Health and Safety Executive

Legionnaires' disease: Technical guidance

Part 2: The control of legionella bacteria in hot and cold water systems. Interim guidance

This online document is **interim guidance** for dutyholders with responsibility for hot and cold water systems. It is an extract from the third edition of L8, *Legionnaires' disease: The control of legionella bacteria water systems. Approved Code of Practice and guidance*. The third edition of L8 was replaced by a fourth edition in 2013. New guidance on hot and cold water systems will be published in 2014.

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Hot and cold water services

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

Box 4: Hot and cold water systems

Gravity system with recirculation

This is the type of system found in many commercial buildings (see Figure 5). Cold water enters the building from a rising main and is stored in an intermediate cold water tank. The cold water storage tank provides backflow protection to the mains supply and a stable pressure in the system. Cold water from this storage tank is fed to the calorifier where it is heated. There is a continuous circulation of hot water from the calorifier (storage heat exchanger) around the distribution circuit and back to the calorifier. The purpose of this is to ensure that hot water is quickly available at any of the taps, independent of their distance from the calorifier. The circulation pump is sized to compensate for the heat losses from the distribution circuit such that the return temperature to the calorifier is not less than 50°C. It does not depend on the projected hot water demand. The pump has little effect on the pressure at the tap which is determined by the relative height of the storage tank. If a heavy hot water demand occurs then water will flow directly to the point(s) of use via the non-return valve. The expansion of water as it is heated within the system is accommodated by a slight rise in the levels of the tank and vent pipe. Ideally the vent pipe should be linked to a separate tundish/drain or else to the cold water storage tank but it should not discharge water except under fault conditions. These design principles also apply where an electrically heated cylinder or direct fired storage water heater is used instead of a calorifier. In the cold water system, water is fed by gravity directly from the cold water storage tank to the points of use without recirculation.

Gravity system without recirculation

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

Pressurised systems

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

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

(a) at the base of calorifiers where the incoming cold water merges with the existing hot water. This water collects sedimented organic and mineral deposits which support bacterial growth, including legionella – this can then be distributed throughout the system to colonise its periphery, especially where optimum temperatures and stagnation occur eg in infrequently used outlets.
(b) water held in pipes between a recirculating hot water supply and an outlet (eg tap or shower) particularly when not in use, as they may not be exposed to biocides and high temperatures.

147 Water systems may occasionally be contaminated with legionella (usually in small numbers) which enter cold water storage systems from the mains supply. This presents little risk under normal circumstances. Legionella will only grow in cold water systems and the distribution pipework when there are increased temperatures (eg due to heat gain), appropriate nutrients and stagnation.

148 Cases of legionellosis have been reported in hospitals where water systems have been colonised by legionella. In addition, there have also been reports of infection when tap water was used to fill personal humidifiers and to wash jet nebulisers and other respiratory equipment. This, together with the presence of susceptible individuals, means that there may be an increased risk in health care premises and additional precautions may be needed.[1]

Substitution

149 Some of the features of gravity hot water systems which influence the risk of exposure to legionella, such as having open tanks and relatively large storage volumes, can be eliminated by moving to mains pressure systems. This requires confidence in the reliability and continuity of the mains supply and may not be acceptable in all cases. Other problems, such as the maintenance of water temperatures throughout the distribution system and changes in demand, can be simplified by changing to point-of-use water heaters with minimal or no storage. Guidance on the general principles and limitations of instantaneous water heaters is given in BS6700:1997.[2]

