GRADE 5 THESIS

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Water Management in Health Care, Design to Handover stage.

Contents

1.0 Introduction

The purpose of this Thesis is to examine the current guidelines on managing water systems in healthcare and the current legislations. I will elaborate on the methods of the water management for hot and cold water systems that are vital for public health.

Hot and cold water systems account for the majority of identified cases of Legionnaires' disease. Healthcare buildings are dependent on water to maintain hygiene, interruptions in the water supply can disrupt healthcare activities or cause a bacterial outbreak in the water systems.

The conclusion of the Thesis will give my thoughts on the best practice for handing over a hot and cold water system that is safe to use and traceable for the end user.

2.0 Background Information

Legionella is the name given to the genus of bacteria, which caused the condition commonly known as Legionnaires' disease. It was named after an outbreak of severe pneumonia that affected a meeting of the American Legion in 1976. It is an uncommon but serious disease. This is a form of pneumonia, which particularly affects those who are susceptible due to age, illness or smoking. People catch Legionnaires' disease by inhaling small droplets of water suspended in the air, which contain the bacteria.

The optimum laboratory temperature for the growth of *Legionella* is 37°C. For hot and cold water services Legionella bacteria may colonise plant, pipework and fittings, but the risk can be avoided by:

- Avoiding water temperatures between 20°C and 45°C
- Keeping hot water storage temperatures above 60°C
- Keeping hot water distribution pipework above 50°C
- Keeping cold water storage tanks and distribution pipework below 20°C
- Avoiding standing water by designing out dead legs.
- Avoiding materials that could promote bacterial growth.
- Keeping systems clean.
- Having a water treatment plan in place.

3.0 Client Requirements & Guidelines

Throughout the healthcare services within the UK, Health Technical Memorandum 04-01 “The control of Legionella, Hygiene, “safe” hot water, cold water and drinking water systems” is the current guideline for comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises.

The guideline HTM04-01 is also used for both new and old buildings and is applicable to construction projects.

HTM04-01 also refers to The Approved Code of Practice and guidance entitled ‘Legionnaires’ disease: The control of *Legionella* bacteria in water systems (L8)

The L8 Approved Code of Practice gives practical advice on the requirements of the risk from exposure to legionella bacteria. In particular it gives guidance on

(a) identify and assess sources of risk - this includes checking whether conditions are present which will encourage bacteria to multiply, eg is the water temperature between 20-45°C, there is a means of creating and disseminating breathable droplets, eg the aerosol created by a shower or cooling tower; and if there are susceptible people who may be exposed to the contaminated aerosols.

(b) Prepare a scheme for preventing or controlling the risk.

(c) Implement, manage and monitor precautions - if control measures are to remain effective, then regular monitoring of the systems and the control measures is essential.

(d) Keep records of the precautions.

(e) Appoint a person to be managerially responsible.

The L8 Code and guidance also set out the responsibilities of suppliers of services such as water treatment and maintenance as well as the responsibilities of manufacturers, importers, suppliers and installers.

During the construction phase of a healthcare project the following should be adhered too and documentation produced for handover.

- Design, Commissioning and treatment is in accordance with HTM04-01 & HSE L8
- Performance monitoring, is carried out throughout the construction phase up to handover.
- Commissioning data is full and comprehensive.
- Comprehensive operational and maintenance manuals.

4.0 Design Stage

During the design stage 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 in healthcare 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 healthcare 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.

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.

At design stage the following points should be considered:-

(a) Systems to be designed in accordance with the Water supply regulations.
(b) Water storage tank locations need to be installed in low temperature areas.
(c) The use of single point hot water heaters for remote or low use areas should be considered.
(d) Showers should be installed where they are likely to be used more than once a week.
(e) TMV's are installed as close as possible to the outlet.
(d) The hot water storage capacity and recovery rate of the calorifier should be designed to not drop in the supply temperature.
(e) Hot water return temperatures should be designed for 50°C or above.
(f) Low-use outlets should be installed upstream of higher use outlets to maintain frequent flow

Is there a need for the installation of a Chlorine dioxide water treatment plant? During my time spent on a recent large healthcare project it was found that the water quality being supplied to the site was not as per the HTM standards and an additional Chlorine dioxide water treatment plant was installed at mid point of the project.

