems during commissioning and re-commissioning and normal operation. It is separate from the main European guidance document, because it is mainly based on technical recommendations contained in the revised UK guidelines published in December 2000 (1). Supplement 1 should be regarded as one example of good practice, which may not be entirely consistent with guidance produced in some other European countries because of legal requirements or constraints within individual countries. It is however, a useful model to follow.

The supplement emphasises the use of temperature control for hot and cold water systems along with good maintenance with regular disinfection and cleaning. It also provides information on the use of alternatives such as chlorine, chlorine dioxide and copper/silver ionisation. The methods of monitoring the operation of the control measures are given. The design, construction operation and control of cooling systems with cooling towers or evaporative condensers is detailed, including the methods of cleaning and disinfection, biocidal regimes and the use of chemical and microbiological monitoring.

Supplement 1 Part B

Treatment methods for different water systems

This section provides brief information on the use of biocides for the regular control of cooling systems. It also describes the use of heat, chlorine, chlorine dioxide and copper/silver ionisation for the disinfection and control of growth of legionella bacteria in hot water systems and considers some alternatives.

Supplement 1 Part C

A list of the current range of technical guidelines produced by individual European countries is provided at the end of Supplement 1, Part C.

Part 1

Legionnaires' Disease and Travel

The prime aim of the European Surveillance Scheme for Travel Associated Legionnaires' Disease is to provide a capability within the European Union countries for the detection, prevention and control of cases and outbreaks of legionnaires' disease. Through shared information and member state shared actions, residents of European countries are increasingly protected from acquiring legionella infection linked to travel, either within their own country or abroad.

1. Background to the guidelines

In recent years, the European Union (EU) has experienced several large outbreaks of legionnaires' disease (6-7). In July 2001 the world's largest community outbreak of legionnaires' disease occurred in Spain (8). In addition, an annual rise in the number of cases, clusters and linked cases associated with a visit to a hotel or other tourist accommodation has been identified by the surveillance scheme (9). Some of these clusters have involved a considerable number of cases. Lack of European guidance or consensus about control measures have created many difficulties for patients, other clients, hoteliers, tour operators and public health authorities in the countries concerned. The European guidelines have been written to address these difficulties and to inform all those that need to know of the new procedures adopted by the EWGLI surveillance scheme.

The European surveillance scheme operates as a disease specific network according to Decisions 2119/98/EC (2) and 2000/96/EC (3) for the setting up of a network for the epidemiological surveillance and control of communicable diseases in the Community. Article 3(F) of Decision 2119/EC98/EC and Article 4 of Decision 2000/96/EC are particularly pertinent for these guidelines and this disease specific network. In August 2000, five members of the surveillance scheme and EWGLI were funded by the European Commission (DG Health and Consumer Protection) to work together for one week and prepare a first draft guidelines document for discussion and comments. Extensive consultations then took place with members of the surveillance scheme and EWGLI, other professional groups and the European Commission Network Committee. The Network Committee and EWGLI members agreed the sixth and final draft of the guidelines in May 2002. Under the European Commission, the status of these guidelines as an official document is yet to be determined. Countries using the guidelines do so because they support and agree their contents. Implementation of the guidelines commenced on 1 July 2002.

2. Introduction

Legionnaires' disease was first identified in 1976 (4). International collaborations at the European level began in 1986 when the European Working Group for Legionella

Infections (EWGLI) was first formed and surveillance of travel associated infections was implemented the year after. Protecting citizens against travel associated legionnaires' disease frequently involves international activities. Therefore it is important that participating countries share the common objective of minimizing risk of infection from recognised environmental sources for all their citizens. These European guidelines aim to provide a set of common procedures that should be followed by all European countries involved in protecting their citizens against legionnaires' disease. They have been produced at this time in response to revised procedures for reporting and responding to cases of travel associated legionnaires' disease within European member states and to reflect changes in the surveillance scheme's formal status within the European Union. They also offer technical advice to professional groups involved with the control and prevention of legionella in water systems.

Cases associated with travel are known to comprise up to 50% of national reports of the disease in some countries (10). Because of widespread media publicity, the public at large is increasingly aware of legionnaires' disease and the risks associated with tourist accommodation. It demands appropriate action from national governments and public health officials to provide them with adequate protection against these risks. Control measures taken in response to cluster detection have frequently included the rapid withdrawal of guests from the accommodation site, thus preventing further cases, and international follow up investigations designed to estimate the full extent of infection in people exposed to the source of infection.

3. Legionella – natural history of the organism

Legionella bacteria are common and can be found naturally in environmental water sources such as rivers, lakes and reservoirs, usually in low numbers. From the natural source, the organism passes into sites that constitute an artificial reservoir (channelled water in towns, water systems in individual buildings, etc). Water temperatures in the range of 20°C to 45°C favour growth of the organism. 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 when water temperatures reach a suitable level. Legionella bacteria also require nutrients to multiply, and sources include commonly encountered organisms within the water system itself such as algae, amoebae and other bacteria. The presence of sediment, sludge, scale, rust 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.

Further details on sources of legionella infection can be found in Part 3 paragraph 25.

4. What is legionnaires' disease?

Legionnaires' disease is a serious form of pneumonia that carries with it a mortality rate in the order of 10-15% in otherwise healthy individuals. Symptoms include a flu-like illness, followed by a dry cough and frequently progress to pneumonia. Approximately 30% of people infected may also present with diarrhoea and vomiting and around 50% may show signs of mental confusion. The incubation period normally ranges from 2-10 days with 3-6 days the typical illness onset time after exposure.

Legionnaires' disease may present as an outbreak of two or more cases following a limited temporal and spatial exposure to a single source, as a series of independent cases in an area in which it is highly endemic or as sporadic cases without any obvious temporal or geographical grouping. Outbreaks have occurred repeatedly in buildings such as hotels and hospitals.

5. Methods of transmission

Legionnaires' disease is normally acquired through the respiratory system by breathing in air that contains legionella bacteria in an aerosol. An aerosol is formed from tiny droplets that can be generated by spraying the water or by bubbling air into it, or by it impacting on solid surfaces. The smaller the droplets, the more dangerous they are. Droplets with a diameter of less than 5µ reach the lower airways more easily. Case to case transmission between humans has never been demonstrated.

6. Recognised potential sources of travel associated infection

The following are all potential sources of travel associated legionnaires' disease:

- Hot and cold water systems
- Cooling towers and evaporative condensers
- Spa pools/natural pools/thermal springs
- Fountains/sprinklers
- Humidifiers for food display cabinets
- Respiratory therapy equipment

7. Risk factors associated with infection

Recognised risk factors for legionnaires' disease include being of an older age group (>50 years), male, having a chronic underlying disease with or without an associated immunodeficiency and being a heavy cigarette smoker. The public health risks associated with legionnaires' disease and travel are mainly related to the special nature of providing temporary accommodation for people in circumstances that may differ from their normal way of life. Older people are more susceptible to legionella infection and during their travels may be subject to changes in life style and a build up of exposure to legionella from infected sources such as air conditioning or contaminated water systems, against which they have less resistance than younger adults. Diagnosis and treatment of some of these people may be compounded by delay in their not seeking medical assistance until they arrive back in their own country.

Although 42 different species of *Legionella* have been described, not all have been associated with human disease (11). *L. pneumophila* is the species most often detected in diagnosed cases.

8. Risks factors associated with accommodation for travellers

Infection linked to travel is associated with particular features of living in accommodation designed for short stays and frequently with in-built seasonal variation in use by people. The occupancy of some accommodation sites and therefore use of the water facilities, may be intermittent, and demands of water use for bathing may surge at particular times of the day and night. The accommodation may be sited in areas of low rainfall that may result in an intermittent water supply of varying quality. Water treatment regimes will need more intensive monitoring and more frequent adjustment than would be normal for a water supply of consistent quality. It is possible that, during periods of water shortage, non-essential facilities such as spa pools may have to be taken out of use because it is not possible to replace the water frequently enough to ensure their safe operation. During the low season, room occupancy may be low, sections of the hotel closed or even the whole hotel closed. These factors can cause the whole or parts of the water system to have low levels of flow and become stagnant, with resulting loss of temperature or residual treatment biocide. The temperature control of hot and cold water may fluctuate because of outside ambient temperatures. Hotels or other accommodation sites frequently have many rooms with individual water outlets, inevitably resulting in very complex water systems, often with long lengths of water piping.

Hotel extensions may be built and connected to the original hot water system, resulting in the heating capacity no longer being sufficient to maintain the circulating temperature throughout the whole premises. Hotel gardens are frequently irrigated with sprinklers and these may present an additional risk, particularly if they utilise recycled grey-water or sewage based water.

The seasonal nature of the holiday trade means that staff may frequently change, making it difficult to maintain a core of adequately trained personnel. In addition hotel engineers often have no training in controlling legionellae in hotel water systems.

9. Surveillance of legionnaires' disease

Legionnaires' disease is a statutorily notifiable disease in many but not all EU member states. Rates of disease vary from 1.0 to 20.0 per million population, depending on ascertainment and reporting procedures in individual European countries. However rates at the lower end of the range represent a considerable under-estimate of incidence and it is thought that the true number of cases may be up to 20 times this figure. It is estimated that less than 5% of cases may eventually be reported to public health authorities through passive surveillance (12).

Studies that have tried to estimate the true incidence of community-acquired legionnaires' disease have found that *Legionella* species cause between 2% and 16% of community-acquired pneumonia cases in industrialized countries (13). One study in the UK showed that although uncommon overall, a diagnosis of legionella infection was more likely in severe cases of community-acquired pneumonia, accounting for 14-37% of cases, with an associated mortality rate in excess of 25% (14). Overall, *Legionella* species are probably the second-to-fourth-most common cause of community-acquired pneumonia (pneumococcal pneumonia is the most common cause).

There are several reasons why legionnaires' disease is under diagnosed and under reported:

- when a patient is diagnosed with pneumonia, treatment is generally started immediately. If the patient is treated with antibiotics that are effective against legionella, the patient usually recovers, without further need to establish the cause of the pneumonia;
- a small proportion of the diagnostic methods for legionnaires' disease lack sensitivity and specificity and may result in producing false negative results;
- patients with a serious underlying disease involving immunosuppression are particularly at risk from legionnaires' disease. If these patients die, death may be attributed to their serious condition, without diagnosing the legionella infection;
- cases of travel associated infection may be diagnosed in some countries but not forwarded to the national collaborator in the European surveillance scheme.

From the above, it can be concluded that the number of cases reported to the European surveillance scheme is a serious under estimate of the true incidence of travel associated legionnaires' disease.

10. European surveillance of travel associated legionnaires' disease

International surveillance has been shown to provide added value to national surveillance and to contribute to the detection, control and prevention of disease within and between countries. It requires close co-operation between European countries. Information about the surveillance scheme and its roles and functions is provided on the public part of the EWGLI website (www.ewgli.org). The scheme also fosters collaborations between European countries through the exchange of clinical and environmental specimens and the exchange of information which will further the epidemiological and microbiological knowledge of legionella infection.