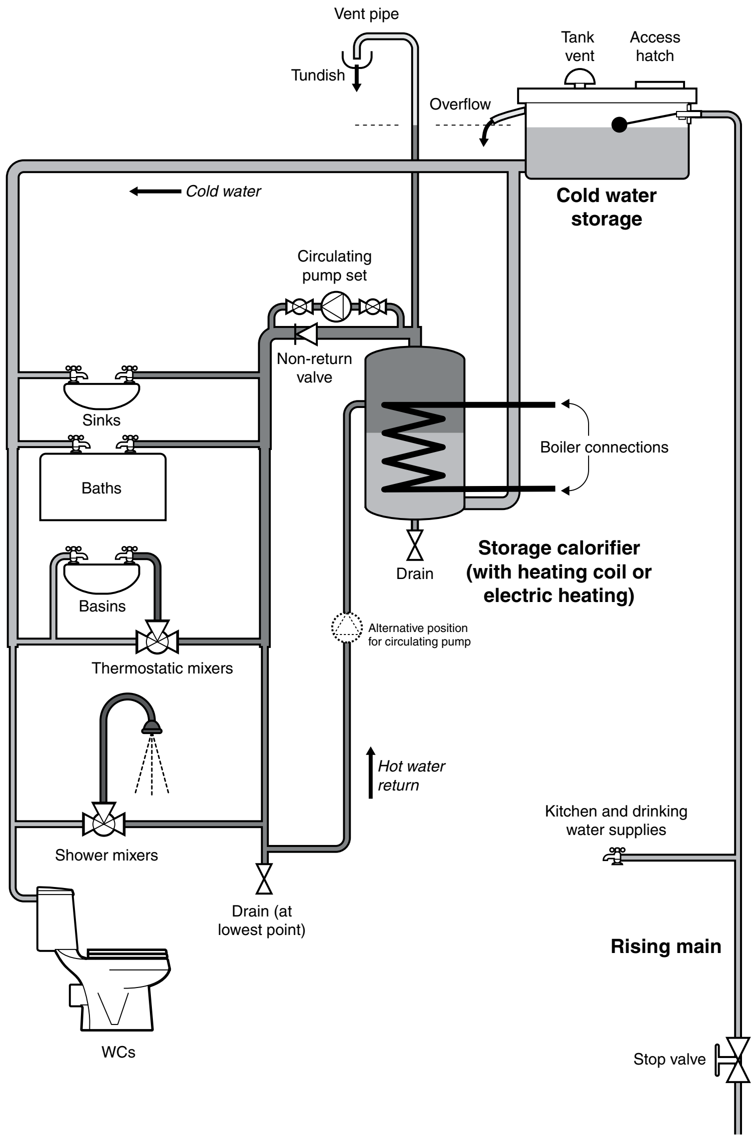
Design and construction

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

150 The overall choice of system depends on the size and configuration of the building and the needs of the occupants. A key issue is whether cold water storage is required and how much. Some activities (health care, catering etc) rely on the continuous availability of hot and cold water but others would not be severely disadvantaged by a short-term loss of supply. Hot and cold water storage systems in commercial buildings are often over-sized in relation to the actual usage because

of uncertainties in occupation at the design stage – this leads to excessive safety margins. If the design needs to allow for future growth in demand, this should be organised in a modular fashion. This enables additional plant to be added at a later stage if required (but see paragraph 152(d)).

Figure 5 Typical gravity system with recirculation



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

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

(a) Materials such as natural rubber, hemp, linseed oil-based jointing compounds and fibre washers should not be used in domestic water systems. Materials and fittings acceptable for use in water systems are listed in the directory published by the Water Research Centre.[3]

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

Hot water systems

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

Cold water systems

(a) Low-use outlets should be installed upstream of higher use outlets to maintain frequent flow; eg a safety shower can be installed upstream of a WC. Access ports should be provided on cold water tanks for inlet valve maintenance, inspection and cleaning (more than one hatch may be needed on large tanks).

(b) The volume of cold water stored should be minimised; it should not normally be greater than one day's water use. Multiple cold water storage tanks require care in the connecting piping to ensure that the water flows through each of the tanks, so avoiding stagnation in any one tank.

