SCOTTISH HOSPITALS INQUIRY

Bundle of documents for Oral hearings commencing from 19 August 2024 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 15 - Water PPP

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Scottish Hospital Technical Note 2

(Version 1)

Domestic hot and cold water systems for Scottish Healthcare Premises

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NHSScotland, P&EFEx, December 1999

Contents

Executive Summary

This Scottish Hospital Technical Note (SHTN) is the result of investigations which have been carried out in consequence of the widespread corrosion of copper piping in the domestic hot and cold water (DHCW) services systems in Scottish Healthcare Premises (SHPs), and gives guidance on the selection of alternative materials for the piping, fittings, associated water filtration equipment requirements, and installation and commissioning procedures.

This document has been revised to include updated materials information. In particular, it includes new Parts 6 and 7 covering the inclusion of the plastic materials, Polybutylene and Crosslinked Polyethylene (PE-X).

The section dealing with filtration has been extended within this revision to include 'operational experience' to assist designers and purchasers.

Since the first issue of this document in 1994, organisational changes in the NHS in Scotland have resulted in the formation of the NHSiS Property and Environment Forum, the publisher of this document.

Introduction

The Scottish Hospital Technical Note series is a series of Scottish Hospital Estate technical guidance notes, intended to assist Chief Executives, General Managers, Facilities Managers and Estates Managers in achieving appropriate technical standards in new and refurbishment projects.

This SHTN addresses the problems experienced by the NHS in Scotland in consequence of the corrosion of copper pipework systems. Despite extensive research, the absolute cause of the corrosion is not yet understood, but enough is understood to allow the conclusion to be reached that copper pipework in Domestic Hot and Cold Water (DHCW) services in hospitals in many areas of Scotland, where the water is soft, and contains high levels of sediment, has a high propensity to failure.

Guidance on approved alternatives to copper pipework is provided in this SHTN. Over time, more alternatives may be developed and tested, and these will be included in future revisions.

The research involved a great deal of 'on site' work in Scottish hospitals over many years. Many hundreds of copper pipework systems, from 18 months old to 50 years old, were opened up for inspection and the levels of detritus found have led to the conclusion that it is essential that hospital pipework systems be filtered to maintain hygienic conditions. Filtration advice, therefore, is also included in this SHTN.

1. Management Overview

General

1.1 This SHTN covers the policy, design, commissioning, operation and maintenance requirements for the installation of domestic hot and cold water (DHCW) services systems in Scottish Healthcare Premises (SHPs).

NOTE: The water (hot and cold) in these systems is considered potable.

1.2 For the NHS in Scotland this SHTN supersedes the specification of domestic hot and cold water systems outlined in the NHS Model Specification CO1 – *Common Services, Mechanical,* except where noted herein.

1.3 In particular, this SHTN addresses the selection of materials for distribution pipework and fittings and gives guidance on water consumption data required to size water filtration equipment to be used in DHCW services systems.

1.4 Since 1983 it has become evident that corrosion of copper piping within DHCW services in many Scottish hospitals and other Healthcare Premises (HPs) is a serious problem.

1.5 This corrosion, which takes the form of localised pitting or 'pinhole' attack to the wall of the piping, may be unique to institutional buildings, and with slight variations, has been found to be predominant in soft water regions throughout Scotland. Other countries in mainland Europe have experienced similar problems, with Northern Ireland and Wales recently identifying corrosion within HPs.

1.6 The 'pinholes' can form singly or in groups, but do not appear to connect one with another to form cracks leading to catastrophic failure of the pipe. Nevertheless, serious leakage occurs.

1.7 The propagation rate of this 'pinhole' corrosion through the pipe wall can be such that the copper pipework could leak in as little as 6 years from the introduction of water into the system. However no definitive time scale can be accurately assessed.

1.8 Although this form of attack has not as yet resulted in a catastrophic form of failure, it does lead nevertheless to a severe shortening of a system's useful life, with a noticeably growing incidence of repair work and disruption to the operation of a hospital as the extent of pipe failure and water leakage increases.

1.9 Several Scottish hospitals which have suffered serious pipework corrosion have now been re-piped using alternative materials for the pipework system.

1.10 It has also been found that when only partial repiping is carried out, using copper tube within an already corroded system, the renewed pipework inevitably suffers similar corrosion. Such remedial treatment, therefore, only defers eventual full scale replumbing for a period of time.

1.11 To date the cause of this form of copper corrosion has not been fully identified, but sufficient evidence has been gathered to confirm its widespread existence throughout Scottish hospitals and other Healthcare Premises.

1.12 As well as investigating possible causes of this corrosion, the NHS has investigated the use of alternative materials to replace copper. The approved alternative materials are, at this time, the austenitic stainless steels, the polyvinyl-chloride (PVC) plastics, polybutylene and crosslinked polyethylene (PE-X). Guidance on the requirements for the specific use of these materials is given in Parts 3, 4, 5, 6 and 7 of this SHTN.

Policy and strategy

1.13 While it is accepted that some areas of the NHS in Scotland suffer less from corrosion of copper pipework than others, as a result of intensive research into the corrosion of copper piping, the implications of the use of copper as a piping material should be very carefully considered prior to the material being proposed for use for DHCW services pipework in new or refurbishment projects.

NOTE: This statement applies only to copper pipe. It does **not** apply to copper alloy fittings which, as indicated in other parts of this SHTN, may be used in conjunction with stainless steel and plastic piping.

1.14 This SHTN supersedes all previous recommendations and/or specifications relating to the selection of materials and the design, installation and maintenance of pipework and associated equipment for DHCW services systems in all SHPs.

1.15 Copper pipe, however, may still be usefully used for on-going maintenance purposes in the DHCW services systems of existing SHPs.

NOTE: Such use shall **not** be construed to infer that the use of copper pipe for sizeable extensions or major repiping of existing water distribution systems is recommended.

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1.16 Legionnaires' disease is considered preventable. Consequently, in addition to the measures stipulated in the relevant codes of practice of the NHS in Scotland and the Health and Safety Executive (HSE), namely:

- Scottish Health Technical Memorandum (SHTM) 2040, *The control of legionellae in Healthcare premises - A code of practice*;
- The Prevention or Control of Legionellosis (including Legionnaires' Disease) - Approved Code of Practice, Health and Safety Executive Booklet HS(G) 70
  and supplement MISC 150 (1998).

Designers, installers, operators and maintainers are recommended to adopt the practices stated herein for achieving and maintaining a high standard of cleanliness in all DHCW services systems.

1.17 In keeping with this, appropriate water filtration equipment should also be introduced to assist in maintaining hygiene and reducing pipework system detritus. Guidance on requirements specific to the use of such equipment is given in Section 8 of this SHTN.

1.18 Some of the alternative materials, when used in the pipework of DHCW services systems, may leach substances potentially harmful to patients, staff and visitors. The use of such materials must not give rise to levels of such contaminants in excess of acceptable toxicity and health standards (e.g. those specified by the World Health Organisation (WHO).

NOTE: This is an important stipulation. This requirement is in addition to the requirement to meet the United Kingdom Water Byelaws Scheme (UK WBS) – managed by WRc plc – which in essence is designed only to satisfy the requirements of BS 6920.

1.19 Compliance with paragraph 1.18 means that system designers, manufacturers and suppliers must use materials which meet acceptable criteria with respect to leaching contaminants into water and potential toxic effects. The Scottish Office will take advice from WRc plc on what constitutes 'acceptable' in this context.

Related standards and codes of practice

1.20 In addition to the requirements specified herein, the design, installation, disinfection, commissioning and maintenance of DHCW services pipework and filtration equipment must also comply with the following standards and codes of practice:

a. BS 6700 (1997) sections as applicable;

b. Health and Safety at Work etc. Act 1974;

c. Water Authority Byelaws of the relevant Councils in Scotland;

d. Water Fittings and Materials Directory;

e. Control of Substances Hazardous to Health Regulations 1999

1.21 Further details of these documents are given in Appendix 1. It is the responsibility of anyone using any of these reference documents to ensure that it is the latest edition, including any amendments, and to pay due attention to the effect of any changes it may have on this SHTN.

Management responsibilities

1.22 It is recommended that Chief Executives, General Managers, Facilities Managers and Estates Managers within the NHS ensure that the guidance given in this SHTN is implemented within their respective areas of responsibility.

1.23 It is also recommended that management ensure that:

a. **all** concerned with the procurement and supply of material and equipment for the DHCW services systems in SHPs are aware of and are contributing (at a level appropriate to their duties and responsibilities in the procurement and/or supply processes) to the Post Commissioning Documentation (PCD) requirements set out in SHTN 1,

b. on delivery, all material and equipment fully complies with the prescribed specifications and contract requirements, and

c. careful consideration is given to assessing levels of 'on site' supervision to ensure continuing compliance.

2. Design and Operational Considerations

General

2.1 The general requirements for the installation and maintenance of DHCW systems are outlined in this section. Specific requirements for materials are laid out in Sections 3, 4, 5, 6 and 7.

2.2 The onset of widespread corrosion in copper piping led to extensive studies of DHCW services systems in SHPs. These studies highlighted many design and operational difficulties. For example, test results showed that there are a number of areas where it is difficult to comply with the maintenance of 'safe' water temperatures, as stipulated in SHTM 2040. Test results also showed that the monitoring of hot and cold water temperature profiles is of paramount importance because of their influence on bacterial growth.

2.3 It has been demonstrated that, when the DHCW services are not circulating, hot and cold water temperatures reach ambient temperature. Cold water circuits, therefore, can readily attain temperatures above 25^{o}C, whilst hot water temperatures can drop to below 50^{o}C in a very short time. Consequently, it is important that care be taken to ensure that 'safe' water temperatures are maintained and that means are provided whereby any potential *Legionella* hazards are minimised.

2.4 To assist in maintaining appropriate cold water temperatures within the system, due consideration should be given at the design stage to the overall layout to ensure that the pipework is so arranged as to minimise stagnation/heat gain in the system. This may incur the use of additional pipework, to ensure that legs of the system terminate at frequently used appliances.

2.5 Pipework should not where practicable be installed adjacent to a known heat source. However it is accepted that this is not always possible particularly when repiping, whilst maintaining the existing system in operation.

2.6 All pipework and fittings should therefore be insulated to a standard to minimise heat gain and maintain the cold water temperature at an acceptable level.

2.7 Furthermore it is important that attention is given to the location and capacity of cold water storage cisterns to avoid undue heat gain from heat sources, such as heat emitting plant and pipework or the sun in summer months.

2.8 To combat the effect of heat gain cold water storage cisterns should be provided with a standard of insulation relative to the highest ambient temperature which may be achieved within the tankroom to prevent the contents of the cistern exceeding the maximum cold water temperatures allowable.

2.9 Insulation/cistern manufacturers and/or suppliers should therefore be advised of the temperature requirements prior to the designers finalising the specification to ensure that the requirements can be achieved.