11. Objectives of the European surveillance scheme

- To enhance the capability within the EU to detect common source outbreaks early, enabling member states to implement timely preventive action;
- to inform all those that need to know about travel associated legionnaires' disease in order to promote primary preventive action and collaborative investigations;
- to inform the European network about community acquired outbreaks of legionnaires' disease of potential international public health importance;
- to reduce the incidence of legionnaires' disease in residents of Europe through the support of active control and prevention programmes in each member state country;
- to improve the methods of communication for reporting and receiving information on legionnaires' disease.

12. Epidemiological methods

The European surveillance scheme is now an official disease specific network according to Decision 2119/98/EC. It adopted the name EWGLINET in May 2002 in order to distinguish it from the other activities carried out by EWGLI. Representatives from the national authorities with responsibility for public health in each member state oversee EWGLINET. They also nominate the official collaborators to participate in the scheme. These are normally one public health epidemiologist from their national public health institute or Ministry of Health and one microbiologist from their national or regional legionella reference laboratory. EWGLINET is currently managed by the co-ordinating centre at the Public Health Laboratory Service (PHLS) Communicable Disease Surveillance Centre (CDSC) in London.

Individual cases of disease are reported by the nominated collaborators to the scheme's co-ordinating centre in London (CDSC). Case definitions for reporting are given in Appendix 1. With complete and rapid reporting the surveillance scheme can detect clusters of travel-associated legionnaires' disease in residents from two or more European countries travelling to a single holiday destination or staying in the same hotel or other accommodation site. Receipt of the information leads to specific and timely action by collaborators to protect European residents travelling to countries inside and outside Europe.

As at July 2002, 43 collaborating centres in 34 European countries (15 member states and 19 non-member states) were contributing or receiving data on travel associated cases. Liaison with other national authorities takes place if the travel associated infection is linked to countries outside Europe, eg the USA, South Africa, the Far East etc. Procedures for reporting cases of travel associated legionnaires' disease to tour operators were formalised and adopted by some European countries following the implementation of the EC Directive for Package Travel (90/314)(15) in 1996.

In 1999, the EWGLI website was developed and collaborators can now transmit and receive case information via a secure part of this facility. All case reports are incorporated into the international database at CDSC which is then searched for other cases who may have stayed at the same place of accommodation at any time since 1987 when records began.

Cases are normally reported to the scheme by the country of residence of the case. The majority of cases are residents of northern European countries, eg the UK, France and the Netherlands and infection is mainly associated with countries in southern Europe. This pattern of illness reflects the migration from north to south of people going to specific holiday resorts for their holiday rather than any bias in susceptibility or reporting between north and south Europeans.

Great care has to be taken with the surveillance. There is a requirement for speed to provide health protection. However cases and clusters seemingly associated with specific hotels can arise by chance and the source of infection may be elsewhere. Also, since all cases require a confirmed laboratory diagnosis and many lead to investigations of environmental sources, it is essential that there be good, standardised microbiological testing and agreed good practices for investigation and response within and between European countries.

13. Results 1987-2001

The number of cases of travel associated legionnaires' disease reported to the European scheme has risen from less than a hundred per year in 1987 to almost 500 in 2001(16). This increase almost certainly reflects increased ascertainment and improved collaborations and reporting by the participating countries. Since 1987, the Surveillance scheme has received details of over 3000 cases and nearly 4000 visits that were associated with more than 65 different countries worldwide. Approximately 40% of these cases were part of recognised clusters or cases linked to the same hotel or building over several years. The proportion of deaths reported each year range from 6% to 15% but are considered an under estimate as many countries are unable to provide mortality data.

The peak months in Europe for onset of legionella infection occur during the summer, the period when most people take their main holidays. August, which is the peak month for school holidays in Europe usually has a lower proportion of cases and suggests that older people who are more at risk of legionella infection tend to take their holidays outside this month. Cases in men outnumber cases in women by approximately three to one and the peak age of infection is between 50 and 65 years, although in recent years there has been an increase in the number of cases reported in those aged 75 years or more.

14. Related activities within EWGLI

Countries that participate in EWGLI are involved in microbiological and environmental studies that contribute to the further understanding and control and prevention of legionella infections. The main objectives of this voluntary group are:

- to continue to support the European Surveillance Scheme for Travel Associated Legionnaires' Disease (EWGLINET);
- to collaborate on the investigation and control of legionnaires' disease;
- to continue to improve the laboratory support to participating laboratories in the scheme through the PHLS External Quality Assessment Scheme (EQA) for the detection of *Legionella* species in water;
- to establish and maintain a European EQA scheme for laboratory diagnostic methods including the detection of legionella urinary antigen;
- to extend the pan-European typing scheme for *L.pneumophila* serogroup 1;
- to develop strategies for the standardised identification and typing of non-pneumophila *Legionella* species.

Part 2

Definitions and Procedures for Reporting and Responding to Cases of Travel Associated Legionnaires' Disease

The following definitions and procedures have been devised in order to improve control and prevention of travel associated legionnaires' disease and to enhance information on the actions taken at accommodation sites when cases are reported to the surveillance scheme's co-ordinating centre in London. The algorithm is shown in Figure 1. The definitions are in line with operating European surveillance under Decision 2119/98/EC (2), although any response by individual countries has to be in accordance with their own laws and guidelines for control and prevention of legionnaires' disease. The European guidelines do not currently over-ride national guidelines but through Decision 2119/98/EC it is assumed that harmonisation of procedures will be introduced in all member states.

The guidelines include important new procedures for informing the public about clusters of legionnaires' disease cases associated with holiday accommodation. (paragraph 18).

15. Responsibility of government nominated surveillance collaborators

Collaborators in EWGLINET are officially nominated by their governments to have responsibility for reporting and responding to cases of travel associated legionnaires' disease in accordance with Decision 2119/98/EC and these guidelines. Collaborators are nominated from people with scientific experience of legionella and with epidemiological or microbiological responsibility for diagnosis and surveillance of legionella infections in their country.

16. Definitions for reporting

Single cases

- Cases who in the ten days before onset of illness stayed at or visited an accommodation site that has not been associated with any other cases of legionnaires' disease, or cases who stayed at an accommodation site linked to other cases of legionnaires' disease but more than two years previously.

Clusters

- Two or more cases who stayed at or visited the same accommodation site in the ten days before onset of illness and whose onset is within the same two-year period.

If any further cases associated with the cluster site occur more than two years after the last case, they will be reported as new single cases, although the country of infection will receive information on all previous cases regardless of the time period involved.

17. Reporting procedures

Reporting to the network's co-ordinating centre

Cases are normally reported to the co-ordinating centre in London by the country of residence, (ocasionally a report may be made on a patient outside their country of residence) via the password protected secure level of the EWGLI website. Cases should be reported as soon as the epidemiological, microbiological and travel information is obtained. The room number, complete accommodation address and other important information such as known use of showers, whirlpool spas or other recognised exposure risks should try to be obtained from the case or their relatives and provided with the case report or as soon as possible thereafter. Without satisfactory information on the travel details, it may not be possible to identify the accommodation site in the presumed country of infection, especially in resorts where similar hotels names are used by many different establishments.

Response by the co-ordinating centre in London

The case is entered onto the international database. This is then searched for any other cases linked to the same accommodation site. If none are found, the co-ordinating centre immediately reports the case to the collaborator in the country of infection.

Response by the collaborator in the country of infection

The collaborator in the country of infection should contact the site and send them the checklist that outlines good practice for minimising the risk of legionella infection. If they cannot do this directly, they should request the relevant local health authority to contact the site and send the checklist. (Appendix 2)

No further follow up procedures at the international level are necessary for a single case of travel associated legionnaires' disease.

Removing hotel names from the database

If after two years, no additional cases of travel associated legionnaires' disease are linked to accommodation sites at which only one case has previously been reported, the name of that hotel or accommodation site is removed from the database accessed by the collaborators.

18. Procedures for clusters

Identification of a cluster is of sufficient importance to warrant an immediate response by the co-ordinating centre in London and the collaborator in the country of infection.

Response by the co-ordinating centre in London

The cluster will be entered onto the international database. All collaborators will be informed immediately of the cluster and any additional cases linked to the same accommodation site outside the two-year period. WHO will be informed of all clusters associated with accommodation sites both within and outside the surveillance network countries and requested to inform the Ministry of Health in the country concerned if it is outside the European network.

Response by the collaborator in the country of infection

The collaborator should arrange for the accommodation site to be inspected by a body authorised by the national authority (eg a local or regional public health authority) as soon as possible. A risk assessment (according to European or national guidelines) should be requested, followed by an environmental investigation, the implementation of control measures and the drawing up of recommendations against existing or future risks of legionella infection. The risk assessment should include a technical inspection of the site, the implementation of emergency remedial measures and the listing of any corrective actions taken. The collaborator should also ensure that their national authority (eg national public health institution or Ministry) is aware of the cluster.

Public disclosure of cluster information

The naming of accommodation sites on the public part of the EWGLI website will be triggered by actions of collaborators and health authorities when they are notified of a cluster associated with their country. By making certain data available to the public, the co-ordinating centre in London is carrying out this function in accordance with agreed procedures in these guidelines. Countries participating in the surveillance scheme believe that protection of their citizens from the risks of legionella infection is paramount and support the decision to make details of accommodation sites available to the public, when appropriate to do so.

The public is increasingly protected from acquiring travel associated legionnaires' disease through the rapid exchange of information between public health specialists when clusters are detected and the use of standardised control and prevention procedures when responding to the cluster alert. However, if any breakdown in these procedures occur or adverse reports are received about the control measures at the accommodation site, the public have a right to be informed about the situation and the reason for the public disclosure.

19. Risk assessment report

Preliminary report within two weeks

The collaborator should complete Form A. This form specifies whether or not an inspection and risk assessment have been carried out at the accommodation site. It should be returned to the co-ordinating centre in London within two weeks of receipt of the cluster alert. *(The two-week period will commence once the details of the accommodation (ie name and address) have been verified as correct by the collaborator in the country of infection).* The report should state whether control measures are in progress and if the hotel remains open or not. On receipt of this report at CDSC, the collaborator in the country of infection and the country of report of the case(s) will be notified. A reporting form is provided in Appendix 3.

If Form A is not received in the specified time period or the form reports that no risk assessment or control measures have been taken, all collaborators will be informed and a notification of the cluster will be posted on the public part of the EWGLI website. The notification will remain on the website until Form A is received or until it is reported that control measures are in place.

Full report within six weeks of the cluster alert

After a further four weeks, information is expected that outlines what investigations and control measures have been taken at the accommodation site and should include the results of any sampling that took place. A summary reporting form (Form B, Appendix 4) should be completed and returned to CDSC within four weeks of the initial preliminary report. The collaborating centre should also enter the results of the investigation report directly into the surveillance scheme's electronic database for environmental investigation results. If Form B is not received, or it states that control measures are unsatisfactory, a statement to this effect will be placed on the public part of the website and the name of the accommodation site made public. The name of the accommodation site will be removed from the EWGLI website when Form B is received or when control measures are considered to have been satisfactorily implemented.