At design stage consideration should be taken into account for commissioning of the systems, the use of Thermostatic balancing valves are recommended as to ensure the return loops are maintaining satisfactory temperatures over the older lock shield valve which only have manual adjustment. Pipework should be designed that the pipe runs are not installed through high temperature areas and ceiling voids. Cold water storage tanks are not installed in boiler rooms were temperatures are likely to be high and cause the cold water storage temperatures to raise when system demand is not high or at operational levels .

Also the design team should look into new technology, at present there are two manufactures which are developing thermostatic balancing valves similar to the hot water thermostatic balancing valves which will control and balance cold water return loops which will design out the risk of dead legs on the cold water pipework.

5.0 Installation

Continuous monitoring is required throughout the installation to ensure that:

(a) Materials and equipment installed comply with the Water Supply (Water Fittings) Regulations 1999 and other British Standards, and are not otherwise unsuitable. Equipment that is listed in the latest edition of the 'Water Fittings and Materials Directory' and installed in accordance with any of its relevant conditions.

(b) The work is done entirely within the specification for the project

(c) All the requirements of current legislation are met, both during construction of the installation and when it is completed, particularly with regard to the Health and Safety at Work Act 1974.

During the installation the system should be regularly checked during installation to ensure that open pipes, valve ends, cylinder connections etc are sealed to prevent the ingress of dust/debris that could cause problems during commissioning and post handover. Checks should also be made to ensure that fittings and materials comply with the Regulations and are those listed in the 'Water Fittings and Materials Directory', and that lead solders are not being used.

Systems should not be filled and left standing for any prolonged periods of time, phased handovers should be managed to ensure that systems which are completed are not put at risk during the testing and commissioning of the newly installed systems.

Draw off regimes should be put in place if systems are to be left standing for any prolonged period of times, as a rule of thumb a outlet should be drawn off for 2 minutes at least once a week, a method statement for this works will require to be submitted to the accepting authorities.

A typical water draw off regime Method Statement should identify the following points:-

(a) Staff training for the works to be carried out
(b) Site health & safety requirements
(c) Draw off regime process as follows :-
(1) Each outlet to have a dedicated reference, a barcode logging system for large systems is recommended.
(2) Record end of line BMS hot and cold water temperatures prior to the start of the work.
(3) Measure the cold water storage or mains cold water inlet temperature to ensure this is below 20°C
(4) Commence the draw off at the sentinel taps as agreed with the project management.
(5) Isolate hot water to tap's / showers / TMV's, cold water to be drawn through for 2 minutes and record the cold water temperature this should be <2.0°C of the cold water storage tank temperature and is less than 20°C.
(5) Open valves to the hot water, draw off taps / showers and measure the pipe surface temperature of the hot water prior to the thermostatic mixing valves after two minutes.
(6) Working back towards the tank, measure the next tap and repeat until all outlets have been measured.
(7) Toilets should be flushed when working through the above process but temperatures not recorded.
(8) Should there be any failures become apparent from the temperatures taken this should be logged and reported, it is important that if a failed temperature the outlet is run and time recorded until the required water temperature is achieved.
(9) Temperatures should be recorded and collaborated in a water log book.

6.0 Commissioning

Correct commissioning is vitally important for the satisfactory operation of the hot and cold Water systems. The designer should prepare a commissioning brief for use by the contractors commissioning engineer. This brief should specify fully and clearly the extent of the commissioning and the objectives which must be achieved, and should include:

(a) Full design data on temperatures, water flow rates and pressures.
(b) Plant and equipment data.
(c) Number commissioning procedures for thermostatic mixing valves in accordance with specification MES D08.
(d) Drawings and schematics.
(e) A list of test certificates to be provided.
(f) Commissioning Method statement.

The following is a summary of the key activities associated with pre-commissioning and commissioning of hot and cold water storage and distribution systems.

(a) Pre-commissioning checks can be carried out on completion of the system installation, filling and pressure testing.
(b) Systems have been provided and installed in accordance with specification and drawings, and that the systems are charged with water, pressure tested, vented and free from leaks.
(c) Regulating valves and flow control devices are installed at the correct locations.
(d) All taps, mixers and outlets operate satisfactorily, and test and record mass flow from outlets (TMVs require hot and cold water for testing and commissioning. Type 3 TMVs are commissioned in accordance with MES D08).
(e) BMS systems operate within the Description of operation, sensors are calibrated, system temperature settings are correct, remote and automatic control of pumps is satisfactory, calorifier commissioning is satisfactory.