2.10 Most hot water systems are already provided with return circuitry or, in some cases, trace heating elements. Nevertheless, problems in maintaining temperatures do occur. Inevitably it is the smaller installations, such as health centres, where these problems occur, possibly due in the main to the shutting-down of the water circulating pumps when the centre is closed at night and during weekends. In these circumstances, consideration should be given to adopting alternative methods such as single pipe systems using cold water and local 'point of use' heaters. More detail is given in SHTM 2040.

Materials

2.11 The alternative materials investigated and deemed acceptable to replace copper piping in DHCW services systems in SHPs are as follows:

a. 316 S16 austenitic stainless steel to the following specifications:
   - BS 3605: Part 1: HFS 316S16:Cat. 2 (for seamless pipes);
   - BS 3605: Part 2: LWHT 316 S16 Cat. 2 (for longitudinally welded pipes);
   - BS 4127;
   - DIN 1988;
   - DIN 2463;
   - BS EN 10088-2.

b. Unplasticized polyvinyl chloride (PVC-U) to the following specification:
   - BS 3505 (for cold water systems only).

NOTE: PVC-U has now generally been superseded in use by PVC-C.

c. Chlorinated polyvinyl chloride (PVC-C) to the following specifications:

- BS 7291: Part 4 (for hot and cold water systems);
- DIN 8079 & DIN 8080.

d. Polybutylene to the following specification:

- BS 7291: Parts 1 and 2.

e. PE-X to the following specification:

- BS 7291: Parts 1 & 3, DIN 16892.

NOTE: PVC-U, PVC-C, PB or PE-X should not be used for a fire hose-reel system.

NOTE: It should be noted by designers and installers that the approved range of thermoplastic materials has a much greater coefficient of thermal movement than metallic pipework. Thermal movement of the pipework system must be allowed for in both design and installation and must comply with manufacturer's requirements.

2.12 The selection of these materials has involved considerable research to prove their worthiness. One consequence of this work is that great importance is now placed on the toxicity of leachates emanating from pipework material.

2.13 In this respect, it is now apparent that many materials previously considered acceptable can release undesirable leachates during the early life of a new or partially repiped system. A typical example is the use of copper alloy fittings, such as gunmetal, which can contain up to 6% lead. During the early commissioning stages, when first immersed in water and the oxide films are forming on the wetted surface of the fittings, a significant release of lead and zinc can take place. This rapidly decays during the first months of operation, after which the traces of lead and zinc may be within acceptable levels. It is therefore advantageous, where possible, to 'pre-soak' these fittings prior to installation by immersion in water.

2.14 This release or leaching occurs in all pipework systems where copper alloy fittings are used. Monitoring tests have only recently highlighted this problem, which has gone unnoticed in the past.

NOTE: The attention of designers and management of all SHPs (and in particular maternity and infant care units) is drawn to the need to examine carefully the design and commissioning of DHCW services systems to ensure that appropriate flushing regimes are carried out and that subsequent post-commissioning monitoring programmes are implemented.

2.15 In the case of the PVC plastics, initial concerns with regard to the use or 'organo-tin' and lead plasticisers have been largely resolved. Recent leachate tests have shown that, for the PVC-C materials tested, only the solvent remains a problem.

2.16 It is important, therefore, that every endeavour should be made, during installation, to minimise the carry-over of solvent material to the internal surfaces of the piping or fittings.

2.17 In addition to the pipework systems discussed above, all materials associated with auxiliary equipment in contact with the water must conform to the requirements of the UK WBS, managed by WRc plc.

Leachate flushing

2.18 The use of stainless steel, PVC-U, PVC-C, PB or PE-X piping requires a leachate flushing regime to reduce the level of contaminants leaching from the piping material into the water.

2.19 Details of this regime are given in paragraph 2.58 and its timing within the construction and commissioning of a new or refurbishment project is shown in Figure 2.2.

Pipe fittings and valves

2.20 All pipe fittings (i.e. couplings and flanges) and valves should be made of materials compatible with the material of the pipe to which they are to be fitted, and all parts in contact with the water **must be non-dezincifiable**.

NOTE: Cast iron must not be used in the construction of any pipes, fittings, valves, pumps or part thereof which may come into contact with the water.

2.21 All valves should be of the 'screw-down', '¼ turn' or 'full-way' patterns, and have either compression coupling ends, screwed ends, flanged ends, solvent cement jointing ends or fusion jointing ends as appropriate to the size and type of pipe to which they are to be fitted.

2.22 Where practicable, only one manufacturer of fittings and only one manufacturer of valves should be used in any one SHP.

Pumps

2.23 All pumps should be made to BS 5257 construction and dimensions and should be supplied with isolating valves on the inlets and non return valves and isolating valves on the discharge. Pump casings should be made of gunmetal or stainless steel depending upon the type of construction used and the shafts and rotating elements should be made from stainless steel. The isolating and non return valves should be made from compatible materials and have ends appropriate to the material and size of pipe to which they are to be fitted.

NOTE: In general, all pumps and their associated valves should comply with the relevant requirements of BS 6920 (where applicable) and the UK WBS. In particular, all parts of the pumps and valves that are in contact with the water must be of stainless steel or non-dezincifiable material.

Cold water storage cisterns

2.24 All cold water storage cisterns should meet the requirements of U.K. WBS Byelaw 30, SHTM 2040 and BS 6700 and be constructed of single piece or sectional glass-reinforced plastic. All internal components of the cisterns (i.e. nuts, bolts, washers, stays, spacers, bracings, etc.) should be of 316L stainless steel. All external components should be zinc plated.

2.25 Where multi-compartment type cisterns are to be provided, these should be so designed and assembled to ensure no leakage occurs when any of the compartments are subjected to unequal forces due to one or more of the compartments being drained for routine maintenance. Cisterns shall have a smooth internal finish with a free draining base. Incoming and outlet pipework shall be so arranged to achieve a balanced flow and prevent stagnation within the cistern. Cisterns shall be fully factory insulated.

Pipework system

2.26 Stainless steel, PVC-C, PB and PE-X piping may be used in hot water systems **and** in cold water systems. PVC-U piping should be used in cold water systems only.

> **NOTE:** Where PVC-C, PB or PE-X pipework is used for hot water distribution, temperature operated actuated valves should be installed on the flow pipework within 300mm of the connection to the calorifier. The valve should be set to operate should the calorifier temperature exceed 75^{o}C.
>
> This may occur should there be a failure within the calorifier control system.
>
> The installation of non-return valves on both the Cold Water Feed and Hot Water Service Return should protect this pipework in the event of calorifier overheating. However, it is possible that the non return valves could be subject to malfunction.
>
> It is therefore recommended that temperature operated actuated valves are installed on both COLD WATER FEED and HOT WATER SERVICE RETURN pipework within 300mm of the connection to the calorifier.
>
> As no valve is allowed on an open vent, consideration should be given to the use of stainless steel for the open vent pipework in a vented system.
>
> The vent should discharge to an 'A' type air gap and tundish discharging to waste.

2.27 Irrespective of which pipe material is used, the design of DHCW pipework systems should meet the following requirements:

i) In general, the pipework should follow the design guidelines laid down in CIBSE Guide and BS 6700.

ii) Due allowance should be made for differences in the thermal expansion characteristics of the pipe material and the material of associated fittings, pipe clips and support brackets, and the system should be designed in such a way as to minimise stress.

Thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

The manufacturer's guidance and recommendations must be adopted at both stages of the work.

There are various methods of containing the effects of thermal movement within the pipework system.

The widely used method within SHP is the use of expansion loops/offsets with fixed points/anchors all arranged in accordance with the manufacturer's data and guidance.

Where space is limited consideration may be given to the use of expansion devices such as bellows or flexible braided sections.

The high co-efficient of linear expansion for thermoplastic pipework compared to metallic pipework results in considerable movement of the pipework due to changes in temperature. This thermal movement is a function of the change in average temperature of the pipe wall. This temperature depends on internal and external environment temperatures. (See Figure. 2.1.)

Figure 2.1

Legend:

S/St - Stainless Steel

CPR - Copper

PB - Polybutylene

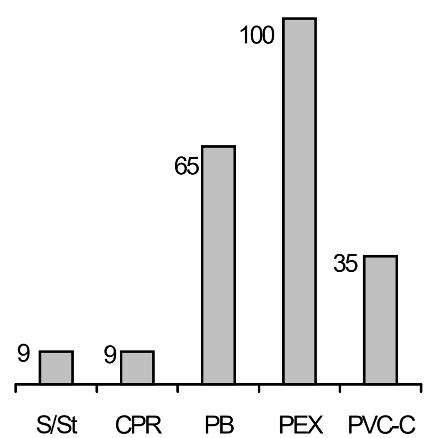
PEX - Cross Linked Polyethylene

PVC-C - Chlorinated Polyvinyl Chloride

Pipe Length - 10m

Temp-Difference - 50°C

Expansion in mm



To accommodate thermal movement, loops/offsets are included within the pipework system, sized in accordance with the manufacturer's data and the relevant temperature differentials.

The pipework is constrained laterally by fixed points/anchors to induce the thermal movement to the loops/offsets.

Where fixed points/anchors are indicated, they must securely fix the pipework at that point.

Fixed points/anchors may be of either a proprietary brand or fabricated to meet specific site conditions.

Should fabrication of fixed points/anchors be adopted, the support arrangement should be offered for manufacturer's approval prior to overall adoption.

NOTE: Manufacturer's literature indicates that a fixed point may be achieved with a tightened pipe clip with oversized pipe shells either side.

Installation experience has shown that the dimension from the building fabric face to the centreline of the pipe is critical. The nippling rod between backplate and pipe ring can flex under the force exerted by movement of the pipework. To eliminate this movement at a fixed point/anchor it is recommended that the distance between backplate fixing to the building and the centre line of the pipe does not exceed that confirmed by the pipework or pipework support manufacturer.

Particular attention should be given to fixed points/anchors on vertical pipework due to the additional force of the weight of the column of pipe and its contents.

NOTE: Where PVC-C, PB or PE-X is utilised on the cold water distribution system allowance should be made in the design of the cold water system for the possible introduction of high temperature hot water (70^{o}C) for control of legionellae within the system (see paragraph 2.64). The cold water system and its associated expansion units, anchors and guides should therefore be designed to accommodate expansion of the same order as the hot water system.

iii) All fixed points and supports should comply with respective manufacturer's requirements.

iv) All pipe clips and support brackets should allow for thermal movement of the pipework in a controlled manner with minimum abrasive action. No clip or bracket should be sited so close to a direction change as to act as an unintentional anchor.

v) Drain cocks should be provided as necessary at all low points to allow the system to be completely emptied of water when required. These drain cocks should be fitted parallel to the pipework where practical and should not provide projections. They should be finished with ends appropriate to the size of pipe to which they are to be fitted.

vi) Unless specified otherwise, servicing isolating valves should be provided on each water draw-off connection to a fitment.

vii) All other valves should be fitted as and where necessary to:

- balance the DHWS system;
- allow isolation of individual circuits;

and

- comply with the Byelaws of the appropriate national and local water authorities.

viii) Where quick closing solenoid valves are fitted, or where due to pressure characteristics, water hammer may develop within the system. The pipework manufacturer should be consulted and the proposed method of containing/absorbing the resultant kinetic energy generated within the pipework system should be endorsed and approved by the manufacturer. It is preferable where possible to eliminate strong pressure surges within the system by carefully designing out any potential problems. Where this is impracticable careful selection of flexible links and surge dampers in conjunction with the pipework manufacturer should be undertaken, to ensure that the surge pressure/velocities generated do not have a detrimental effect on the integrity of the pipework system, or lead to excessive noise.

ix) The sizing of pipework should be as small as possible, consistent with current design practices, whilst ensuring that noise levels arising from the water flow remain satisfactory under maximum and minimum usage conditions.

x) All pipe runs should be graded to ensure adequate venting and draining.

xi) Pipe runs should not be excessively long and dead legs should be kept to an absolute minimum to avoid stagnant flow conditions.