Collaborators in the country of infection will be reminded 2-3 days in advance of the report deadline of two weeks and six weeks if Forms A or B have not been received. All collaborators will be informed when names of accommodation sites have been removed from the public part of the website. It will be the responsibility of the collaborator in the country of infection (or their designated authority) to liaise with the hotel or other site if that accommodation site has had its name posted on the public website. Public information about the accommodation site will be moved to an archive file if after one year the status of the accommodation site has not been resolved.

Parts 3 and 4 of these guidelines offer guidance on how to carry out a risk assessment and environmental investigation.

20. Report of an additional case with date of onset two to six weeks after the first cluster alert

Five day deadline

If an additional case is reported with a date of onset two to six weeks after the first cluster alert, there is a strong probability that guests are continuing to be exposed to legionella at the accommodation site. The co-ordinating centre will immediately contact the collaborator in the country of infection and enquire about control measures at the accommodation site. A response should be provided to the co-ordinating centre within five working days. If none is received, the name of the accommodation will be posted onto the public part of the EWGLI website and will remain there until a report is received that indicates satisfactory control measures have been applied.

21. Report of new cluster cases within two years of environmental investigations

Two year review

If new cluster cases arise within two years from an accommodation site where a report was previously received stating all control measures were satisfactorily implemented, a new and more thorough investigation will be expected. This should be organised by the collaborator in the country of infection. The steering committee of the surveillance scheme can provide a list of independent experts whom collaborators or their national authorities might wish to consult for a further risk assessment exercise. The results of the new investigation should be reported to the co-ordinating centre in the standard way using forms A and B within two weeks and six weeks. If no reports are received within the outlined time frame the name of the hotel will be made public on the EWGLI website and all national authorities will be informed. As before, the name will be removed once satisfactory control measures have been implemented and reported to the scheme.

22. Follow up of clusters associated with more than one accommodation site

Each year approximately 25-30% of all travel associated cases stay at more than one accommodation site in the 2-10 days before onset of illness for legionnaires' disease, making it difficult to organise follow up of all accommodation sites. For single cases the recommended procedures should be followed, ie distribution of the checklist to each of the sites.

For clusters, an extensive itinerary involving several accommodation sites may be associated with two or more cases and all of these sites may need investigating. Alternatively, one accommodation site from a travel itinerary may also have been used by another case with a different travel itinerary and hence become associated with a cluster. Where multi-sites are associated with a cluster, it is recommended that the network collaborator in the country of infection should prioritise the follow up of these sites and inform the London co-ordinating centre of their actions. Discretion will be used concerning the publication of hotel names on the EWGLI website for these clusters.

23. The role of tour operators in relation to reports of travel associated legionnaires' disease

Through the Package Travel Directive (15), tour operators in Europe have a legal duty to protect the health and welfare of clients within the package they provide. In the last few years several countries have informed tour operators of clusters and/or single cases because they can play a useful role in helping to identify hotel locations and people who have stayed at them. These guidelines outline a change in policy in relation to reporting to tour operators.

The co-ordinating centre in London no longer reports cases or clusters of travel associated legionnaires' disease to any individual, national or international group of tour operators. Very occasionally however, tour operators receive notification of a case of legionnaires' disease directly from a client. In this situation, tour operators should advise the informant to contact their doctor and request the doctor to report the case to the appropriate authority in the country concerned.

The revised reporting procedures have been introduced because many tour operators responded to cluster reports by commissioning commercial companies to carry out investigation and control measures at the accommodation site. These were rarely done in collaboration with local public health staff and the results of their investigations were not made available to the surveillance scheme. The fact that less than 50% of all holiday bookings are made through tour operators was an additional reason for changing policy. The majority of tourists were not protected by the interventions carried out by tour operators.

Organising the investigation of clusters associated with hotels or other tourist accommodation sites is the responsibility of collaborators in each country, who through their governments have national responsibility for ensuring that control and prevention measures are implemented when clusters are reported. It is not the responsibility of tour operators. However, it is recognised that tour operators may continue to commission inspection of hotels in the absence of intervention by the public authorities. In the event of this situation occurring, the tour operator's investigation report should be shared with the co-ordinating centre in London.

It is the responsibility of the collaborator in each participating country to arrange for hotels and other tourist accommodation sites to be informed of the procedures in these guidelines. Hotels should be informed that they might be subject to publicity on the EWGLI website, as a consequence of a cluster report to the collaborator in the country of infection. Countries that fail to take action in response to cluster alerts and do not submit two-week or six-week investigation reports will have details of the cluster made publicly available on the EWGLI website. Members of the public and tour operators will then be able to choose whether or not to continue to use the hotel in question.

When three or more cases are associated with a cluster, or a third case has occurred subsequent to the cluster alert, it is possible that tour operators will withdraw their clients from the hotel. A decision to withdraw should be universally taken by all tour operators based on the advice they receive from a collaborator, although some may choose to accept future bookings whilst investigations are in progress. It will be the decision of the tour operators as to what extent information on the outbreak is disseminated to their clients.

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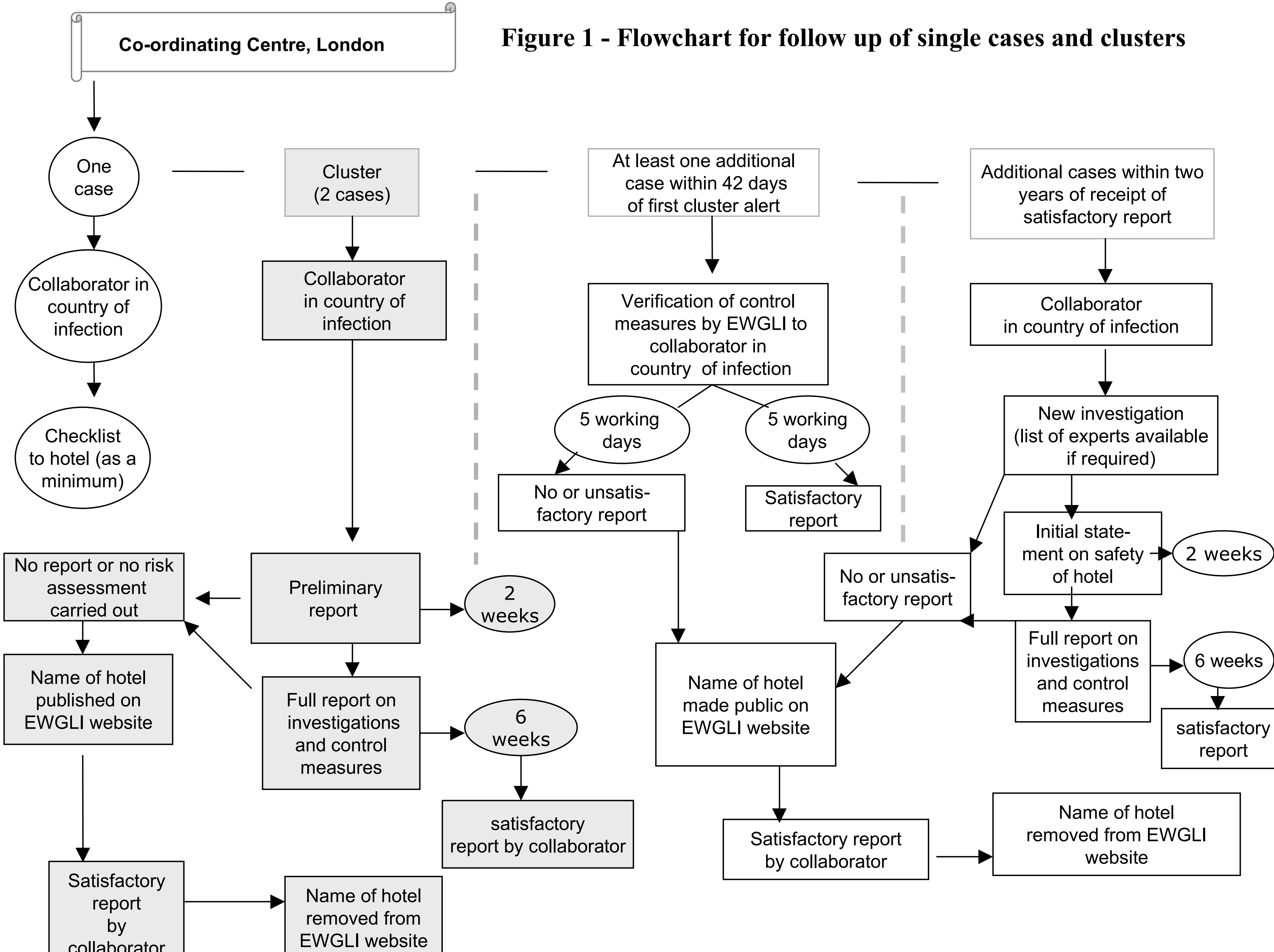
Figure 1 - Flowchart for follow up of single cases and clusters



Microbiological case definitions

Legionnaires' disease is an uncommon form of pneumonia. The disease has no particular clinical features that clearly distinguish it from other types of pneumonia, and laboratory investigations must therefore be carried out in order to obtain a diagnosis. The following definitions have been agreed for the European surveillance scheme:

Confirmed case

An acute lower respiratory infection with focal signs of pneumonia on clinical examination and/or radiological evidence of pneumonia and one or more of the following:

- Isolation of any legionella organism from respiratory secretion, lung tissue or blood.
- A fourfold or greater rise in specific serum antibody titre to L. *pneumophila* sg1.
- The detection of specific legionella antigen in urine using validated reagents and methods recommended by EWGLI in 1998 (17).

Presumptive case

An acute lower respiratory infection with focal signs of pneumonia on clinical examination and/or radiological evidence of pneumonia and one or more of the following:

- A fourfold or greater rise in specific serum antibody titre to L *pneumophila* other serogroups or other legionella species.
- A single high titre* in specific serum antibody to L. *pneumophila* sg1 or other serogroups or other legionella species.
- The detection of specific legionella antigen in respiratory secretion or direct fluorescent antibody (DFA) staining of the organism in respiratory secretion or lung tissue using evaluated monoclonal reagents.
- The detection of legionella specific DNA by polymerase chain reaction (PCR).

***A single high serological titre:** as differing serological testing methods are used in different countries, and as an internationally accepted validation exercise has not been carried out, no specific serological test or titre level can be specified. It is suggested however that the single high titre result considered to indicate recent legionella infection, in the presence of compatible symptoms, be set at a sufficiently high level to be specific for legionella infection (ie. to produce a low level of false positives).

Laboratory methods for diagnosis of legionnaires' disease

Details of specimens to be collected and laboratory methods to be used for diagnosis of legionnaires' disease can be found in laboratory manuals and standard textbooks on legionella.