Temperature tests should be performed prior to contractual handover and bringing the system into use. Separate thermostatic measuring and recording equipment should be used, that is, independent of any building management system. It will be necessary to have systems fully operational and to simulate typical draw-off of water.

Tests should include:

(a) Measuring the incoming water temperature at the main water meter;
(b) Testing the inlet, outlet and surface water temperatures of cisterns and cold water feed/ header tanks for the hot water calorifier. The temperature should not be greater than 2°C above that measured at the water storage tank or incoming main.
(c) Testing the flow and return temperatures at connections to calorifiers and water heaters. These should not be less than 60°C and 50°C respectively;
(d) Testing the temperature in branches of hot water circulating systems installed in all departments to ensure that the system has been balanced, and that under “no draw-off ” conditions 55°C is achieved in the circulating system at outlets furthermost from the calorifier/heater;
(e)Testing single hot water outlets and inlets to mixing valves to ensure that a minimum of 55°C is achieved within 1 min.

(f) Full load test on the system should be carried out, the design team will identify the system diversity, outlets should be run for a agreed length of time, temperatures recorded at outlets and main items of plant.
(g) Water flows from taps recorded.

7.0 Water treatment

Guidance on disinfection is given in BSRIA's (2004) Application Guide 1/2001.1: 'Pre commission cleaning of pipework systems', which contains recommendations for the design, installation, system-flushing and chemical cleaning of pipework systems. Disinfection should be applied to the complete hot and cold water service systems.

Chlorine dioxide is the most common used method for cleaning and disinfecting hot and cold water systems, Thermal disinfection can also be used by raising the water temperature above a level at which legionella will not survive >60°C.

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 chlorine shows at these points, then closing them and leaving it to stand for an appropriate period. This depends on chlorine concentration. The system should be thoroughly flushed following chlorination.

Legionella samples should be taken 2 or 3 days after chlorination has taken place and not directly after the chlorination, number of samples and sample locations are to be agreed with all parties involved to give a full representation of the system.

Monitoring of the hot and cold water systems should then take place following chlorination taking into account the HTM04-01 table 1:-

Table 1: 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
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.

8.0 Conclusion

Throughout 2006 to 2011 I worked on two major healthcare projects, Pinderfields & Pontefract hospital (£300m) & Whiston Hospital (£338m) during these projects I experienced a number of issues with the management of the water systems, to date both of these hospitals still have a number of issues with the water quality, incorrect temperatures and high legionella counts, both of which could have been designed out or managed more efficiently with more specific guidelines.

From past experience on healthcare projects the water management throughout the construction phase of the project can be overlooked by the project management team, more consideration at design stage will benefit a fully functional and safe hot and cold water system.

At present I don't feel that the current guide lines elaborate on the water management throughout the construction and commissioning phase of a healthcare project, information with respect to phased handovers is not identified clearly enough within the current guidelines for a project team to work against. More detail for the number of legionella samples to be taken, when they are to be taken and the locations could be more clearly identified.

Draw off regimes, Temperature recording and monitoring of temperatures within the current guidelines are not specified and can be open to excessive testing, can just sentinel points be tested during the construction draw off regime.

Method statements need to be clearer on the management of water systems identifying all elements of the process and agreed by all parties involved on the project. Drawings identifying sample locations and temperature monitoring require submitting to the accepting authority for approval prior to commencement of the works.

I would suggest that for larger healthcare projects a dedicated water treatment manager or commissioning manager is employed to manage the water systems, from design stage with full input at design meetings, verifying method statements ensuring all elements of the water management have been taken into consideration, installation to ensure that systems are installed to current guidelines and the commissioning and water treatment phases up to practical completion.

9.0 References

HTM 04 01 Design, Installation & Testing
HTM 04 01 Operational management
BSRIA TN 13/98 Cold Water Storage tanks
BSRIA TN 2/98 Chlorine Dioxide Water Treatment
BSRIA BG 29/2011 Pre-Commission cleaning of pipework systems
BSRIA AG 20/2000 Guide to Legionellosis – Risk Assessment
BSRIA AG 4/94 Guide to Legionellosis – Temperature measurements for H&C water services
HSE L8 The control of legionella bacteria in water systems
www.hse.gov.uk/legionnaires