NOTE: This is particularly applicable to hot water systems, for which compliance with SHTM 2040 is necessary.

xii) Where there is risk of minimal flow or stagnant dead legs consideration should be given to re-routing pipework to ensure that the final connection is made to a frequently used fitment.

xiii) Where a reduction of bore is accomplished at a pipe joint by the use of an insert type reducer it should be made with a chamfered seat to prevent the accumulation of debris at this point.

xiv) Thermal insulation should comply with BS 5970 and should **not** be applied to any pipework until after the pipework has been pressure tested. (See Note at end of paragraph 2.28 and also paragraphs 2.49 and 3.1).

Sleeves

2.28 Unless otherwise specified, tubular pipe sleeves should be fitted to all pipes which pass through external walls and internal divisions in the building fabric (i.e. walls, floors, ceilings, etc.) These sleeves should have internal diameters of sufficient size as to permit the free passage of the pipes through the building fabric and also ensure that the pipes do not touch either the sleeve or the building fabric.

NOTE: Pipes should **not** be insulated over the length within the sleeves.

2.29 At an external wall and where the internal division in the building fabric is **not** constructed as a fire barrier:

i) the sleeve should be:

- constructed from a pipe cut-off of the same material as the pipe;
- be set in position in the building fabric prior to the completion of finishing works, such as plasterwork, screeding, etc;
- extend the full thickness of the building fabric **and** finishing works in which it is set;
- be cut back carefully to avoid protrusion beyond the finished surface of the wall, floor or ceiling.

NOTE: For requirements specific to **wet** floors see NHS Model Engineering Specification C01, Element 02, Item 09.

ii) at an external wall:

- the space between the sleeve and the pipe and the space between the sleeve and the wall should be sealed with mastic compound.

iii) at an internal division:

- the space between the sleeve and the pipe should be packed with inert, vermin proof, non-combustible fibrous material, and the sleeve ends should be sealed with non-combustible, non-hardening, non-cracking, intumescent mastic;

- the space between the sleeve and the building fabric should be packed with inert, vermin proof, non-combustible fibrous material.

NOTE: Filler rings should be fitted to facilitate (ii) and (iii). The sleeve infill should extend along the full length of the sleeve.

Fire sleeves

2.30 Where pipes pass through internal divisions in the building fabric which are constructed as fire barriers, the sleeves fitted should be **fire sleeves** where required by Building Standards (Scotland) Regulations and NHS in Scotland Firecode.

2.31 In general, these fire sleeves should comply with the following:

a. They should be specifically manufactured to suit the outside diameter of the pipe to which they are to be applied.

b. They should be cylindrical in shape and closely, neatly and uniformly fit the pipe to which they are applied.

c. They should be of robust construction.

d. They should have a fire resistance rating of not less than the fire division through which the pipework is penetrating.

e. Casings should not distort during the specified period of fire resistance.

2.32 In particular, they should comply, as appropriate, with the requirements given in Parts 3, 4, 5, 6 and 7 for stainless steel, PVC-U, PVC-C, PB & PE-X pipework systems respectively.

Installing the pipework system

2.33 Site supervision should be such as to ensure that a high standard of cleanliness is attained and maintained throughout all stages of installation.

2.34 All pipes, pipe fittings, valves, pumps and any other associated equipment should be inspected by site supervisory staff on delivery to site, to verify that they meet specification and contract requirements. All these items should also be checked to verify that they have been supplied properly protected, undamaged and free from surface abrasions or defects, in a clean condition (internally and externally) and with all pipe ends cut square and capped.

NOTE: Any item which, on delivery, does not meet the specification and contract requirements should be rejected and replaced.

2.35 The pipes should then be stored carefully in racks and kept protected in a clean dry condition until used in the pipework system. All other items should be stored in appropriate protected, clean dry conditions until used.

2.36 Each item should be examined carefully by the installer prior to installation to ensure that it has not suffered accidental damage whilst being transported about the site and is clean and free from dirt or contamination.

2.37 The pipes should be handled carefully and supported during the installation stages to ensure that the roundness of the pipe is maintained within the specified limits. Proper support is of particular importance when a pipe is clamped in a vice to ensure that its roundness is not affected by overclamping.

NOTE: The vice jaws should be of a construction and material that does **not** mark or damage the surface of the pipe or impregnate the pipe.

2.38 When a pipe is cut on site it is imperative that proper methods of cutting are employed. The cut should be square with the pipe's length, and the cut-off portion and the remainder of the pipe should both be properly dressed, reamed and cleaned to ensure all debris from the cutting is removed. Purpose made tools should be used whenever possible.

2.39 All cuttings of pipe should be capped immediately after they have been cut from a length of pipe and so also should the remainder of the length. If not, site supervisory staff should reject them from use on the system.

2.40 Temporary caps should be fitted to all open pipe ends of the pipework during installation, to protect it from ingress of dirt when it is not being worked on.

2.41 All fittings, valves, pumps and other items should be installed in accordance with the manufacturer's detailed instructions.

NOTE: This is of particular importance for compression couplings. Overtightening can impair the integrity of the joint and also, in stainless steel systems, lead to stress corrosion in the pipe in the vicinity of the compression ring if overtightening has excessively deformed the pipe.

2.42 Samples of pipework may be removed from the installation during construction for examination and analysis to ensure appropriate levels of workmanship are being maintained.

2.43 The pipework should be installed so it is consistent with maintaining prescribed minimum clearances between pipes and adjacent surfaces after the installation of wall, floor and ceiling finishing works and any thermal insulation to the pipework.

2.44 For prescribed minimum clearances with respect to:

a. walls;

b. ceilings;

c. finished floors;

d. adjacent pipes, both insulated;

e. adjacent pipes, both uninsulated;

f. adjacent pipes, only one insulated;

g. insulated pipes, adjacent to conduit or trunking;

h. uninsulated pipes adjacent to conduit or trunking;

i. insulated pipes adjacent to electrical cables not in conduit or trunking;

j. uninsulated pipes adjacent to electrical cables not in conduit or trunking.

See NHS Model Engineering Specification C01, Element 02, Item 08 and SHTM 2023: Access and accommodation for engineering services.

2.45 Notwithstanding the minimum clearances, the contractor should allow sufficient space to facilitate easy application of the pipework insulation.

2.46 When fitting sleeves and fire sleeves, the contractor should ensure that no damage is caused to the pipework and building fabric during the operation.

Testing the pipework system

2.47 The testing procedure should be in compliance with BS 6700 and the manufacturer's recommendations. The contractor should carry out a programme of testing the pipework system and its associated fittings and equipment, in individual sections and as a whole, as appropriate to the complexity of the system and maintaining progress with the construction project.

2.48 This programme includes testing the integrity of the system pipework together with its joints and preparing the complete system or section thereof, for final commissioning. The constituent parts of this programme are to be implemented as indicated in Figure 2.2.

Pressure testing

2.49 If, contrary to paragraph 2.27(xiv), thermal insulation has been applied to untested pipework, it should be removed and the pipework re-insulated after pressure testing.

2.50 Water is the accepted means for carrying out pressure tests.

2.51 All pipework and fittings within the system should be pressure tested. The pressure applied should normally be 1½ times the actual working pressure imposed upon the system when in use, the test pressure being held for a period of 1 hour.

NOTE: The test pressure applied should not exceed the nominal pressure rating of the lowest rated item in the pipeline system by more than 50%.

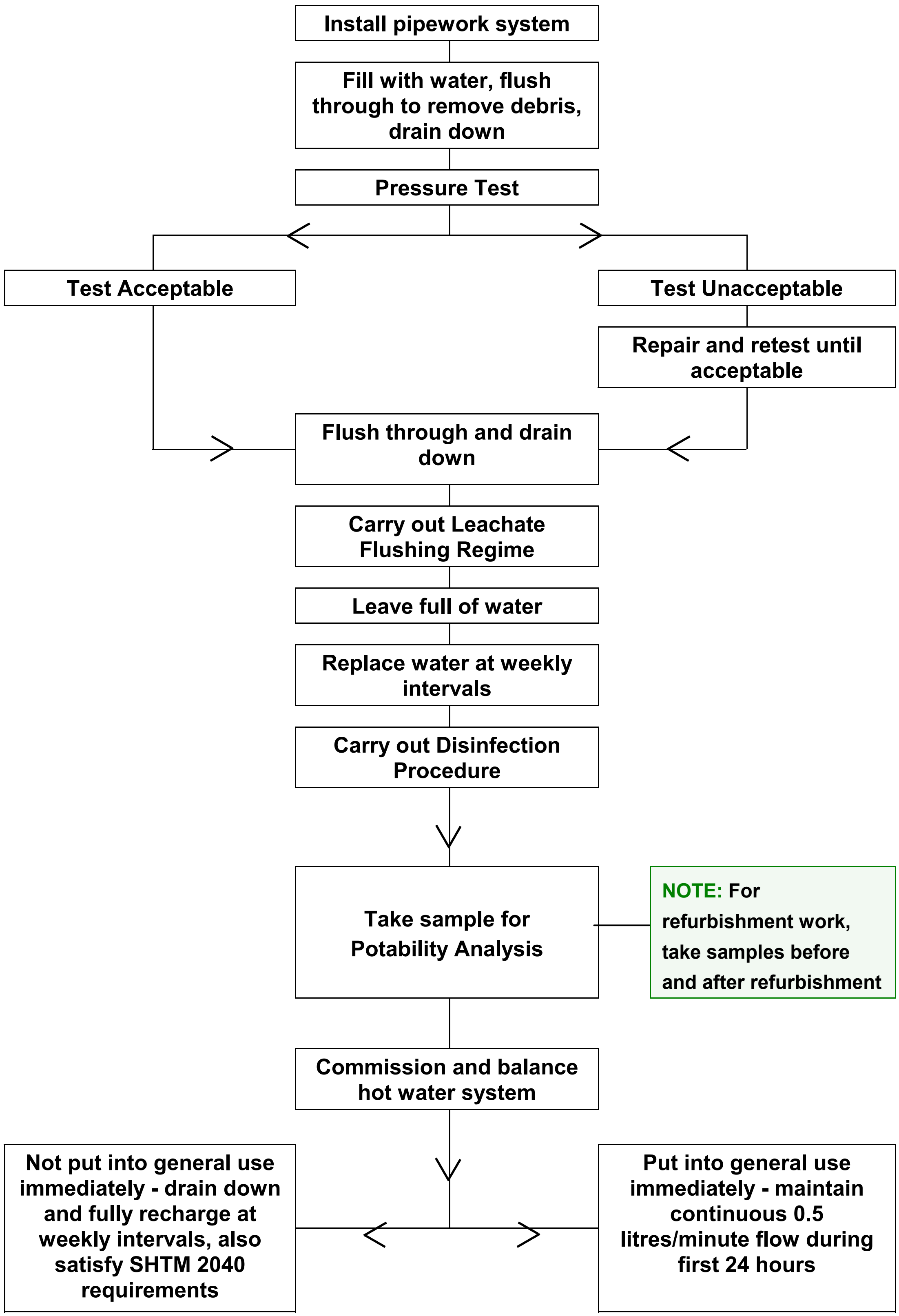
(For PB and PE-X pipework and fittings the system should be pressure tested in accordance with BS 6700 test procedures for elastomeric pipes at a pressure indicated by BS 6700 or by the manufacturer.)