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Legionnaires' Disease: - Minimising the Risk

Check List for Hotels and other Accommodation Sites

Legal claims for legionnaires' disease can be a significant cost e.g. a man who became infected in a hotel was recently awarded €21,000 compensation. The illness is often fatal and the publicity attracted by such cases can severely harm the hotel business. The risk from legionnaires' disease can be reduced by careful attention to a number of simple measures. Nearly 500 cases of legionnaires' disease in European residents were reported to be associated with staying in hotels or other holiday accommodation in 2001.

1. What is legionnaires' disease

A form of pneumonia which kills about 13% of those infected and is caused by legionella bacteria. Legionella bacteria can also cause less serious illness. Illness usually develops 3-6 days after infection but may take longer.

2. Symptoms

The illness usually starts with a fever, chills, headache and muscle pain. This is followed by a dry cough and breathing difficulties that may progress to severe pneumonia. About 30% of those infected will also have diarrhoea or vomiting and about 50% become confused or delirious.

Accurate diagnosis requires specific laboratory tests which often will not be done until the guests have returned home.

3. How is legionnaires' disease caught?

Breathing in air containing the legionella bacteria in an invisible aerosol. Aerosols can be formed from fine droplets generated from water containing the bacteria by, for example, running a tap or shower, flushing a toilet, or from bubbles rising through water in a spa pool. The bacteria can live and multiply in water at temperatures of 20°C to 45°C. They can be found in the natural environment such as rivers, lakes and moist soil but in usually in low numbers. High numbers occur in inadequately maintained man-made water systems.

4. Where are the potential risk areas in hotels?

- Wherever water droplets can be created there is a risk of infection e.g.:
- Showers and taps
- Spa baths and whirlpool baths
- Turkish baths and saunas
- Cooling towers and evaporative condensers, even if situated on the roof or in the grounds
- Ornamental fountains, particularly indoors
- Humidified food displays

5. Where can legionella multiply?

- Hot and cold water tanks / cisterns
- Warm water between 20°C and 45°C
- Pipes with little or no water flow (this includes unoccupied rooms)
- Slime (biofilm) and dirt on pipe and tank surfaces
- Rubber and natural fibres in washers and seals
- Water heaters and hot water storage tanks
- Scale in pipes, showers and taps.

These situations and conditions encourage the growth of legionella bacteria and increase the risk of infection to hotel guests and staff.

6. Reducing the risk

The risk of legionnaires' disease can be avoided. Any hotel that does not have an active programme to control the growth of legionella bacteria is negligent in ensuring the safety of their guests. This programme should include the following:

- Have one named person responsible for legionella control.

- Ensure the named person is trained in control of legionella and other staff are trained to be aware of the importance of their role in controlling legionella

- Keep hot water hot and circulating at all times: 50^{o}C - 60^{o}C (too hot to put hands into under for more than a few seconds)

- Keep cold water cold at all times. It should be maintained at temperatures below 25^{o}C

- Run all taps and showers in guest rooms for several minutes at least once a week if they are unoccupied and always prior to occupation.

- Keep shower heads and taps clean and free from scale

- Clean and disinfect cooling towers and associated pipes used in air conditioning systems regularly – at least twice a year

- Clean and disinfect water heaters (calorifiers) once a year

- Disinfect the hot water system with high level (50mg/l) chlorine for 2-4 hours after work on water heaters and before the beginning of every season

- Clean and disinfect all water filters regularly - every one to three months

- Inspect water storage tanks, cooling towers and visible pipe work monthly. Ensure that all coverings are intact and firmly in place

- Inspect the inside of cold water tanks at least once a year and disinfect with 50mg/l chlorine and clean if containing a deposit or otherwise dirty

- Ensure that system modifications or new installations do not create pipework with intermittent or no water flow

- If there is a spa pool (synonyms whirlpool spas, “Jacuzzis”, spa baths) ensure
  - It is continuously treated with 2-3mg/l chlorine or bromine and the levels are monitored at least three times a day
  - replace at least half of the water each day
  - backwash sand filters daily
  - clean and disinfect whole system once a week

- keep daily records of all water treatment readings such as temperature and chlorine concentrations and ensure they are checked regularly by the manager.

Further advice about specific controls should be sought from experts in this field who can carry out a full risk assessment of the hotel site.

7. Legionella testing

Testing for legionella (which is not compulsory) can be misleading. Samples should only be collected by trained personnel and examined by laboratories accredited for testing water for legionella bacteria. A negative test does not necessarily mean that the hotel is clear of legionella or that there is no risk.

8. Further information

Further information can be obtained from the European Guidelines for Control and Prevention of Travel Associated Legionnaires’ Disease.

Form A
Two Week Post-Cluster Report

EWGLI Cluster No:………………

Name of hotel/accommodation site……………………………..……….

Resort/Country……………………………………………

Date cluster alert issued by CDSC *dd/mm/yy*

Date cluster alert received by
collaborator in country of infection *dd/mm/yy*

Statement

The above named accommodation site has been visited and an immediate risk assessment (without results from environmental investigations) has been made.

Based on the report received from the investigator, I confirm the following:

	Yes	No
A risk assessment has been carried out	☐	☐
Control measures are in progress	☐	☐
The hotel or other accommodation site remains open	☐	☐

Date of this report to CDSC *dd/mm/yy*

Name of (or on behalf of) collaborator sending report …………………………….

Country of report……………………………….

Comments

Please return by email to: ewglinet@ewgli.org

Form B
Six Week Post-Cluster Report

EWGLI Cluster No:………………

Name of hotel/accommodation site……………………….………………

Resort/Country…………………………..…………………

Date cluster alert issued by CDSC *dd/mm/yy*

Date cluster alert received by
collaborator in country of infection *dd/mm/yy*

Statement

An environmental investigation has been carried out at the above named accommodation site.

Based on the report received from the investigator, I confirm the following*:

	Yes	No
Environmental sampling was carried out		
***Legionella* was found in the water system(s)**		
Control measures are satisfactory		
The hotel or other accommodation site remains open		

Date of this report to CDSC *dd/mm/yy*

Name of (or on behalf of) collaborator sending report …………………………….

Country of report………………………………..

Comments

Return by email to: ewglinet@ewgli.org

** Answers must be provided to all of these questions. Details of the investigation should also be entered into the EWGLI environmental results database.*

Part 3

Procedures for the Risk Assessment, Environmental Investigation and Control and Prevention of Legionella in Water Systems

24. Introduction

This part of the guidelines outline the general principals and procedures that should be followed in order to carry out a risk assessment of the control measures against the proliferation of legionella bacteria in an establishment such as a hotel. It must be emphasised that, for the effective prevention of legionnaires' disease, risk assessments and control measures must be implemented proactively and not merely in response to a case or cluster of cases of legionnaires' disease. Consequently if a single case is associated with the establishment it should only be necessary to ensure that an adequate up-to-date risk assessment is in place and check that all the control measures are operating correctly and consistently. However following a cluster of cases it will be necessary to carry out a new thorough risk assessment.

This part should be read in conjunction with Supplement 1 that provides more technical information on the methods available to control the growth of legionellae in different kinds of water systems. Although this document deals primarily with travel associated legionnaires' disease and is therefore concerned mostly with hotels, the risk assessment procedures and technical guidance can be applied to all kinds of premises.

25. Scope

These guidelines apply 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. For example, hotels, holiday apartments, camp sites, cruise ships, leisure centres, trade shows and factories. These guidelines should be read in conjunction with the technical notes (Supplement 1).

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;
d) natural thermal springs and their distribution systems;
e) spa pools;
f) humidifiers;
g) other plant and systems containing water which is likely to exceed 20°C and which may release a spray or aerosol (i.e. a cloud of droplets and/or droplet nuclei) during operation, demonstration or when being maintained, for example industrial water systems and horticultural sprinkler systems.

Not all of the systems listed above 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.

A water system includes all plant/equipment and components associated with that system, e.g. all associated pipework, 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, e.g. sections of hotels that are closed in the low season, 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 overload the water treatment regime and result in dissemination of legionellae throughout the system

Other systems, such as humidifiers and air washers, spa baths and pools, car/bus washes, wet scrubbers, industrial water systems, fountains and water features, also need to be considered.

26. Identification and assessment of the risk

A survey is required to identify and assess the risk of exposure to legionella bacteria from water systems on the premises and any necessary precautionary measures. The individual whose duty it is to have the assessment carried out is:

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
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 (e.g. where a building is let to tenants but the landlord retains responsibility for its maintenance); or
d) the person who is in control of premises used for overnight accommodation, such as hotels, holiday apartments, campsites and cruise ships where the risk is present from water systems in the building.

The person conducting the assessment must be competent to assess the risks of exposure to legionella bacteria in the water systems present in the premises and the necessary control measures (e.g. a microbiologist, environmental health officer or water engineer with this specific expertise).

The assessment should include a full inspection to identify and evaluate 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.

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. Carrying out a risk assessment

The risk of a person being infected with legionellae depends on a number of factors. These include:

a) the presence of legionella bacteria;
b) conditions being suitable for multiplication of the organisms for example a suitable temperature (20°C to 50°C) and a source of nutrients such as sludge, scale, rust, algae and other organic matter;
c) a means of creating and disseminating inhalable droplets such as the aerosol generated by operating a tap, shower or cooling tower;
d) the presence (and numbers) of individuals who may be exposed,
e) the vulnerability of these individuals e.g the elderly.

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 pose a risk to those at work or other persons.

The following list contains some of the factors that 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, hot water storage heater, cooling tower or any other system using water that may present a risk of exposure to legionella bacteria;
c) the normal equipment operating characteristics;
d) unusual, but reasonably foreseeable, operating conditions, for example, breakdowns;
e) the position of air intakes for buildings which should not be located near to cooling tower exhausts.

A fully documented record of the risk assessment should be kept and where there is a risk the record of the assessment should be linked to other relevant health and safety records.

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.

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

The assessment should be reviewed regularly (at least every two years) and in any case whenever there is reason to suspect that it is no longer valid. This could occur when due to changes to the water system or its use or the results of checks indicate that control measures are no longer effective.

28. Managing the risk: management responsibilities, training and competence

Where the assessment has identified a risk and it is reasonably practicable to prevent exposure or control the risk from exposure, the person on whom the duty falls (see paragraph 26 above) should appoint a person or persons to take day to day managerial responsibility and to provide supervision for the implementation of precautions 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 structure and policy in the organisation.

Inadequate management, lack of training and poor communication have all been identified as contributory factors in outbreaks of legionnaires' disease. Persons who carry out the assessment and who draw up and implement precautionary measures should have such ability, experience, instruction, information, training and resources as to allow 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;
c) measures to be taken to ensure that controls remain effective, and their significance.

Where the above expertise is not possessed by the person or persons appointed under paragraph 28, it may be necessary to enlist help and support from outside the organisation. In such circumstances, the person or persons appointed under paragraph 28 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.

Management and communication procedures should be periodically reviewed as appropriate.