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

Management of hot and cold water systems

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

Commissioning and recommissioning

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

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

Operation

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

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

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

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

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

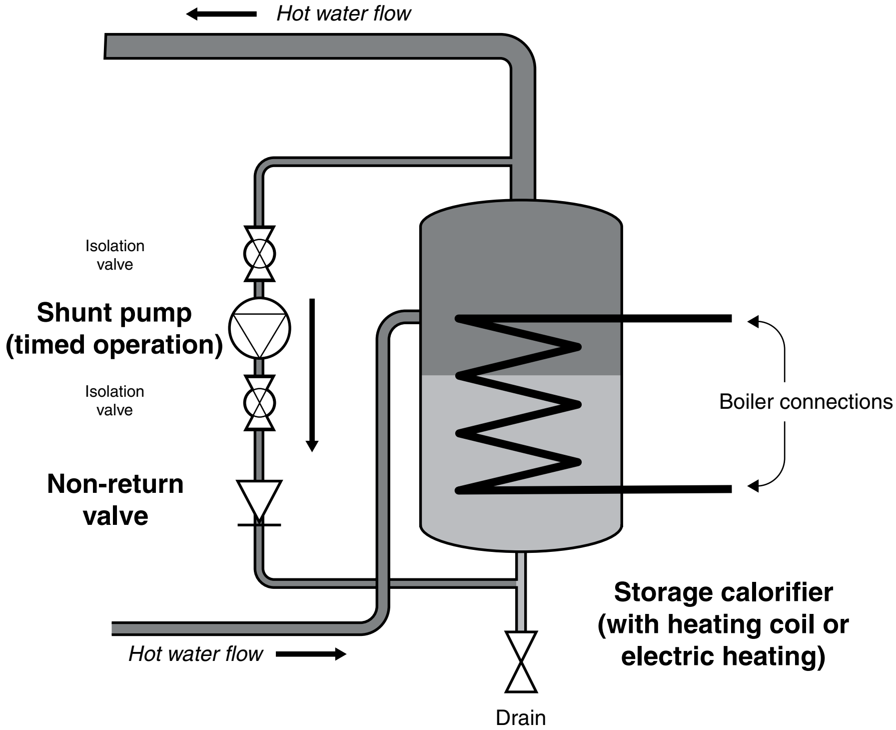
160 Ideally the calorifier will have specific connections for the shunt pump return, as low down on the calorifier as possible. For existing calorifiers without suitable connections, the drain point may sometimes be used (see Figure 6). This should not be done before cleaning and descaling of the calorifier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

Maintenance

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

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

Figure 6 Shunt pump for calorifier mixing



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

Regular flushing of showers and taps

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

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

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

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

Treatment and control programmes

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

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

Temperature regime

169 This is the traditional approach to legionella control. It is recommended that hot water should be stored at 60°C and distributed so that it reaches a temperature of 50°C within one minute at outlets. Care is needed to avoid much higher temperatures because of the risk of scalding. At 50°C the risk of scalding is small for most people but the risk increases rapidly with higher temperatures and for longer exposure times. However the risk, particularly to young children, or the handicapped or elderly, and to those with sensory loss will be greater.[4-6] Where a significant scalding risk has been identified, the use of TMVs on baths and showers should be considered to reduce temperature. These need to be placed as close to the point of use as possible.

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

Monitoring the temperature regime

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

Biocide treatments

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

Chlorine dioxide

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

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

Table 3: Monitoring the temperature control regime

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

Monitoring the chlorine dioxide regime

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

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

Ionisation

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

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

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

Monitoring the ionisation regime

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

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

Ozone and UV treatment

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

General monitoring

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

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

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

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

Annual check

182 This should comprise the following.

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

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

Microbiological monitoring

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

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

Monitoring for legionella

185 It is recommended that this should be carried out:

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

186 Samples should be taken as follows:

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

187 The complexity of the system will need to be taken into account in determining the appropriate number of samples to take. For example, if there is more than one ring main present in the building, taps on each ring (as described in paragraph 186)

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

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

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

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

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

Cleaning and disinfection

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

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

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

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

(a) by the use of suitable chemical disinfectants, eg by chlorination (see BS6700:1997) when it is necessary to disinfect the whole system including storage tanks; or
(b) by thermal disinfection, ie by raising water temperature to a level at which legionella will not survive.

Chemical disinfection

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

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

Thermal disinfection

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

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

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

References

1 *Water Systems: The control of legionella, hygiene, 'safe' hot water, cold water and drinking water systems. Part B: Operational management* HTM04-01 Department of Health 2006 ISBN 978 0 1132 2745 7

2 BS 6700:1997 has been superseded. See BS 8558:2001 *Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806* British Standards Institution

3 *Water fittings and materials directory* Water Regulations Advisory Scheme www.wras.co.uk/Directory

4 *Health and safety in care homes* HSG220 HSE Books 2001 ISBN 978 0 7176 2082 1 www.hse.gov.uk/pubns/books/hsg220.htm

5 '*Safe' hot water and surface temperatures* NHS Estates 1998 ISBN 978 0 1132 2158 5

6 *Hot and cold water supply, storage and distributions for healthcare premises* HTM04-01 Department of Health 2006 www.gov.uk

Acknowledgements

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Further information

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