2.52 During this time the system or section thereof should be examined for leaks.

2.53 If during this period leaks are evident or the test pressure falls the test shall fail. The system or section thereof shall be drained and repairs actioned and further testing carried out until the test is satisfactory.

2.54 On completion of satisfactory pressure testing, the pipework should be drained in readiness to complete the commissioning procedure shown in Figure 2.2.

Figure 2.2: Sequence of events



2.55 Pressure test certification should be signed by both the installer and the client's supervising officer.

2.56 These certificates should clearly indicate the section of pipework under test, test pressure and test period and should be handed over for inclusion within the Post Commissioning Documentation (see para 2.84).

Flushing

2.57 As and when appropriate after pressure testing, the system (in sections and finally as a whole) should be filled with water, thoroughly flushed through to remove debris, and then drained down.

Leachate flushing regime

2.58 The leachate flushing regime, which should be used with all currently approved metals and plastics, is as follows:

i) after the final connections have been made, the pipework should be filled with water, thoroughly flushed out, and fully recharged with fresh water by the use of temporary full bore outlets using cold water at maximum mains pressure.

ii) The system should then be left to stand fully charged for successive periods of 1 day, 7 days, and finally, 1 day.

iii) After each of these periods, the water in the system should be fully discharged and the system fully recharged with fresh water.

iv) Upon completion of the final 1 day period, the site supervisor's approval of the leachate flushing should be obtained.

v) If disinfection is to follow immediately, the system should first be drained down.

vi) If disinfection is **not** to follow immediately, the system should be left full of water and thereafter, until disinfection is carried out, the system should be fully drained down and replenished with fresh water at weekly intervals.

Disinfection

2.59 It is recommended that specialist firms are engaged for the disinfecting and water sampling process.

No section of a pipework system should be connected to a 'live' system prior to disinfection, nor should it be connected to a 'live' system while the disinfection process is in process. A full physical break must be provided between it and any 'live' system.

NOTE: A closed isolating valve is **not** acceptable as a physical break. All outlets shall be clearly marked with **Disinfection in Progress. Do Not Use.**

2.60 The disinfection procedure should generally be in compliance with BS 6700, taking into account the information contained in SHTM 2040, Part 6, Appendix 1, but with the exception that chlorine should **not** be used for the disinfection of:

i) stainless steel piping;

or

ii) membrane filters manufactured from polypropylene.

2.61 With these two materials, the sterilising agent used should be either peracetic acid or chlorine dioxide. Proxitane 0501 (a proprietary brand of peracetic acid) or Purogene (a proprietary brand of chlorine dioxide) may be used or other equal and approved.

NOTE: The contractor's attention should be drawn to the necessity to comply with the requirements of the Control of Substances Hazardous to Health Regulations 1999 and that these requirements must be fully adhered to when handling disinfectants.

2.62 It is important to note that high concentrations of peracetic acid can have a detrimental effect on copper and that this, conversely, can reduce the disinfecting potential of the peracetic acid. It is necessary, therefore, to evaluate the percentage of copper and/or copper alloy (fittings, valves, alloy, calorifiers, etc.) in the system and to derive, in conjunction with the manufacturer of the disinfectant, appropriate concentration levels for adequate disinfection of the system. The concentration to be used, thus, depends upon individual systems, but a concentration of 50ppm (that is, 50 parts peracetic acid to 1 million parts of water) should be considered.

2.63 It is also necessary for system designers, installers and specialists to ensure that all materials forming part of system components are compatible with the disinfecting agents used in any particular system.

2.64 The design of hot water systems and cold water systems should both cater for shock dosing to control *Legionella* outbreaks, either by the use of disinfectants or by flushing out with high temperature hot water (70°C). Suitable means should be installed to cope with pipework expansion during the hot water pasteurisation process.

NOTE: PVC-U piping should **not** be subjected to temperatures exceeding 60°C.

Commissioning and using the system

2.65 When all disinfection work has been completed the whole system should be drained down, thoroughly flushed out and fully recharged with fresh water in preparation for commissioning and 'balancing' the hot water system.

NOTE: Disinfection and this subsequent flushing should be carried out preferably as continuous and consecutive operations without any intermediate delays.

2.66 Water samples should be obtained from appropriate points in the system after each recharging. Potability analysis of these samples of water should be carried out by the Public Analyst, or an approved independent body, and the contractor should supply a full set of the analysis to the site supervisor for approval before the system is put into use.

2.67 During the first 24 hours of the system being adopted for general use, a continuous flow of 0.5 litres per minute should be maintained through the system.

2.68 In the event of the system not being in general use for periods of 24 hours or more during the first month after commissioning, the system should be fully drained down and recharged with fresh water prior to general use.

2.69 If the system is not immediately put into use after commissioning, partial replumbing or maintenance work, the system should be fully drained down and recharged with fresh water at weekly intervals until it is put into use.

2.70 If the system requires to be left unused for any appreciable period, it should be drained down completely and all taps and drains should be opened to allow as much air as possible to enter the system.

NOTE: The system should be disinfected and flushed out before being put back into use.

2.71 Local disinfection should be carried out on those parts of a system affected by partial replumbing and maintenance work.

Water consumption

2.72 The corrosion research programmes mentioned earlier helped to provide a better understanding of current water consumption rates of a DGH. This arose as a result of the investigations into filtration, and gave a useful indicator for the prediction of water consumption for new hospitals.

2.73 Water consumption design estimates are based upon data generated by The Hospital Engineering Research Unit in the early 1960s and the results published in a series of data sheets by DHSS in 1973. In Data Sheet DY1.1 it is suggested that an increase on about 3% per annum should be allowed for as an ongoing correction factor. On that basis a present-day estimate of water consumption for a similar unit would be of the order of 2 times the 1963 value, which would appear to be excessive.

2.74 There is a need therefore, for the original data and the basis of calculation to be re-assessed.

2.75 Some interim guidelines to assist designers, particularly with regard to the sizing of filtration equipment, are given in Section 8 of this SHTN. These graphs are based on data collected for the NHS in Scotland National Energy and Environmental Report.

Water storage

2.76 The quantity of cold water storage requires careful consideration. There is a need to satisfy the requirements of the minimum storage requirement of the Local Water Authority and the hospital.

2.77 The guidance contained in the CIBSE Guides, SHTM 2027: *Hot and cold water supply, storage and mains services*, and SHTM 2040: *The control of legionellae in healthcare premises - A code of practice*, should be complied with.

Water filtration

2.78 As stated earlier, SHTM 2040 seeks to reduce the propagation of *Legionellae* in DHCW services systems by temperature control and maintaining high standards of cleanliness, both during the installation of pipework systems and throughout their subsequent operation. This can be achieved by the introduction of modified work practices and high standards of filtration of water, air vents and water overflows.

2.79 It is emphasised, however, that extremely high degrees of filtration, such as might be achieved by, say, nano-filtration or osmosis, are not required for use in normal potable water services in hospitals (dialysis units, etc. are special cases).

2.80 To help achieve the above and minimise the formation of bio-films in pipework, the following guidelines should be followed in selecting appropriate levels of filtration:

i) for the range of approved thermoplastics pipework covered by this SHTN a maximum cut off of 5 microns should be specified.

ii) for stainless steel pipework covered by this SHTN a maximum cut off of 0.5 micron should be specified.

iii) in the instance where the recommendation of this SHTN is not adhered to and copper pipework is installed it is strongly recommended that a filtration level of 0.5 micron absolute is specified.

2.81 Further guidance is given in Section 8 of this SHTN.

2.82 In addition, the filtered water cistern's air inlets and water overflow connections should be protected to afford similar levels of protection against the ingress of bacteria and debris.

Spares

2.83 The contractor should supply an approved and agreed set of spare parts and replacements for the pipework system and all items of plant installed. These should be handed over not less than two weeks prior to the contractor's completion date.

Record documentation

2.84 The installing contractor should supply such documents and drawings as are specified in the contract for inclusion in the Post Commissioning Documentation. These documents and drawings should be compiled, supplied and updated as and when necessary to meet the ongoing requirements of PCD, as stated in SHTN 1.

2.85 As a minimum, for a new installation or major refurbishment, and in addition to the stipulations of SHTN 1, the contract should require the following documents and drawings to be supplied:

a. Full manufacturing details, including batch numbers of all pipes and fittings;

b. Full records and certificates of pressure tests for all sections of pipework;

c. Results of any tests undertaken on any stainless steel welding;

d. Full records and certificates confirming disinfection carried out as per specification, complete with readings;

e. Full records and certificates confirming leachate and other flushing regimes, complete with final water quality analysis results;

f. Settings of all balancing valves, with readings of flow rates and temperatures of domestic flow and return, where applicable;

g. Settings and temperatures recorded at all mixing valves, where applicable;

h. Full details of each item of plant, including detail and arrangement drawings and manufacturer's test certificates and engineers' test certificates where applicable;

i. 'As Fitted' drawings covering the complete DHCW services system;

NOTE: These drawings must be fully detailed with positions of:

- balancing valves, indicating flow and setting;
- isolation valves;
- drain valves;

all clearly and precisely detailed.

j. For each item of plant, manufacturer's recommended maintenance and list of spare parts and replacements.

2.86 The documentation at handover should also include a clear description of the design intent and proposed operation of the system, along with full details of routine monthly, biannual and annual maintenance requirements.

Statutory requirements

2.87 In addition to the requirements previously specified, the design, installation, disinfection, commissioning and maintenance of DHCW services systems must also comply with the following standards and codes of practice:

a. Health and Safety at Work, etc. Act 1974;

b. Ionising Radiation (Sealed Sources) Regulations 1969;

c. Radioactive Substances Act 1960;

d. Water Byelaws;

e. The Building Standards (Scotland) Regulations 1980 (as amended). Technical Standards D2.16 to D2.18 (Service Openings), D2.19 (Cavity Barriers);

f. Water Fittings and Materials Directory
Published by WRc plc for the UK Water Byelaws Scheme.