29. Competence

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 that ensures that tasks undertaken are carried out in a safe, technically competent manner. Regular refresher training should be undertaken and records of all initial and refresher training need to be maintained. Although training is an essential component of competence, it is not the only component - it is a product of sufficient training, experience, knowledge and other qualities that are required to undertake a job safely. Competence is dependent on the needs of the situation and the nature of the risks involved.

30. Implementation of the control scheme

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

Arrangements should be made to ensure that appropriate staff levels are maintained during all hours when complex water systems are in operation. The precise requirements will depend on the nature and complexity of the water system. Appropriate provision should be made to ensure that the responsible person or an authorised deputy can be contacted at all times.

Call out arrangements for persons engaged in the management of water systems that operate automatically need to be similarly maintained. 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.

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 the person who monitors 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.

The employment of contractors or consultants does not absolve the duty holder (as defined in paragraph 26 above) 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.

31. Preventing or controlling the risk from exposure to legionella bacteria

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.

The scheme should specify measures to be taken to ensure that it remains effective, together with remedial action required in the event that the scheme is shown not to be effective. The scheme should include:

a) the 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) the checks to be carried out to ensure efficacy of scheme and the frequency of such checks.

The primary objective should be to avoid conditions that permit legionella bacteria to proliferate and to avoid creating a spray or aerosol. If it is practicable to prevent a risk by replacing a piece of equipment that presents a risk with one that does not, this should be done.

In general, proliferation of legionella bacteria may be avoided by:
a) avoiding water temperatures between 20°C and 50°C. Water temperature is a particularly important factor in controlling the risks and water should be either below 20°C or above 50°C;
b) avoiding water stagnation. Stagnation may encourage the growth of biofilm (slimes that form on surfaces in contact with water) which can harbour legionella bacteria and provide local conditions that encourage its growth;
c) avoiding the use of materials in the system that can harbour or provide nutrients for bacteria and other organisms e.g. natural rubber washers and hoses;
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.

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, together with measurement methods and sampling locations, test frequencies and procedures for maintaining consistency;
e) remedial measures to be taken in the event that the control limits are exceeded including lines of communication;
f) cleaning and disinfection procedures.

There should also be a description of 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 the event of system malfunction;
d) maintenance requirements and frequencies;
e) operating cycles - to include when the system plant is in use or idle.

32. Review of control measures - monitoring and routine inspection

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;
c) monitoring to ensure that the treatment regime continues to control to the required standard.

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

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 e.g., a water treatment company or consultant, or else 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.

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 undertaken for cooling towers and spa pools rather than hot and cold water systems. Periodic sampling and testing for the presence of legionella bacteria may also be appropriate as an indication 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.

A suitably experienced and competent person should interpret the results of monitoring and testing. Where necessary, any remedial measures should be carried out promptly.

33. External audit

An external competent person should audit the risk assessment and operation of the control measures periodically (at least every two years).

34. Record keeping

The person or persons appointed under paragraph 32 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 31 and details of its implementation;
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, i.e. in use / not in use.

Records kept in accordance with paragraph 33 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 33 (d) should be retained for at least five years.

35. Responsibilities of manufacturers, suppliers and installers

Outbreaks of legionnaires' disease have been associated with faulty installation of equipment used in hotels (18). 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;
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.

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 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;
e) ensure that their staff have the necessary ability, experience, instruction, information, training and resources to carry out their tasks competently and safely.

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

Part 4

Methods for the Investigation and Control of an Outbreak of Legionnaires' Disease in an Hotel or other Accommodation Site

General – competent persons

The appropriate health authorities, in accordance with national arrangements for communicable disease control should investigate each outbreak. Sampling and microbiological analysis should be carried out by a laboratory that is accredited for the detection of *Legionella* species from environmental samples and capable of the recognition of *Legionella* species and serogroups. It is recommended that the engineer responsible for maintenance and operation of the water systems, assist in the sampling. The laboratory findings should be interpreted by a microbiologist experienced in the microbiology of water systems and the detection and ecology of *Legionella* species.

36. Sampling

Safety measures

Persons taking the samples should follow the recommendations given in paragraph 1.A22 in Supplement 1A of these guidelines.

37. Sampling the hotel's water systems

Aim

Confirmation or exclusion of the hotel as a source of infection

Objectives

- Risk assessment of the hotel water systems
- Distinguishing between local and systemic colonisation of the water systems
- Identification of sites of highest risk
- To check the regulation of the temperature, pressure and flows in the plumbing system
- Selection of the right strategy for the short term control of legionella
- Proposal for the long term control strategy for the whole facility

Sample sites should be chosen to be representative of the whole water system. The piping plans should be consulted prior to selecting the sample points.

Distribution of sites to be sampled:

1. systemic	incoming cold water to the facility hot water leaving the water heater circulating hot water returning to the heater
2. basic	the outlet nearest to the entry of the hot water into the facility the most distal sites within the distribution system the hotel room where the infected guest was accommodated
3. complementary systems	guest rooms on different floors to be representative of the different loops of the distribution

38. How to sample

Collect one litre samples in sterile containers containing sufficient sodium thiosulphate to neutralise any chlorine or other oxidising biocide. The temperatures are measured using a calibrated thermometer, placed in the middle of the water stream.

Systemic points
Samples are collected in the boiler room from the discharge valves of the hot water outgoing pipeline, return water and cold water to be heated. If hot water storage heaters are installed, samples from the sludge drain valves should also be collected. If there are no suitable sample points representative of the water in the heater, the water flowing from the heater and the flow returning to the heater this fact should be recorded.

Basic and complementary points

Hot water
Collect the water discharging from the tap immediately after it is switched on. This "immediate" sample will be representative of the colonisation of the outlet. Leave the water running for at least a further 60 seconds, measure the temperature and collect a second sample, the "post flush sample", which will be more representative of the water flowing in the system.

Swabs - sample the inner walls of showerheads and handles with a sterile cotton swab using a rotating motion. Sample shower hoses at the point where it is attached to the fitting. Swabs should be transported in 0.5-1.0 ml of the same residual water.

Sieves on mixer valves – remove the sieves and culture any deposit within them.

Cold water
Collect an immediate sample as for the hot water, then leave the water running for two minutes and before measuring the temperature of the flowing water. Finally collect a post-flush sample. When the water temperature is < 20^{o}C, the number of samples can be reduced.

Water closet cisterns
These should not be overlooked as potential sources of infection as they can become heavily colonised if the ambient temperature is high. Collect water samples directly from the cistern using a clean sterile container.

Cooling towers
If suitable sample points are available collect a sample from the water returning to the cooling tower in addition to a sample from the cooling tower pond, as far away from the fresh water inlet as possible. Collect samples of 200ml to 1000ml.

Spa pools
Collect water samples of 1000ml from the pool, filter housing and balance tank where fitted. In some investigations water from the pool has yielded few legionellae at the time of sampling although filter material and biofilm from inside the pipes contained large quantities of legionellae. This probably reflected the type and positioning of the biocide treatment and zones within the piping where the biocidal effect did not penetrate adequately. Therefore, it is also important to inspect the air and water circulation pipes and hoses for the presence of biofilm containing legionellae. Biofilm samples should be collected with swabs from the inside of some sections of these pipes. It is sometimes possible to do this by removing a jet but quite often sections of pipe will have to be cut out to gain adequate access.

Air washers and humidifiers.
Collect samples of at least 200ml directly from the source.

Decorative fountains
Collect samples of at least one litre.

39. Sample transport and laboratory processing

Samples must be kept at ambient temperature and protected from direct light. Water and swabs should be processed on the day of collection or the next day when stored at a refrigerator temperature (ISO 11731 (18)). Do not freeze samples.

During the sampling, all details that may help the implementation of possible remedial measures should be recorded. For example, obvious pressure and tehmperature drops or rises in the water circuits, the presence of iron sediment or sludge, the condition of aerator and taps, the occurrence of scale, and the presence of various rubber and plastic attachments.

Warning: It is important to follow the sampling procedure. Incorrectly collected samples make interpretation of the results difficult

40. Emergency action

Emergency control measures must be carried out as soon as possible after the outbreak has been recognised but not before samples have been collected. Non-essential equipment such as spa pools and cooling towers associated with air conditioning systems can be rendered safe by switching them off until samples can be collected and remedial measures implemented. A risk assessment should be carried out and emergency control measures implemented. The exact choice of measures will depend on the risk assessment and any available epidemiological evidence. The measures will usually involve disinfection of potential sources by high levels of chlorine or another oxidising biocide, cleaning of tanks and water heaters and raising the circulating hot water temperature if this is below 60C. The potential control measures are discussed more fully elsewhere in this document (see Supplement Part A and B).

41. Long term remedial measures

The selection of the long-term remedial measures must be based on a thorough risk assessment combined with any epidemiological information available. Effective long- term control depends on the rigorous adherence to the control measures. The measures will probably be a combination of those described elsewhere in this document. They are likely to require engineering modifications to the existing water systems as well as improvements in monitoring controls, management and staff training.

Part 5

Glossary

Adiabatic	Process in which there is no transfer of heat into or out of the system in question (thermodynamics)
Aerosol	A suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having negligible falling velocity
Algae	Small, usually aquatic, plants which require 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 system (CWS)	Cold water service of system. 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 know as cycle of concentration. Usually determined by comparison of either the chloride or magnesium hardness concentration
Corrosion inhibitors	chemicals which protect metals by: (i) passivating the metal by the promotion of a thin metal oxide film (anodic inhibitors); or (ii) 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 microbial colonies resulting are estimated by reference to 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 system (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 **legionellae**
Legionella	A genus of aerobic bacteria that belongs to the family Legionellaceae and has over 42 species. These are ubiquitous in the environment and found in a wide spectrum of natural and artificial collections of predominantly warm water
legionella	A bacterium belonging to the genus ***Legionella*** (note the name is italicised when referring to the genus)
Legionellae	Plural of **legionella,** bacteria belonging to the genus ***Legionella***
L. pneumophila	The species of *Legionella* that most commonly causes **legionnaires' disease**
Legionellosis	Any illness caused by exposure to **legionellae**
Pontiac fever	An upper respiratory illness caused by **legionellae**, but less severe than **legionnaires' disease**
Make-up water	Water which is added to a cooling water system to compensate for wastage (e.g. 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 existing organic matter, e.g. 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 pathogens usually at high temperature

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 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 Sludge	A general term for soft mud-like deposits found on heat transfer surfaces or other important sections of a cooling system
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 living **micro-organisms** (per volume or area) in a given sample remembering that it only includes those organisms detectable by the particular method used
Risk assessment	Indentifying and assessing the risk from **legionellosis** from work activities and water sources on premises and determining any necessary precautionary measures

Supplement 1

Part A

Technical Guidelines for the Control and Prevention of Legionella in Water Systems

Supplement 1 provides the technical background to the control measures commonly applied to hot and cold water systems and cooling systems, including features of the design and construction, management of the systems during commissioning and re-commissioning and normal operation. Supplement 1 is mainly based on technical recommendations contained in the UK Health and Safety Commission Legionella Guidelines published in December 2000(1). It should therefore be regarded as one example of good practice, and may not be entirely consistent with guidance produced in some other European countries because of legal requirements or constraints within individual countries. Although it is a supplement to the main European guidance, it is nevertheless a useful model to follow.