3. Stainless Steel Pipework Specification

General

3.1 Requirements specific to the design and installation of stainless steel pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

3.2 Stainless steel pipework and fittings intended for the conveyance of potable cold water and hot water service for uses within Scottish Healthcare Premises (SHPs) should comply with the requirements of the following:

BS EN 10088-2
BS 3605
BS 864 Part 2
DIN 2463
BS 4127
DIN 1988

NOTE: All materials in contact with stainless steel must not have a chloride content exceeding 0.05%. (This applies in particular to insulation.)

3.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

Pressures and temperatures

3.4 The working pressures and operating temperatures of press fitting, stainless steel pipework and fittings are listed for guidance in Table 3.1.

Table 3.1: Stainless steel pipework- working pressures/operating temperatures

Pressure Ratings – Pipe, Fittings and Valves Press fitting System at 80°C		
Product	**Size**	**Pressure Rating at 80°C**
Fittings	15mm-100mm	16 Bar
Valves	15mm-100mm	16 Bar
Pipe	15mm-100mm	16 Bar

NB: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.

Normal operating temperatures will be in the range of 10°C - 60°C.

NOTE: Maximum operating temperature must not exceed 110°C continuous or 130°C for a period of not exceeding one hour.

3.5 The whole of the stainless steel pipework installation shall be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

BS 6700
SHTM 2040
SHTM 2027
HS(G) 70

and the relevant manufacturer's instructions.

3.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings.

3.7 The use of stainless steel does not impose any additional requirements in respect of hot and cold water systems providing all materials within the system are fully compatible for use with stainless steel. However it should be noted that sacrificial anodes should not be used.

3.8 Insulation for stainless steel pipework systems should preferably be chloride free, however it is acceptable to use material where the content by weight of water soluble chloride ions does not exceed 0.05%.

3.9 Where the insulation materials exceeds the above parameter, a protective aluminium foil should be applied to the pipework system prior to insulation.

Pipes

3.10 All stainless steel piping used in the hot and cold water services system should comply with the following:

BS 3605: Part 1 HFS 316S16 Cat. 2
BS 3605: Part 2 LWHT 316S16 Cat. 2
BS 4127 LWHT 316S16
DIN 1988 Part 2 LWHT 316S16
DIN 2463
BS EN 10088-2.

Pipe fittings and valves

3.11 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be supplied/or approved by the pipework manufacturer for use with the pipework system.

NOTE: BS 3605 Part 1 HFS 316S16 Cat. 2 pipe would generally not be specified unless there was a specific requirement for this grade of tube. Pipework normally selected for use within Scottish Healthcare Premises is generally DIN 1988, 2463/BS 3605 Part 2 for use with press fitting fittings or in some cases on smaller diameters for use with compression fittings.

Pipework complying with BS 4127 is unsuitable for use with press fitting joints.

Pipework exceeding 100mm diameter will require to be flanged.

3.12 Non-manipulative type 'A' compression joints may be used on pipework not exceeding 54mm diameter. The joints shall be constructed from a non-dezincifiable alloy.

NOTE: Experience has indicated that where compression fittings are used, the compression cone should be suitable for use with stainless steel pipework. Prior to specification the proposed fittings manufacturer must be consulted to verify their requirements for their range of fittings for use with stainless steel.

3.13 Stainless steel compression fittings to BS 4368 Part 3 and DIN 2353 are available but are generally not considered for widespread use.

NOTE: Should BS 4127 pipework be specified, joints on pipework exceeding 54mm diameter will require to be flanged, with the flanges welded to the pipework.

Flanges should comply with BS 4504 and should be PN 16.

Sealing rings and gaskets used in flanged joints should be made of BS 2494 Type W material with regard to the specific requirements in relation to bio-degradation.

3.14 Valves for stainless steel pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

i) Gunmetal gate valves complying with BS 5154, complete with flanged bush connectors for pipes over 63mm outside diameter or with threaded connectors for pipe up to and including 63mm outside diameter, may be supplied by the pipe or fittings manufacturer provided they are manufactured entirely from non-dezincifiable materials.

ii) Also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

3.15 Where servicing ball valves are required at fitments, these shall be of non dezincifiable construction with compression ends suitable for direct connection to stainless steel pipework.

Cleanliness requirements

3.16 As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations. To satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplied to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

3.17 The finished tube shall be smooth, free of internal and external mechanical imperfections, and shall have a clean bright appearance.

Packaging and transportation

3.18 The pipes should be delivered in straight lengths with each end securely capped against ingress of dirt. The capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, metal or alloy designation, size, total length or piece count and name of supplier.

NOTE: Any pipes delivered unprotected or with open ends should be rejected.

3.19 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that 'heat' identification is required, the purchaser shall specify the details desired.

Pipework systems

3.20 It may be appropriate to use 'pulled' bends in parts of a pipework system. When used these bends should conform to the bore of the pipe and the centre to end radius of the bend should be not less than three times the pipe bore.

3.21 The bend should be smoothly formed. Wrinkled or flattened bends should not be accepted.

3.22 Where expansion loops are used, they should be formed using fittings and pipe of the same material and specification as the pipework system.

3.23 Where expansion bellows are utilised, they should be:

i) of stainless steel construction 316S16;

ii) of a design incorporating internal sleeving (to minimise the accumulation of debris in crevices);

and

iii) be finished with compressing coupling or flanged ends which meet the materials requirements stated in para.3.13 (Note) and are appropriate to the size of pipe to which they are to be fitted.

NOTE: All parts of the expansion bellows in contact with water must be of stainless steel 316S16 construction.

3.24 Bellows should be equipped and installed with stainless steel lined guides as required by the expansion bellows manufacturer.

3.25 All pipes should be supported by pipe clips and/or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 3.2 or as advised and confirmed by the pipe manufacturer.

Table 3.2: Support Bracket Spacing; 60°C

Pipe Outside Diameter (mm)	Maximum Interval	
	Horizontal (metres)	Vertical (metres)
15	1.2	1.8
20	1.2	1.8
25	1.5	2.4
32	1.8	3.0
40	1.8	3.0
50	1.8	3.0
65	2.4	3.0
80	2.4	3.7
100	2.4	3.7

3.26 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such clips and brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

3.27 Pipe clips and support brackets in contact with the surface of stainless steel pipework should be compatible with the pipework system.

Fire sleeves

3.28 Fire sleeves for stainless steel pipework should generally comply with the requirements of paragraph 2.31 and should be made of stainless steel and be sealed with a Class 'O' fire resistant infill which is chloride free.

Installing the pipework

3.29 Any welding of stainless steel pipe should be carried out by the tungsten inert gas (TIG) welding process, using an argon shield gas, in accordance with BS 7475. When this method of jointing is employed it is of great importance that the faces of the pipe and fitting to be butted together are cut square and have no malformation and the ovality is maintained at a minimum to ensure proper fusion of the weld.

3.30 All welders employed should have been approved in accordance with BS EN 287: Part 1 and have current certificates for argon arc welding, and should be required to demonstrate their skills by providing sample welds prior to carrying out welding on the system.

3.31 While the thermal expansion/contraction of stainless steel is considerably less than thermoplastic pipework nevertheless it must be taken into account during both the design stage and the installation stage of the work. It is incumbent on the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

NOTE: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

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4. PVC-U Pipework Specification

General

4.1 Requirements specific to the design and installation of PVC-U pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

4.2 PVC-U pipework and fittings intended for the conveyance of potable cold water for use in all domestic cold water services within Scottish Healthcare Premises (SHPs) should comply with the requirements of the following:

Pipe	BS 3505 Class E
Fittings	BS 4346 Part 1

4.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

> **NOTE:** Whilst the operating temperature of PVC-U is rated to a maximum of 60ºC at a pressure of 2 Bar it should not however be specified for other than domestic cold water systems.

4.4 The working pressures and operating temperatures of PVC-U pipework and fittings are listed for guidance in Table 4.1.

4.5 The whole of the PVC-U pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

BS CP 312
BS 6700
SHTM 2040
SHTM 2027
HS(G) 70

and the relevant manufacturer's instructions.

4.6 Care should be exercised whilst off-loading, storing, transporting about the site, and installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

4.7 Great care should also be exercised in the storage and use of pipe cleaning materials and solvent cements. The requirements of the HSE and rules and regulations for working with materials hazardous to health should be adhered to at all times. It is essential that materials containing solvents should be stored in a secure lockfast store when not in use.

Pipes

4.8 All PVC-U piping used in the **cold water systems** of DHCW services systems in SHPs should be to BS 3505 Class E.

Pipe fittings and valves

4.9 All associated pipe fittings (i.e. unions and flanges) should be manufactured to the composition, properties and conditions specified in:

- BS 4346 Part 1 (for unions);
- BS 4504 (for flanges).

4.10 Valves in PVC-U pipework should generally be PVC-U ball valves incorporating, double socket disconnecting ends, removable seating seals and direction of flow arrow. They should be as supplied for the application by the piping manufacturer and be of the double-union ball valve pattern - Class E for sizes up to 54mm (2 inch nominal size) and Class C for 75mm (3 inch for nominal size) and above - all to BS 3505. Where space is limited, butterfly type valves may be considered for use.

Metric – Imperial equivalence

4.11 At the date of publication of this SHTN, the information given in BS 3505 and BS 4346 is based on the Imperial Unit system and it is understood that the British Standards Institution has no plans to issue metric editions of these Standards.

4.12 Therefore, to enable compatibility with other metric dimensioned pipework and fittings indicated upon contract drawings and included within the contract documents, it is suggested:

i) that metric terminology be adopted when PVC-U pipes and fittings are being specified:

and

ii) that a table, such as Table 4.2, relating the indicated metric dimensions to the equivalent Imperial dimensions be included on the contract drawings.

Table 4.1: PVC-U pipework (inch) - working pressures/operating temperatures

Pressure Ratings – Pipe, Fittings and Valves		
Product	**Size**	**Pressure Rating at 20°C**
Fittings (solvent cement)	½" – 6"	15 Bar
Fittings (threaded)	½" – 4"	10 Bar
Ball Valves	½" – 2"	16 Bar
All other valves	½" – 6"	10 Bar & 6 Bar
All actuated valves	½" – 6"	10 Bar & 6 Bar
Pipe	½" – 6"	15 Bar

***NB:** The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.*

Normal operating temperatures will be in the range 10°C - 20°C.

NOTE: Maximum temperature must not exceed 60°C at a maximum pressure of 2 Bar.

Table 4.2: PVC-U Pipes (BS 3505) & PVC-U Fittings (BS 4346)

Indicated Metric Diameter (mm)	Equivalent Normal Size (inch)
15 mm	0.5"
22 mm	0.75"
28 mm	1.0"
35 mm	1.25"
42 mm	1.5"
54 mm	2.0"
75 mm	3.0"
100 mm	4.0"

Cleanliness requirements

4.13 As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplied, to pass the 'cleanliness test' described in ASTM: B280-86 clause 12.

Workmanship, finish and appearance

4.14 The finished tube shall be smooth, free from internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

4.15 The pipes should be delivered in straight lengths with each and every end securely capped against ingress of dirt, and the capped tubes shall be bundled by size, in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier.

NOTE: Any pipes delivered unprotected or with open ends shall be rejected.

4.16 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

4.17 The pipes and fitting should be entirely compatible with each other, should be jointed by means of the manufacturer's approved cleaner and solvent cement and the jointing should be carried out in strict accordance with the manufacturer's printed instructions. PVC-U solvents should comply with BS 4346: Part 3 and the solvent cement should be based on methyl ethyl ketone (MEK) with a minimum contamination of other solvents.

NOTE: The use of solvents which contain n-hexane and propylene oxide should **not** be permitted.

4.18 Unless indicated otherwise, the pipe joints in PVC-U pipework should be made by socket and spigot solvent cemented joints. To enable disconnections to be effected, demountable socket unions to BS 4346: Part 1: Class E should be fitted on pipes not exceeding 54mm outside diameter (2 inch nominal size). On 75mm (3 inch nominal size) and 100mm (4 inch nominal size) outside diameter pipes, unions to BS 4346: Part 1: Class C or PVC-U flanges to BS 4504 should be used.

NOTE: Locations for demountable unions and flanges should be selected by the site supervisor.

4.19 Screwed adaptor fittings should be used at screwed joints to appliances and the like. PVC-U flanges, having dimensions in accordance with BS 4504, should be provided for connections to cisterns or pumps.

Pipework system

4.20 Samples of the following should be submitted to the site supervisor for approval:

- PVC-U piping;
- PVC-U pipework regulation and isolation valves;
- PVC-U pipework bends, tees and tap connectors;
- PVC-U cleaner and solvent cement.

4.21 The installation contractor should not confirm orders for the system pipework, nor should the construction of the installation of the system proceed until these samples have been approved in writing.

4.22 The approved samples should be retained on site for comparison with the work as actually installed.

4.23 At connections to taps on sinks, worktops, etc. the final connector should be a 0.5 metre (approximate) length of stainless steel pipe and arrangements should be made to ensure that it and the PVC-U pipe to which it is joined are guarded and secured in such a way as to be protected from impact damage or undue torque.

Fire sleeves

4.24 Fire sleeves should be used where PVC-U pipes of 54mm outside diameter (2 inch nominal size) and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

i) They should be constructed with an outer galvanised steel casing and intumescent lining.

ii) Each sleeve should be manufactured in two longitudinal half sections. The sections should be joined together, around the pipe, utilising galvanised steel slide on clamping strips.

iii) Casing should accommodate the expansion of intumescent linings during fire conditions.

iv) Intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accord with pipe manufacturer's requirements.

v) Individual sleeves mounted on vertical pipework should:

- be of construction suitable for surface mounting;
- not exceed 200mm in length;
- be fitted with a flanged, galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
- be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position).

vi) Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

4.25 The contractor should:

i) check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;

ii) check that all the piping and fittings supplied are uniform in colour density;

and

iii) exercise particular care in storing, handling and installing to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

4.26 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

4.27 It is incumbent upon the contractor to ensure that all pipe cleaners and solvent cements being used are within their designated shelf life. Any materials found to be beyond their shelf life should be removed from site.

4.28 The cleaners should be applied in strict accordance with the manufacturer's printed instructions and should not be detrimental to long term joint performance and should have no toxicological implications.

4.29 It is essential that cleaners are correctly applied to the pipe ends and sockets prior to the application of solvent cements, with cleaning pads changed regularly in accordance with manufacturer's instructions. After swabbing the ends of pipes and surface of moulded fittings, a bead of solvent cement on the outside will provide evidence of complete solvent cementing.

NOTE: When preparing pipework and fittings for jointing in ambient temperatures less than 5°C, the manufacturer's advice should be sought to establish appropriate jointing procedures.

4.30 Great care should be taken to ensure that only the manufacturer's installation procedures are followed and, in particular, that the full curing period is maintained before any joint is considered to be complete.

4.31 Care should be exercised to ensure that, wherever practical, the PVC-U pipework does not suffer from the effects of heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 (xiv) should be applied.

4.32 On no account should ladders, scaffold or other building items be propped against the PVC-U pipework installation.

4.33 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PVC-U piping any offsetting required should be formed using fittings. No thermally induced bending of PVC-U pipes, through the application of local heating, should be permitted.

4.34 All PVC-U pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 4.3 or as advised and confirmed by the pipe manufacturer.

Table 4.3: Support Bracket Spacing; 20ºC

Pipe Outside Diameter		**Maximum Interval**	
mm	**inch**	**Horizontal metres**	**Vertical metres**
15	0.5	0.8	1.2
22	0.75	0.8	1.2
28	1.0	0.9	1.5
35	1.25	1.0	1.5
42	1.5	1.1	1.5
54	2.0	1.2	1.8
75	3.0	1.5	1.8
100	4.0	1.7	1.8

4.35 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

4.36 PVC-U pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

4.37 Where PVC-U piping is supported using other than standard PVC-U pipe clips, the supports should comprise steel split pipe rings with rubber insert, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

4.38 Thermal expansion/contraction of the material must be taken into account during both the design stage and installation stage. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

NOTE: The manufacturer's guidance and recommendations should be adopted at both stages of work.

5. PVC-C Pipework Specification

General

5.1 Requirements specific to the design and installation of PVC-C pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

5.2 PVC-C pipework and fittings intended for the conveyance of potable cold water and hot water service for use in all domestic hot and cold water services within Scottish Healthcare Premises (SHPs) should comply with the requirements of the following:

DIN 8079
DIN 8080
DIN 1988
BS 7291 (Parts 1 & 4)
BS 5955 Part 8

5.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

5.4 The working pressures and operating temperatures of PVC-C pipework and fittings are listed for guidance in Table 5.1.

Table 5.1: PVC-C pipework (metric) - working pressures/operating temperatures

Pressure Ratings – Pipe, Fittings and Valves		
Product	**Size**	**Pressure Rating at 80°C**
Fittings (solvent cement)	16mm - 50mm	6 Bar
Fittings	63mm - 160mm	4 Bar
Valves	16mm - 63mm	6 Bar
Valves	63mm - 160mm	4 Bar
Pipe	16mm - 50mm	6 Bar
Pipe	63mm - 160mm	4 Bar

NB: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.

Normal operating temperatures will be generally be in the range 10°C – 60°C.

NOTE: Maximum temperature must not exceed 95°C at a maximum pressure of 3.5 Bar.

5.5 The whole of the PVC-C pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

BS 5955 Part 8
BS 6700
SHTM 2040
SHTM 2027
HS(G) 70

and the relevant manufacturer's instructions.

5.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

5.7 Great care should also be exercised in the storage and use of pipe cleaning materials and solvent cements. The requirements of the HSE and rules and regulations for working with materials hazardous to health should be adhered to at all times. It is essential that materials containing solvents should be stored in a secure lockfast store when not in use.

Pipes

5.8 All PVC-C piping used in DHCW services pipework systems in SHPs should be to BS 7291: Part 4 or DIN 8079/DIN 8080/DIN 1988.

Pipe fittings and valves

5.9 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be PVC-C manufactured to the composition, properties and conditions specified in BS 7291: Parts 1 and 4.

5.10 Valves for PVC-C pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

- i) PVC-C ball valves, for pipe sizes up to and including 110mm outside diameter, meeting the resistance to pressure requirement of DIN 3441, allowing bi-directional flow with floating ball, and complete with double socket disconnecting ends, removable seals and direction of flow arrow.
- ii) PVC-C flanged butterfly valves for pipe sizes 63mm outside diameter and above, allowing bi-directional flow, of overall dimensions complying with DIN 3441: Part 5 or ISO 7508 and having valve body holes to allow connection to flanges drilled in accordance with DIN 8063: Part 4, ISO 2536 or BS 10: Tables D or E.
- iii) Gunmetal gate valves complying with BS 5154, complete with flanged bush connectors for pipes over 63mm outside diameter or with threaded connectors for pipe up to and including 63mm outside diameter may be supplied by the pipe or fittings manufacturer provided they are manufactured entirely from non-dezincifiable materials.
- iv) Also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

5.11 Where servicing ball valves are required at fitments, these shall be of non dezincifiable construction with compression ends suitable for direct connection to PVC-C pipework.

Cleanliness requirements

5.12 As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplies, to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

5.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

5.14 The pipes should be delivered in straight lengths with each and every end securely capped against the ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier.

NOTE: Any pipes delivered unprotected or with open ends should be rejected.

5.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

5.16 The pipes and fittings should be entirely compatible with each other, should be jointed by means of the manufacturer's approved cleaner and solvent cement and the jointing should be carried out in strict accordance with the manufacturer's printed instructions. PVC-C solvents should comply with BS 7291: Part 4.

NOTE: The use of solvents which contain n-hexane and propylene oxide should **not** be permitted.

5.17 Unless indicated otherwise, the pipe joints in PVC-C pipework should be made by socket and spigot solvent cemented joints. The specification for these should be dependent on the manufacturer of the PVC-C piping and the joints should in all respects be compatible with the installed pipework. They should comprise either:

i) push-fit conical self-centering pattern spigot and socket joints with raised marking arrows to allow correct lining up with pipe markings and ensure that all branches in a pipe length are in the correct plane;

or

ii) parallel sided spigot socket joints with internal stop heads or shoulders to prevent over penetration of the pipe into the fitting.

5.18 Where directed, to enable disconnections to be undertaken, demountable socket unions should be fitted on pipes not exceeding 63mm outside diameter. Above 63mm outside diameter, flanged joints should be used.

NOTE: Locations for demountable unions and flanges should be selected by the site supervisor.

5.19 Screwed adaptor fittings should be used at screwed joints to appliances and the like. PVC-C flanges, having dimensions in accordance with BS 4504, should be provided for connections to pumps or cisterns.

Pipework system

5.20 The piping contractor should provide samples of the following for approval:

- PVC-C piping;
- PVC-C pipework valves, or (if applicable) gunmetal gate valves and connectors;
- PVC-C pipework bends, tees and tap connectors;
- PVC-C cleaner and solvent cement, or (if applicable) gunmetal or stainless steel compression fittings for use with PVC-C.

5.21 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system be proceeded with until these samples have been approved in writing.

5.22 The approved samples should be retained on site for comparison with the work as actually installed.

5.23 At connections to taps on sinks, worktops, etc. the final connector should be a 0.5metre (approximate) length of stainless steel pipe and arrangements should be made to ensure that it and the PVC-C pipe to which it is joined are guarded and secured in such a way as to be protected from impact damage or undue torque.

5.24 No PVC-C pipework should be connected direct to any heat source (for example, a secondary domestic hot water heater). Final connections up to a length of 1.0 metre, or as advised by the manufacturer of the PVC-C pipework, should be made with stainless steel pipe and clearance between PVC-C piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5metre.