1.A1 Hot and cold water systems

There are a variety of systems available to supply hot and cold water services:

Pressurised system

The rising main is connected directly to the water heater. A double non-return valve on the cold feed to the water heater provides back-flow protection. 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 systems, which are normally fitted in large buildings, and non-recirculation systems, which are normally found in dwellings and some small buildings. In recirculating systems there is a continuous circulation of hot water from the water heater around the distribution circuit and back to the heater. The purpose of this is to ensure that hot water is quickly available at any of the taps, independent of their distance from the storage water heater.

Gravity system

Cold water enters the building from a rising main and is stored in an intermediate cold water tank. The cold water storage tank provides back-flow protection to the mains supply and a stable pressure in the system. Cold water from this storage tank is fed to the water heater where it is heated. The hot water system can be recirculating or non-recirculating.

Hot water systems present the greatest risk in environments that allow the proliferation of legionella. For example:

- at the base of storage water heaters where the incoming cold water merges with the existing hot water;
- water held in pipes between a recirculating hot water supply and an outlet (e.g. tap or shower) particularly when not in use as they may not be exposed to biocides and high temperatures.

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 in cold water systems and the distribution pipe-work when there are increased temperatures (e.g. due to heat gain), appropriate nutrients and stagnation.

Some of the features of gravity hot water systems that increase 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. 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.

1.A2 Design and construction

Hot and cold water storage systems in commercial buildings are often over sized relative 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 then this should be organised in a modular fashion. This enables additional plant to be added at a later stage if required.

Water service systems have to comply with the national regulations.

Hot and cold water systems should be designed to aid safe operation by preventing or controlling conditions which permit the growth of legionella and which allow easy cleaning and disinfection. In particular, the following 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 for use in water systems should be known not to support microbial growth;

b) water storage tanks should be fitted with covers which comply with the national water regulations and insect screens fitted to any pipework open to the atmosphere, e.g. the overflow pipe and vent;

c) multiple linked storage tanks should be avoided because of operational difficulties due to possible unequal flow rates and possible stagnation;

d) accumulator vessels on pressure boosted hot and cold water services should be fitted with diaphragms which are accessible for cleaning;

e) the use of point of use hot water generators, with minimal or no storage for remote low use outlets should be considered;

f) thermostatic mixing valves (TMV) if any are fitted, 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 pipe work should be kept as short as possible. Where a single TMV serves multiple showerheads, it is important to ensure that these showers are flushed frequently.

Hot water systems

The storage capacity and recovery rate of the water heater 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 storage water heater which allows for the increase in volume of the water should be of sufficient size and suitably sited on the water circuit to prevent hot water being discharged into the tundish.

Where more than one storage water-heater is used, they should be connected in parallel. If temperature is used as a means of control, each water-heater should deliver water at a temperature of at least 60°C. All storage water-heaters 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 storage water heater incorporates a non-return valve).

It should be possible to balance the flow of water throughout the hot water circuit by adjusting regulating valves to ensure that the target temperature is achieved throughout the system under all levels of water consumption.

If temperature is used as the means of controlling legionella, the hot water circulating loop should be designed ideally to give a return temperature to the storage water heater of 55°C but certainly not less than 50°C. The pipe branches to the individual hot taps should be of sufficient size to enable the water in each of the hot taps ideally to reach 55°C, but certainly not less than 50°C, within one minute of turning on the tap. Thermometer/immersion pockets should be fitted on the flow and return to the storage water heater and in the base of the storage water heater in addition to those required for control.

In larger storage water heaters, the fitting of time controlled shunt pumps should be considered to overcome temperature stratification of stored water.

Hot water distribution pipes should be insulated sufficiently not to affect cold water pipes.

Cold water systems

Access hatches should be provided on cold water tanks for inlet valve maintenance, inspection and cleaning (more than one hatch may be needed on large tanks).

The volume of cold water stored should be minimised and 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.

The cold water storage tank should be sited in a cool place and protected 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 pipe work should be easy to inspect so that the thermal insulation can be checked to see that it is in position and has remained undisturbed.

1.A3 Management of hot and cold water systems

Commissioning and re-commissioning

Following the commissioning of a new hot water system, the water temperature should be measured continuously at the bottom and the outlet of the storage water heater over a typical day. If the storage vessel is of sufficient capacity to deal with the demand then the outlet temperature should not fall below 50°C for more than 20 minutes in a day. If the storage water heater is undersized then 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.

If a storage water heater or any substantial part of a hot water system is on standby use or has been taken out of service for longer than one week, then the water in the storage water-heater should be brought up to 60°C for one hour before being used; this should be measured with circulating pumps operating normally and not with the system in a stagnant state. If there are standby recirculating pumps on the hot water circuits, then 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 throughout the system before being used.

1.A4 Operation

Cold water

Cold water from the water utility is usually delivered to consumer buildings with a trace of active chlorine disinfectant and in a potable state to the customer but 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 equivalent quality to the mains supply.

The Council Directive 98/83/EC on The Quality Of Water Intended For Human Consumption permits water to be supplied 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 could be found and removed. If this is not possible, the risk assessment should reflect this increased risk and appropriate action taken if necessary.

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 storage water heater. Storage water heaters heated directly by gas or oil flame have been shown to have the lowest incidence of colonisation by legionella. The storage water heater can also be heated by electricity or by means of an electric immersion heater within the vessel.

In a hot water system, cold water enters at the base of the storage water heater 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 storage water heater should be fitted to the storage water heater near the top and adjusted so that the outlet water temperature is constant. The water temperature at the base of the storage water heater (i.e. 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 storage water heater, 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 storage water heater heat source) and is usually arranged during a period of low demand e.g. during the early hours of the morning. A shunt pump to move hot water from the top of the storage water heater to the base is one way of achieving this - in all cases the operation of the pump should be controlled by a time clock.

Alternatively, some storage water-heaters 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.

Ideally the storage water heater will have specific connections for the shunt pump return, as low down on the storage water heater as possible.

Maintenance

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 storage water heater at temperatures greater than 60°C. It is recommended that an inspection port be fitted in the side of the storage water heater so that the cleanliness of the base can be checked regularly and cleaned when needed.

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 incorporation of these units into routine use. Standby pumps should be changed over and used each week to avoid water stagnation. Standby storage water heaters should be emptied of water and there should be specified procedures in place to be followed before they are bought back into use.

Maintaining the cleanliness of water softeners and filters is important and best achieved 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

Before the following procedures are carried out, consideration should be given to the removal of infrequently used showers and taps. If they are removed then the redundant supply pipe work should be cut back, as far as possible, to a common supply, for example to the recirculating pipe work or the pipe work supplying a more frequently used upstream fitting.

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.

Where it is difficult to carry out weekly flushing, the stagnant and potentially contaminated water from within the shower/tap and associated deadleg 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, e.g. additional piping may be used to purge contaminated water to drain.

Treatment and control programmes

It is essential that system cleanliness is achieved and maintained 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.

Different treatment methods are detailed in Supplement 1B.

Monitoring the temperature regime

It is recommended that hot water should be stored at 60°C and distributed such that a temperature of at least 50°C and preferably 55°C is achieved 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 persons but the risk increases rapidly with higher temperatures and for longer exposure times. The difference between the highest and lowest temperatures recorded at the taps after one minute should not be greater than 4°C. A wider difference may indicate inadequate flow, a poorly balanced system, a lack of insulation or backflow of cold water into the hot system.

In addition to the routine monitoring and inspection when using temperature as a control regime, the following checks should also be carried out and appropriate remedial action taken if necessary (Table 1).

Table 1: 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 or less 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 i.e. the loop is functioning as required
	If fitted, input to thermostatic mixer valves (TMV) 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 the water heater		Outgoing water should be at least 60°C, return at least 50°C	If fitted, the thermometer pocket at the top of the hot water storage heater 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		The most convenient place to measure is usually at the ball valve outlet to the cold water storage tank
Six monthly	Representative number of taps on a rotational basis	The water temperature should be 20°C or less after running the water for two minutes	The water temperature should be at least 50°C within a minute of running the water. The difference between the highest and lowest temp recorded at the taps after one minute should not be greater than 10 °C	This check makes sure that the whole system is working properly

1.A5 Biocide treatments

Where biocides are used to treat water systems they, like the temperature regime, will require meticulous control if they are to be equally effective. It is recommended that the control system be checked at least weekly to ensure that it is operating correctly and continuing to control legionella.

Monitoring oxidising biocides (chlorine, chlorine dioxide)

For most systems routine inspection and maintenance will usually be sufficient to ensure control (see paragraph 1.6A) if the following areas are checked at regular intervals and appropriate remedial action taken when necessary, with details of all actions being recorded. These include:

a) the quantity of chemicals in the reservoir;
b) the rate of addition of the agent to the water supply;
c) on a monthly basis, the concentration of the agent should be measured at the sentinel taps;
d) on an annual basis, the agent concentration at a representative number of outlets.

Monitoring ionisation

For most systems routine inspection and maintenance will usually be sufficient to ensure control if the following parameters are also monitored at regular intervals and appropriate remedial action taken when necessary, with details of all actions being recorded. These include:

a) the rate of release of ions into the water supply;
b) the silver ion concentrations at a small number of sentinel outlets, should be checked at least quarterly;
c) the measurement of silver ion concentrations at representative taps selected on a rotational basis once each year;
d) the condition and cleanliness of the electrodes when fitted should be checked at least monthly unless an anti-scaling type of electrode cell is employed;
e) the pH of the water supply along with the other analyses.

Unless automatic controls are employed, fluctuations in concentrations of treatment may occur and therefore it is advisable to regularly check the concentrations of both silver and copper ions.

1.A6 General monitoring

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.

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, hot water

storage heaters and relevant items of plant, especially water softeners, filters, strainers, pumps and all water outlets.

Annual check

This should comprise:

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 stagnation is not occurring. Whenever the building use pattern changes, this measurement should be repeated;
c) draining the hot water storage heater and checking for debris in the base of the vessel. The hot water storage heater should then be cleaned if considered necessary;
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 should be noted. Any insulation should be checked to ensure that it remains intact. Any water outlets that are no longer used should be removed.

Microbiological monitoring

Routine microbiological monitoring of hot and cold water systems using dip slides or TVCs is **not** appropriate, since systems will be supplied with water of potable quality. In addition, these systems should be totally enclosed, i.e. they are not open to the elements and to significant external contamination (in the same way as cooling towers are).

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, in which case the system should be investigated fully.

Monitoring for legionella

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;

b) in systems where control levels of the treatment regime (e.g. temperature, biocide levels) are not being consistently achieved. In addition to carrying out a thorough review of the system and treatment regime, frequent samples e.g. weekly, should be taken until the system is bought back under control;
c) when an outbreak is suspected or has been identified.

Samples should be taken as follows:
a) cold water system - from the cold water storage tank and the furthest outlet from the tank;

b) hot water system - from the hot water storage heater outlet or the nearest tap to the hot water storage heater outlet plus the return supply to the hot water storage heater or nearest tap to that return supply. Samples should also be taken from the base of the hot water storage heater where drain valves have been fitted. The furthest outlet from the hot water storage heater should also be sampled.

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 ring main present in the building, taps on each ring (as described above) will need to be sampled. In order to be representative of the system as a whole, samples should be of circulated treated water and not be taken from temporarily stored water e.g. at TMV controlled taps and showers. These may require sampling but this should be determined by risk assessment e.g. where such fittings are used in areas where susceptible individuals may be exposed (see paragraph 1.4A for advice on flushing of such fittings):

Analysis of water samples for legionella should be carried by an accredited laboratory which takes part in an external quality assessment scheme for the isolation of legionella from water. The interpretation of any results should be carried out by experienced microbiologists.

Table 2 (below) gives guidance on action to be taken in the event of finding legionella in the water system.

Table 2: Action levels following legionella sampling in hot and cold water systems

Legionella bacteria (cfu/litre)	Action required
More than 1,000 but Less than 10,000	Either: (i) if only one or two samples are positive, system should be resampled. If a similar count is found again, then a review of the control measures and risk assessment should be carried out to identify any remedial actions; (ii) 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 10,000	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.

1.A7 Cleaning and disinfection

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;
b) if the system has been out of use for more than one month e.g. a hotel during the low season;
c) if the system or part of it has been substantially altered or entered for maintenance purposes in a manner which may lead to contamination;
d) during or following an outbreak or suspected outbreak of legionellosis.

Disinfection can be carried out by the use of chemical or thermal disinfection as described in Supplement 1B. It is preferable to use chemical disinfection. It is essential that the system is clean prior to disinfection and that all parts of the system are treated, not just those that are readily accessible.

1.A8 Cooling systems

There are a range of evaporative cooling systems available that 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.

1.A9 Cooling towers

There are two main types of evaporative cooling towers: mechanical draught and 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, 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. 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.

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. The cooling tower used will depend on the nature of the system duty.

1.A10 Evaporative condensers

Evaporative condensers 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.

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. Adiabatic cooling systems are increasingly used 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.

1.A11 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, control is typically 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.

1.A12 Design and construction

Cooling systems should be designed and constructed so as to control the release of drift, to aid safe operation, cleaning and disinfection.

1.A13 Management of cooling towers

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.

1.A14 Commissioning

Systems should be properly commissioned to ensure that they operate correctly 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 risk of exposure to legionella during normal operation of cooling systems also apply to the commissioning process.

1.A15 Operation

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 the water quality monitored. The whole system should be run long enough to thoroughly distribute treated water. If the system is out of use for a week to one month, in addition to the above, the water should be treated with biocide immediately on reuse.

If the system is out of use for more than one month, and there are continued management/monitoring arrangements in place, it should be kept full of treated water which should be checked for biocide levels and water quality and circulated once a week (see part 3 paragraph 32). 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 dessicant left in the system to reduce the effects of corrosion. Full recommissioning will be required before the system can be brought 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 effective levels of biocide are maintained at all times.

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.

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 the treatment is being applied. Irrespective of the dosing method, both the quantity and frequency of chemical application should be recorded, including:

a) the results of the monitoring and any action required and carried out;
b) normal control parameters;
c) limits, with corrective actions, for out of specification situations, or where plant operating conditions or make-up water quality have changed;
d) cleaning and disinfection procedures.

Where automatic controls are employed for chemical additions or to allow bleed-off, they should be checked over their full operating ranges. Where conductivity controls are used the conductivity cell should be regularly recalibrated.

1.A16 Maintenance

The operations manual should include a detailed maintenance schedule that 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 relevant operatives.

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.

1.A17 Treatment programmes

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.

There are a number of factors which will influence the effectiveness of any treatment programme: corrosion, scale formation, fouling and microbiological activity (see further discussion below).

All components of the treatment programme should preferably be dosed by pump or eductor (sometimes referred to as an ejector) systems or by a suitable halogen dosing system.

1.A18 Microbiological activity

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 as protozoa, algae, fungi and bacteria, including legionellae. Both surface adhering (sessile) and free flowing (planktonic) bacteria need to be controlled for a complete and effective treatment programme. Methods of treatment are detailed in Supplement 1 Part B.

1.A19 Monitoring

General monitoring

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 2).

Many routine monitoring tasks can be performed in-house provided that the individuals are trained and competent. Any laboratory tests, such as culturing for legionellae should be performed by laboratories that are accredited for the tests in question.

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.

Table 3: 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

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 should be used as an indication of whether microbiological control is being achieved.

Table 4 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 number 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 assist in the monitoring of any trends.

Monitoring for legionellae

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 (Table 3), unless sampling is necessary for other reasons, such as to assist in identifying possible sources of the bacteria during outbreaks of legionnaires' disease. 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 (Table 4). More frequent sampling should be carried out when commissioning a system and establishing a treatment programme. The method of sampling and analysis should be in accordance with ISO 11731(19) and the biocide neutralised where possible. Samples should be taken as near to the heat source as possible. They should be tested by a laboratory accredited by their national accreditation body and participate in an 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.

Legionella bacteria are commonly found in almost all natural water sources, so sampling of water systems and services will often yield positive results. 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. The interpretation of any results should be carried out by experienced microbiologists.

Table 4: Action levels following microbial monitoring for cooling towers

Aerobic count * cfu/ml at 30^{o}C (minimum 48 hours incubation)	**Legionella bacteria cfu/litre ?**	**Action required**
10, 000 or less	1000 or less	System under control
more than 10,000 and up to 100,000	more than 1000 and up to 10,000	**Review programme operation** – The count should be confirmed by immediate resampling. 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
more than 100,000	more than 10,000	**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

* colony count determined by pour plate method according to ISO 6222(20) or by spread plate method on yeast extract agar

? determined in accordance with ISO 11731(19).

1.A20 Cleaning and disinfection

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.

Disinfection, cleaning and manual de-sludging of cooling towers should be undertaken at least twice a year, but more frequent cleaning may be necessary dependent 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 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 it is used correctly.

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);
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;
e) if microbiological monitoring indicates that there is a problem.

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 undertaken by the addition of either sodium hypochlorite solution or chloroisocyanurate compounds available as rapid release tablets to achieve a measured residual of 5mg/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.

The chlorinated water containing 5mg/l free chlorine should be circulated through the system for a period of five hours with the fan off, maintaining a minimum of 5mg/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 15-20mg/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 dechlorinated and drained.

Cleaning

Manual cleaning operations can then be undertaken, 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 to members of the public who may be in the vicinity during cleaning.

Cleaning staff who carry out water jetting should wear suitable respiratory protective equipment such as a positive pressure respirator with full face piece 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).

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, then routine inspection and testing of water quality should be particularly thorough.

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

Post-cleaning disinfection
On completion of the cleaning operation, the system should be refilled and chlorinated to maintain a minimum level of 5mg/l of free chlorine for a period of five hours with the fan off. This needs to be checked hourly to ensure a concentration of 5mg/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 dechlorinated, drained, flushed and refilled with fresh water and dosed with the appropriate start-up level of treatment chemicals, including the biocides.

Whilst the maintenance of a continuous minimum residual of 5mg/l of free chlorine for a minimum period of five hours is considered the best practice, where 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, e.g. 50mg/l for one hour or 25mg/l for two hours. This should only be undertaken 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 dechlorinated, drained, flushed and refilled with fresh water and dosed with the appropriate start-up level of treatment chemicals, including the biocides.

Before water containing high residual free chlorine is discharged to drain, it may need to be dechlorinated to comply with local environmental standards or prevent damage to sewage works.

1.A21 Other risk systems
There are a number of other systems (which produce aerosols) which may pose a risk of exposure to legionella. These include:

Spa pools
A spa pool (also known as a spa bath, whirlpool spa and commonly known as a Jacuzzi - a trade name) 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 than 30°C and the deliberate agitation creates a spray or aerosol above the surface of the water. Spa pools are a recognised cause of legionnaires' disease. Spa pools can be a risk even when not being used by bathers, for example when being run for display purposes. 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. Whirlpool

baths (baths fitted with high velocity water jets and/or air injection but without water recirculation) do not present the same risk as spa pools because the water is discharged after each use.

At least half the water in the spa pool should be replaced each day. The pools should be fitted with a sand filter of the type fitted to swimming pools and this should be backwashed each day. The turnover time (the time taken for the whole volume of the system to cycle through the filter and back to the pool) should be six minutes. Paper or polyester filters should not be used. The pool should be treated automatically and continually with an oxidising biocide ideally injected prior to the filter. Hand dosing must not be use except in an emergency. Where chlorinating disinfectants are used a free chlorine residual of 3 - 5 mg/l should be maintained in the spa water. The pumps and disinfection system should be left operating 24 hours per day. The residual disinfectant concentration and pH should be measured before use and every two hours during use. Pool waters should be tested microbiologically once a month. The colony count at 37^0C should be less than 100cfu/ml and preferably less than 10cfu/ml; there should be <10cfu *Pseudomonas aeruginosa* per 100ml and there should be no coliforms or *Escherichia coli* in 100ml. Pools on display in retail outlets should be treated in the same manner as if they were being used. Details on the maintenance of spa pools are given in the booklet *"Hygiene for Spa Pools"* (21).

Humidifiers and air washers

Atomising humidifiers, ultrasonic misters/humidifiers and spray-type air washers may use water from reservoirs or tanks where the water temperature exceeds 20°C. Misters/ humidifiers are increasingly used in food display cabinets in supermarkets and some hotels and have been associated with outbreaks. 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, i.e. steam humidifiers.

The actions that need to be taken with regard to these and other risk systems are detailed in Checklist 3. In general, these systems 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 e.g. fire mains and the cold water system.

1.A22 Protection of personnel

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

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 that 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.

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 consequently resistance to air can increase with consequent discomfort to the operator.

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 can be obtained from The Selection, Use and Maintenance of Respiratory Protective Equipment - a Practical Guide (22).

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 3
	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 3 monthly, according to risk (See Table 3)
	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	6 monthly

Checklist 2: Hot & cold water services

Service	Task	Frequency
Hot water services	Arrange for samples to be taken from hot water water heaters, in order to note condition of drain water	Annually
	Check temperatures in flow and return at calorifiers	Monthly
	Check water temperature up to 1 minute to see if it has reached 50°C in the sentinel taps	Monthly
	Visual check on internal surfaces of water heaters 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	6 monthly
	Check that temperature is below 20°C after running the water for up to 2 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	Weekly

Checklist 3: Other risk systems

System/service	Task	Frequency
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	6 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	6 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	6 monthly
Spa baths	Check filters – sand filters should be backwashed daily	Daily
	Check water treatment - pools should be continuously treated with an oxidising biocide	3 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
Fountains and water features (particularly indoors)	Clean and disinfect ponds, spray heads and make-up tanks including all wetted surfaces, descaling as necessary	Interval depending on condition

Supplement 1

Part B

Treatment Methods

1.B1 Cooling systems

Biocides

Biocides are used for the long-term control of microbiological activity in cooling systems, and can be oxidising or non-oxidising. The frequency and quantity of additions will depend on the microbiological activity of the system.