Fire sleeves

5.25 Fire sleeves should be used where PVC-C pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

i) They should be constructed with an outer galvanised steel casing and intumescent lining.

ii) Each sleeve should be manufactured in two longitudinal half sections. The sections should be jointed together, around the pipe, utilising galvanised steel slide on clamping strips.

iii) Casings should accommodate the expansion of intumescent linings during fire conditions.

iv) Intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accordance with the pipe manufacturer's requirements.

v) Individual sleeves mounted on vertical pipework should:

- be of construction suitable for surface mounting;
- not exceed 200mm in length;
- be fitted with a flanged galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
- be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position);

vi) Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

5.26 The contractor should:

i) check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;

iii) check that all the piping and fittings supplied are uniform in colour density;

and

iii) exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

5.27 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

5.28 It is incumbent on the contractor to ensure that all pipe cleaners (where required) and solvent cements are within their designated shelf life. Any materials found to be beyond their stated shelf life should be removed from site.

5.29 The cleaners (where required) and the solvent cement should be fully compatible with the pipework system. Only cleaners/solvents approved and supplied by the manufacturer shall be used, they should not be detrimental to long-term joint performance and should have no toxicological implications.

5.30 It is essential that cleaners, where required, are correctly applied to the pipe ends and sockets prior to the application of solvent cements, with cleaning pads changed regularly in accordance with manufacturer's instructions. After swabbing the ends of pipes and surface of moulded fittings, a bead of solvent cement on the outside will provide evidence of complete solvent welding.

NOTE: When preparing pipework and fittings for jointing in ambient temperatures less than 5°C, the manufacturer's advice should be sought to establish appropriate jointing procedures.

5.31 Great care should be taken to ensure that only the manufacturer's installation procedures are followed and, in particular, that the full curing period is maintained before any joint is considered to be complete.

5.32 No pipework, or section thereof, shall have pressure applied until the manufacturer's stipulated curing period has elapsed.

> **NOTE:** This may vary according to the manufacturer and should be confirmed by the manufacturer of the system being installed.

5.33 Great care should be exercised to ensure that, where practical, the PVC-C pipework does not suffer from the effects of undue heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 (xiv) should be applied.

5.34 On no account should ladders, scaffold or other building items be propped up against the PVC-C pipework installation.

5.35 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PVC-C piping any offsetting required should be formed using fittings. No thermally induced bending of PVC-C pipes, through the application of local heating, should be permitted.

5.36 All PVC-C pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer) the spacing of which should not exceed the maximum intervals given in Table 5.2 or as advised and confirmed by the pipe manufacturer.

> **NOTE:** Some manufacturers supply a metal support tray system for use with pipework up to and including 32mm diameter.
>
> The use of this support system increases the distance between supports and therefore reduces number of support brackets required.

Table 5.2 Support Bracket Spacing; 60ºC (without support tray)

Pipe Outside diameter (mm)	Maximum Interval	
	Horizontal (metres)	Vertical (metres)
16	0.65	0.85
20	0.75	0.90
25	0.75	0.98
32	0.85	1.10
40	0.95	1.25
50	1.05	1.35
63	1.20	1.55
75	1.25	1.65
90	1.35	1.75
110	1.60	2.00
160	1.75	2.25

NOTE: For support centres utilising support tray, consult relevant manufacturer's literature.

5.37 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

5.38 PVC-C pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

5.39 Where PVC-C piping is supported using other than standard PVC-C pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

5.40 Thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

NOTE: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

6. Polybutylene Pipework Specification

General

6.1 Requirements specific to the design and installation of PB pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

6.2 PB pipework and fittings intended for the conveyance of potable cold water and hot water service for use within Scottish Healthcare Premises (SHPs) should comply with the requirements of the following.

DIN 16986/16969
DIN 1988
BS 5955 Part 8
BS 7291 Part 1 & 2

6.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

6.4 The working pressures and operating temperatures of PB pipework and fittings are listed for guidance in Table 6.1.

Table 6.1: PB pipework - working pressures/operating temperatures

PB Pressure Ratings – Pipe, Fittings and Valves		
Product	**Size**	**Pressure Rating at 80°C**
Fittings	16mm – 110mm	10 bar
Valves	20mm – 63mm (PVC-C)	5 bar
Pipe	16mm – 110mm	10 bar

N.B: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature.

Maximum operating temperature will be 60°C.

NOTE: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

6.5 The whole of the PB pipework installations should be tested in accordance with the requirements of the following:

BS CP 312
BS 6700
SHTM 2040
SHTM 2027
HS(G) 70
and the relevant manufacturer's instructions.

6.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to effects of ultra-violet radiation including daylight.

6.7 Care should be exercised in the storage and use of pipe cleaning materials. Degreasing tissues impregnated with 70% isopropyl alcohol should be used.

Pipes

6.8 All PB piping used in DHCW services pipework systems in SHPs should be to BS 7291: Parts 1 and 2, BS 5955 Part 8, DIN 16968/DIN 16969, DIN 1988.

Pipe fittings and valves

6.9 Unless specified otherwise, all associated pipe fittings (i.e. manifolds, unions and flanges) should be of polybutylene manufacture generally in accordance with BS 7291: Parts 1 and 2, and DZR brass fittings (see 2.20) manufactured generally in accordance with BS 864: Part 2, and be fully compatible with the pipe system they are to be installed with.

6.10 Valves for PB pipework should be fully compatible with the pipework system to which they are to be connected, comprising variously:

i) PB gate valves for pipe sizes up to and including 110mm outside diameter, allowing bi-directional flow with direct sealing of slide in valve body operating at 90 degrees to direction of pump flow with non rising valve spindle.

(ii) PVC-C ball valves, for pipe sizes up to and including 63mm outside diameter, meeting the resistance to pressure requirement of DIN 3441, allowing bi-directional flow with floating ball, and complete with double socket disconnecting ends and removable seals.

(iii) Polyvinylidene fluoride (PVDF) flanged butterfly valves, for pipe sizes over 63mm outside diameter, allowing bi-directional flow, of overall dimensions complying with DIN 3441: Part 5 or ISO 7508 and having valve body holes to allow connection to flanges drilled in accordance with DIN 8063: Part 4, ISO 2536 or BS 10: Table D or E.

(iv) DZR Brass ball valves and gate valves should be suitable for connection with PB pipe directly, or with adapters to flanged or threaded connectors.

(v) Only pipe thread lubricants and sealants specifically approved by the pipe and fittings manufacturer should be used.

6.11 Where servicing ball valves are required at fitments these shall be of non-dezincifiable construction with female thread ends suitable for PB threaded adapters.

Cleanliness requirements

6.12 As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the "cleanliness test" described in ASTM: B280-86 clause 12.

Workmanship, finish and appearance

6.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

6.14 The pipes should be delivered in coils or straight lengths with each and every end securely capped against ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, material designation, size, total length or piece count and name of supplier.

NOTE: Any pipes delivered unprotected or with open ends should be rejected.

6.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation.

Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

6.16 The pipes and fittings should be entirely compatible with each other, and the jointing should be carried out in strict accordance with the manufacturer's printed instructions.

6.17 Unless indicated otherwise the pipe joints in PB pipework should be made by *socket fusion, electrofusion or compression.* The assembly of these should be carried out in strict accordance with the manufacturer's instructions, by fully trained and certified installers in the manner indicated below:

i) *Socket fusion,* utilising the correct tools for assembly, melting and jointing times in accordance with the manufacturer's instructions.

ii) *Electrofusion,* utilising correct tools for assembly, melting times in accordance with the manufacturer's instructions.

ii) *DZR Brass compression,* fittings to include internal pipe sleeve as integral part of fitting with grip ring to hold pipe in place. Assembly to be in accordance with manufacturer's instructions.

6.18 Where directed, to enable disconnections to be undertaken, socket unions should be fitted on pipes up to and including 63mm outside diameter. Above 63mm outside diameter, flanged joints should be used.

> **NOTE:** Locations for demountable unions and flanges should be selected by the site supervisor.

6.19 Screwed adapter fittings should be used at screwed joints to appliances up to 63mm outside diameter; PB flange adapters having dimensions in accordance with BS 4504 should be provided for connections to pumps, cisterns or equipment above 63mm outside diameter.

Pipework system

6.20 The piping contractor should provide samples of the following for approval:

- PB piping;
- PB pipework regulation and isolation valves;
- PB pipework bends, tees and tap connectors;
- PB cleaner and jointing equipment or (if applicable) compression fittings for use with polybutylene.

6.21 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system proceed until these samples have been approved in writing.

6.22 The approved samples should be retained on site for comparison with the work as actually installed.

6.23 At connections to taps on sinks, worktops etc, the final connector may either be a 0.5 metre (approximate) length of stainless steel pipe (to the standard specified in Section 3 of this guide.) or the PB pipe manufacturer's suitable DZR brass outlet connectors. Arrangements should be made to ensure that the fitting and the PB pipe to which it is joined are guarded and secured in such a way as to be protected from undue damage or torque.

6.24 No PB pipework should be connected direct to any heat source (for example, a secondary domestic hot water storage calorifier or direct gas-fired water heater). Final connections up to a length of 1.0 metre, or as advised by the manufacturer of the PB pipework, should be made with approved stainless steel piping. Clearance between PB piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5 metre.

Fire sleeves

6.25 Fire sleeves should be used where PB pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

i) They should be constructed with an outer galvanised steel casing and intumescent lining.

ii) Each sleeve should be manufactured in two longitudinal half sections. The sections should be joined together, around the pipe, utilising galvanised steel slide on clamping strips.

iii) Casings should accommodate the expansion of intumescent linings during fire conditions.

iv) Intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accord with the pipe manufacturer's requirements.

v) Individual sleeves mounted on vertical pipework should:

- be of construction suitable for surface mounting;
- not exceed 200mm in length;
- be fitted with a flanged galvanised steel collar, the flange of which should be drilled for bolt type fixings;
- be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar buttoned up against the fire barrier and the flange bolted into position).

vi) Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

6.26 The contractor should:

i) check that the exterior of the piping is marked at intervals not exceeding 1 metre with the manufacturer's name, type of material, pipe size and standard with which it complies,

ii) check that all the piping and fittings supplied are uniform in colour density, and

iii) exercise particular care in storage, handling and installation, of all piping and fittings to avoid deterioration due to ultra violet light (including daylight) and impact damage.

6.27 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported as indicated upon the drawings and as detailed within the contract documents.

6.28 It is incumbent upon the contractor to ensure that any pipe cleaners being used are within their designated shelf life. Any materials found to be beyond their shelf life should be removed from site.

6.29 It is essential that cleaners are correctly applied to the pipe ends and sockets prior to fusion and electrofusion jointing with cleaning pads changed regularly in accordance with manufacturer's instructions. After fusion jointing, a ring of polybutylene will be visible on the outside of the pipe, as evidence that a joint has been completed. After electrofusion jointing an indicator ‘pip’ will raise above the surface of the fitting as evidence that a joint has been completed.

6.30 Great care should be taken to ensure that the manufacturer's installation procedures are followed and, in particular, that the full cooling period is maintained before any joint is considered to be complete.

6.31 Care should be exercised to ensure that, where practical, the PB pipework does not suffer the effects of heat from other pipes and appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 (xiv) should be applied.

6.32 On no account should ladders, scaffold or other building items be propped up against the PB pipework installation.

6.33 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. Changes in direction can be achieved using the pipes’ flexibility in accordance with the manufacturer's instructions. No thermally induced bending of PB pipes, through the application of local heating, should be permitted.