Biocides have been shown to be effective in preventing the proliferation of legionella when applied and controlled as part of a comprehensive water treatment programme. 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;
b) adherence at all times to the recommended application, monitoring and control procedures.

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.

Specific surfactants (biodispersants) function by wetting biofilms and aiding penetration of the biocides into them. In microbiologically dirty systems that 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.

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. Where a biocide has been selected specifically for control of legionella the supplier should be able to present test data to demonstrate its efficacy.

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. This 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, depending 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.

Oxidising biocides are also used for disinfection either in emergency or as part of the routine cleaning programme. For disinfection, much higher doses of up to 50 mg/l may be used.

Oxidising biocides have the advantage that they can be readily monitored by simple chemical tests that can be performed on site, are relatively cheap and are easy to neutralise for microbiological monitoring and disposal. Their major disadvantage is that they can be corrosive and their activity, particularly for chlorine, is pH dependent.

Non-oxidising biocides

Non-oxidising biocides are generally more stable and longer lasting than oxidising biocides. However, 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 that 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;
- effluent constraints.

Ionisation

"Ionisation" is the term given to the electrolytic generation of copper and silver ions for use as a water treatment. Metals such as copper and silver are well known bactericidal agents. They act on the cell wall of the micro-organism that alters the cells permeability which, together with protein denaturisation, lead to cell lysis and death.

Copper and silver ions are generated electrolytically and their concentration in the water depends on the power applied to the electrodes. 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 then silver ion concentrations between 30 to 20 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.

The application of ionisation will need to be properly assessed, designed and maintained as part of an overall water treatment programme. The national water regulations may prescribe a maximum value for the level of copper and silver ions in potable 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.

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, unless anti-scaling electrode cells are employed. High concentrations of dissolved solids may precipitate 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 require additional water treatments.

The method is easy to apply and is not affected by the temperature of the water. However because the system is subject to fluctuations in concentration unless automatic controls are employed, it is necessary to check the concentration of the two metals regularly, as well as the pH of the water at 6-8. This technique is not suitable for systems that employ zinc cathodic protection for water systems because the metal deactivates silver ions. Furthermore, if the treatment is used continuously it is necessary to check that the maximum permissible concentration (CMA) laid down by current legislation for drinking water is not exceeded.

1.B2 Hot water systems

Thermal shock

Thermal shock treatment at 70-80ºC for relatively short periods has been used both for emergency disinfection, and also for periodic disinfection of systems, as part of long-term control programmes.

Thermal disinfection is carried out by raising the temperature of the whole of the contents of the hot water storage heater to 70-80°C then circulating this water throughout the system for up to three days. To be effective, the temperature at the hot water storage heater should be high enough to ensure that the temperatures at the taps and appliances do not fall below 65°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. Some authors recommend emptying the hot water tanks in advance, cleaning them and decontaminating them with chlorine (50 mg/l for one hour or an equivalent) but this may cause corrosion.

It is essential to check that during the procedure, the temperature of the water in distal points reaches or exceeds 65°C.

At the end of the procedure, samples of water and sediment should be collected at distal points of the installation and examined for legionellae. If the result is unsatisfactory, the procedure must be repeated until documented decontamination is achieved. Following decontamination, microbiological checks must be repeated periodically.

Thermal treatment has the advantages that no particular equipment is required so that the procedure can be carried out immediately, provided there is sufficient heat capacity in the system. However the procedure requires considerable energy and manpower and is not normally practical for large buildings but may be suitable for small systems. There is a severe risk of scalding at these temperatures. Although the numbers of legionellae may be reduced, recolonisation of the water system can occur from as little as a few weeks after treatment, particularly if it has not been accompanied by other remedial measures.

Constant maintenance of the temperature between 55-60°C

At 60°C it takes approximately two minutes to inactivate 90% of a population of *L. pneumophila.* The effectiveness of maintaining the circulating temperature at 60ºC has been demonstrated both in hospitals and in hotels. Hot water installations maintained at temperatures above 50°C are less frequently colonised by legionella. Circulating water at 60°C, such that the temperature at each outlet reaches at least 50ºC and preferably 55ºC within one minute of opening the outlet, is the method most commonly used to control legionella in hot water distribution systems. Although raising the temperature to a constant 60ºC has consistently been shown to control outbreaks it does not necessarily eliminate legionellae from the system but controls them at a level that prevents further cases. Provided there is sufficient heating capacity it is relatively easy to implement and is easy to monitor continuously. It has the possible disadvantage of increasing energy consumption and there is an increased risk of scalding.

Oxidising biocides

Chlorination

Chlorine has also been used for the treatment of hot water systems. As the bactericidal action of the chlorine is pH sensitive and decreases rapidly at values above 7 the pH of the water will have to be monitored and may need adjustment.

Shock hyperchlorination

This must be carried out in water at a temperature below 30°C, with a single addition of chlorine to the water to obtain concentrations of free residual chlorine of 20-50 mg/l throughout the installation, including distal points. After a contact period of at least two hours with 20 mg/l of chlorine or at least one hour with 50 mg/l of chlorine, the water is drained. Fresh water is then let into the installation until the level of chlorine returns to the concentration of 0.5-1 mg/l.

Continuous chlorination
This is achieved by the continuous addition of chlorine, usually in the form of calcium hypochlorite or sodium hypochlorite. Residual levels of chlorine can vary depending on the quality of the water, the flow, and the amount of the biofilm in the system. However the residual disinfectant must be between one and two mg/l. Where there are stagnant areas or circulation problems in the water distribution system, the chlorine will not inactivate legionella in these areas.

Although continuous chlorination has been used as a means of control in hot water systems, it is difficult to maintain the required levels of chlorine as it volatilises off from hot water. In addition chlorine is corrosive and this effect is increased with raised temperatures.

Alternative oxidising biocides
Chlorine dioxide
Chlorine dioxide has been successfully used to control legionellae in some hot water systems and can be used in the same manner as chlorine. It has the advantage that it is not as volatile at high temperatures as chlorine and is said to be more active on biofilms.

Monochloramine
There is some evidence that hospitals receiving water that has been treated with monochloramine rather than chlorine are less likely to have outbreaks of legionnaires' disease and are less colonised with legionellae. It is possible that treating hot water systems with monochloramine may prove more effective than chlorine. Monochloramine is more slow acting than chlorine but persists longer and is therefore said to be more effective against biofilms.

Hydrogen peroxide and silver
Treatment is carried out using a stable concentrated solution of hydrogen peroxide (oxygenated water) and silver, exploiting the bactericidal action of each of the two components and the synergy between them. The technique is relatively recent and requires further experimental confirmation.

Ultra violet (UV) radiation
Irradiation with ultraviolet light is an alternative method for the disinfection of drinking water. Ultraviolet light (254 nn) inactivates bacteria by producing thymine dimers in their DNA that inhibit replication. The application of ultra-violet light is a method of disinfection that has proven effective close to the point of use. The thermal shock and chlorination methods can be used prior to application of ultraviolet light to control legionella present in the system. UV equipment is relatively easy to install and has no adverse effects on the taste or potability of the water and does not damage piping. The technique is not suitable as the only method for an entire building or water system because there is no residual effect, and legionella remains in the biofilms, dead ends and stagnant areas of the system.

1.B3 Cold water systems

Oxidising biocides are the most widely used method of controlling legionellae in cold water systems. Chlorine, monochloramine and chlorine dioxide can all be used although chlorine has been most widely applied. If the water is to be used for drinking it is important to ensure that the national drinking water regulations are complied with. The maximum concentration permissible will usually be 0.5mg/l.

1.B4 Spa pools

It is imperative that spa pools are rigorously maintained. The water should be continuously filtered and treated continuously with chlorine or bromine to provide a residual concentration of 1 - 2 mg/l of chlorine or 2 - 3 mg/l of bromine. Public spa pools should be equipped with a sand filter of the type used for swimming pools and this should be back-washed each day. At least half the water should also be replaced each day. The water circulation and treatment system should be operated 24 hours a day. The residual concentration of chlorine or bromine should be measured several times a day. Spa pools on display should be treated in the same way as those used by bathers.

Supplement 1

Part C

References for National Guidelines for Control and Prevention of Legionnaires' Disease

Country	Name of document	Year	Publication
Belgium	Relatif aux dangers de et aux mesures préventives contre une contamination par Legionella en Belgique (C.S.H. : 4870)	Sept 2000	Conseil Supérieur d'Hygiène Brussels
	Recommandations Pour La Prevention Des Infections A Legionella Dans Les Etablissements De Soins N° CSH: 7509	January 2002	As above
Czech Republic	Metodicky navod k zajisteni programu surveillance legioneloz	2000	Ministerstvo Zdravoknictvi Praha
Denmark	Guidelines: Legionella	1998	Statens Serum Institut, Copenhagen
	En Vejledning: Legionella i varmt brugsvand. Overvågning, udbredelse og forebyggelse af legionærsygdom. ISBN 87-89148-25-8	2000	As above
France	Guide des bonnes pratique: Legionella et tours aéroréfrigeérantes	June 2001	Directorate-General of health, Paris
	Gestion du risque lié aux legionelles: Rapport du Conseil Supérieur d'Hygiène Publique de France	July 2001	As above
Germany	Drinking water heating systems and conduits; Technical measures to decrease legionella growth	1993	W 551 DVGW, Eschborn
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	Protection of Infection Act (IfSG) Act on Prevention and Control of Infectious Diseases in Man	July 2000	Federal Ministry of Health

Country	Name of document	Year	Publication
Ireland	The Management Of Legionnaires' Disease in Ireland	2002	National Disease Surveillance Centre, Dublin.
Italy	Linee - guida per la prevenzione ed il controllo della legionellosi	May 2000	Gazzetta Ufficiale della Repubblica Italiana, serie generale, n.103
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Portugal	Doença dos Legionários.Procedimentos de controlo nos empreendimentos turísticos	July 2001	Direcção Geral de Saúde e Direcção Geral de Turismo
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Country	Name of document	Year	Publication
Switzerland	Légionelles et légionellose. Particularités bioloqiques, épidémiologie, aspects cliniques, enquêtes environnementales, prévention et mesures de lutte.	1999	Office Fédéral de la Santé Publique, Berne
United Kingdom	Legionnaires' disease The control of legionella bacteria in water systems (L8)	2000	Health and Safety Commission
WHO	Guidelines For Safe Recreational-Water Environments. Vol. 2: Swimming pools, spas and similar recreational-water environments	August 2000	WHO Headquarters Geneva

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