6.34 All PB pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 6.2 or as advised and confirmed by the pipe manufacturer.

NOTE: Some manufacturers supply a metal support tray system for use with pipework up to and including 63mm diameter.

The use of this support system increases the distance between supports and therefore reduces number of support brackets required.

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6.35 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the "maximum intervals" stated or advised for each of the pipes being supported.

6.36 If fixed brackets are being used to avoid longitudinal expansion of PB pipes, the installation of both the pipe and bracket manufacturers should be located at fittings and must grip the pipe on both sides of the fitting, or according to manufacturer's instructions.

6.37 PB pipework in exposed positions (or where distortion is likely to occur) should be supported using the piping manufacturer's standard pipe clip or support pipe carrier tray.

Table 6.2: Support Bracket Spacing; 60°C (without support tray)

Pipe Outside Diameter (mm)	Maximum Interval	
	Horizontal (metres)	Vertical (metres)
16	0.64	0.83
20	0.72	0.94
25	0.75	0.98
32	0.85	1.10
40	0.95	1.24
50	1.06	1.38
63	1.19	1.55
75	1.30	1.70
90	1.42	1.85
110	1.73	2.25

NOTE: For support centres utilising support tray, consult relevant manufacturer's literature.

6.38 Where PB piping is supported using other than standard PB pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to a rail support or the building fabric.

6.39 Thermal expansion/contraction of the material must be taken into account during both the design stage and installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

NOTE: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

7. PE-X Pipework Specification

General

7.1 Requirements specific to the design and installation of PE-X pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

7.2 PE-X pipework and fittings intended for the conveyance of potable cold water and hot water service for use within Scottish Healthcare Premises (SHPs) should comply with the requirements of the following:

DIN 4726
DIN 16892
BS 7291 Parts 1 and 3

7.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

7.4 The working pressures and operating temperatures of PE-X pipework and fittings are listed for guidance in Table 7.1.

Table 7.1: PE-X pipework - working pressures/operating temperatures

Pressure Ratings – Pipe, Fittings and Valves		
Product	**Size**	**Pressure Rating at 80°C**
Fittings	All	As advised by respective manufacturer
Valves	All	As advised by respective manufacturer
Pipe	15mm - 28mm	6 Bar
Pipe	32mm - 110mm	6 Bar

*NB**:** The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the materials.*

Normal operating temperatures will be in the range 10°C – 60°C.

NOTE: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

7.5 The whole of the PE-X pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

BS 6700
SHTM 2040
SHTM 2027
HS(G) 70

and the relevant manufacturer's instructions.

7.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

7.7 It should be noted that whilst BS 7291 only covers PE-X piping up to 35mm outside diameter, PE-X pipe and fittings are available in a range of sizes up to and including 110mm.

Pipes

7.8 All PE-X piping used in DHCW services pipework systems in SHPs should be to BS 7291: Parts 1 and 3 DIN 4726/ DIN 16892.

Pipe fittings and valves

7.9 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be supplied/or approved by the pipework manufacturer for use with the pipework system.

7.10 Valves for PE-X pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

i) Gunmetal gate valves complying with BS 5154, complete with flanged bush connectors for pipes over 63mm outside diameter or with threaded connectors for pipe up to and including 63mm outside diameter may be supplied by the pipe or fittings manufacturer provided they are manufactured entirely from non-dezincifiable materials.

ii) Also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

7.11 Where servicing ball valves are required at fitments these shall be of non dezincifiable construction with compression ends suitable for direct connection to PE-X pipework, with approved pipe with support liners.

Cleanliness requirements

7.12 As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplies, to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

7.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

7.14 The pipes should be delivered in straight lengths with each and every end securely capped against the ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier. Smaller bore pipes shall be delivered in individually boxed coils.

NOTE: Any pipes delivered unprotected or with open ends should be rejected.

7.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

7.16 The pipes and fittings should be entirely compatible with each other, and jointing should be carried out in strict accordance with the manufacturer's printed instructions.

7.17 Unless indicated otherwise, the pipe joints in PE-X pipework should be made by compression type joints. The specification for these should be dependent on the manufacturer of the PE-X piping and the joints should in all respects be compatible with the installed pipework. They should comprise either:

i) type A compression fittings to BS 864 Part 2 (DZR) complete with pipe support inserts for use with pipework 15mm - 28mm diameter;

or

ii) couplings specifically designed for the connection of PE-X piping for diameter 35mm - 100mm.

7.18 Screwed adaptor fittings should be used at screwed joints to appliances and the like.

Pipework system

7.19 The piping contractor should provide samples of the following for approval:

- PE-X piping;
- PE-X pipework valves, or (if applicable) gunmetal gate valves and connectors;
- PE-X pipework bends, tees and tap connectors;
- DZR compression fittings for use with PE-X pipework.

7.20 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system be proceeded with until these samples have been approved in writing.

7.21 The approved samples should be retained on site for comparison with the work as actually installed.

7.22 No PE-X pipework should be connected direct to any heat source (for example, a secondary domestic hot water heater). Final connections up to a length of 1.0 metre, or as advised by the manufacturer of the PE-X pipework, should be made with stainless steel pipe and clearance between PE- X piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5 metre.

Fire sleeves

7.23 Fire sleeves should be used where PE-X pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

i) They should be constructed with an outer galvanised steel casing and intumescent lining.

ii) Each sleeve should be manufactured in two longitudinal half sections. The sections should be jointed together, around the pipe, utilising galvanised steel slide on clamping strips.

iii) Casings should accommodate the expansion of intumescent linings during fire conditions.

iv) Intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accordance with the pipe manufacturer's requirements.

v) Individual sleeves mounted on vertical pipework should:

- be of construction suitable for surface mounting;
- not exceed 200mm in length;
- be fitted with a flanged galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
- be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position).

vi) Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

7.24 The contractor should:

i) check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;

ii) check that all the piping and fittings supplied are uniform in colour density;

and

iii) exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

7.25 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

7.26 Great care should be exercised to ensure that, where practical, the PE-X pipework does not suffer from the effects of undue heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 (xiv) should be applied.

7.27 On no account should ladders, scaffold or other building items be propped up against the PE-X pipework installation.

7.28 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PE-X piping any offsetting required should be formed using fittings, or bending of the pipes in accordance with manufacturer's directions.

7.29 All PE-X pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer) the spacing of which should not exceed the maximum intervals given in Table 7.2 or as advised and confirmed by the pipe manufacturer.

Table 7.2: Support Bracket Spacing; 60°C

Pipe Outside Diameter (mm)	Maximum Interval	
	Horizontal (metres)	Vertical (metres)
15	0.4	0.5
22	0.6	0.8
28	0.65	0.85
32	0.8	1.0
40	1.0	1.3
50	1.2	1.6
63	1.3	1.7
75	1.45	1.9
90	1.6	2.1
110	1.6	2.1

7.30 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

7.31 PE-X pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

7.32 Where PE-X piping is supported using other than standard PE-X pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

7.33 Thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent on the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

> **NOTE:** The manufacturer's guidance and recommendations should be adopted at both stages of the work.

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7.34 The high co-efficient of linear expansion for PE-X compared to metallic pipework results in considerable movement of the pipework due to changes in temperature. This thermal movement is a function of the change in average temperature of the pipe wall. This temperature depends on internal and external environment temperatures.

7.35 To accommodate thermal movement, loops/offsets are included within the pipework system (sized in accordance with the manufacturer's data and the relevant temperature differentials).

8. Water Filtration

General

8.1 This section gives guidance on the filtration of incoming cold water supplies for domestic use in Scottish Healthcare Premises (SHPs).

8.2 The quality of water is coming under increasingly close scrutiny. Examinations of domestic water systems in numerous Scottish hospitals have revealed that significant deposits of sediment and debris can occur in pipework. These deposits can give rise to breeding grounds for health debilitating bacteria as well as biofilms which can ultimately cause deterioration of adjacent material surfaces. To avoid these potentially damaging circumstances, all incoming cold water supplies destined for domestic use within SHPs should be filtered.

Requirements

8.3 Filtration should be introduced to:

i) ensure that domestic water supply and hence all associated pipework is maintained at high standard of cleanliness, from the supply point to all potable water outlets.

ii) reduce the build-up in water systems of sediments and deleterious biofilms, which may act as nutrient sources for bacteria.

Limitations

8.4 Filtration should not be installed as a means of:

i) sterilising or disinfecting water;

or

ii) improving the potability of water.

8.5 Filtration need not be a requirement for incoming cold water destined for non-domestic use, such as fire fighting, boiler feed or other chemically treated or dosed systems.

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Responsibilities

8.6 It is the responsibility of the water supplier to ensure water reaches the end user in a potable condition. It is the responsibility of the end user to ensure that the water remains potable from point of receipt to point of discharge at potable outlets. Thus, filtration plant must not result in any degradation of the water supply.

8.7 It should be noted that the Control of Substances Hazardous to Health Regulations 1999 impose a personal responsibility on managers to enforce codes of practice relating to potentially harmful micro-organisms.

Description

8.8 Filtration is normally used to prevent ingress of suspended solids into plant and pipework, and as such may be defined as the process of separating solids from liquids using a porous medium. The medium could consist of granular materials (sand, clay, carbon etc.) assisted by chemical and/or bacterial activity, woven meshes and screens made of metals, fabrics, ceramics and polymeric membranes.

8.9 Filtration plants are usually specified by various criteria including minimum particle size diameter retained, expressed in microns. 'Absolute filtration' of a given size indicates that a plant can remove 99.9% of all particulates above a given size. 'Nominal filtration' is normally taken to mean that 95% of all particulates above the specified size will be removed.

8.10 As a guide, suspended materials are normally classified as shown in Table 8.1.

Table 8.1: Classification of suspended materials

Material	Particle Diameter (mm)	Particle Diameter (micron)
Pebbles	>10	-
Gravel	10 -2	-
Very Coarse Sand	2 -1	-
Coarse Sand	1 - 0.5	1000 - 500
Medium Sand	0.50 - 0.25	500 - 250
Fine Sand	0.25 - 0.10	250 - 100
Silt	0.10 - 0.01	100 - 10
Clay	<0.01	<10
Colloid	10^{-4} - 10^{-6}	0.1 - 0.001

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8.11 In practice, water will contain a range of sizes of suspended particulates. The rate of blockage by suspended solids for any given filter will depend on a number of factors such as:

- throughput;
- concentration of suspended solids and other fouling debris;
- size distribution;
- shape of particulates.

8.12 Particles less than 0.1 micron are invisible microscopically. The smallest visible particle is approximately 40 microns in diameter. Particles less than 0.001 micron are considered to be dissolved and in solution.

8.13 The level of filtration within SHPs where thermoplastic pipework systems are installed should be 5 micron absolute.

8.14 The level of filtration within SHPs where stainless steel pipework systems are installed should be 0.5 micron absolute.

Process selection

8.15 Plant should be selected to meet the operational requirements of the particular Unit and satisfy the requirements of the user. Generally a filtered water storage cistern would be provided to cope with heavy peak hourly demands.

Water throughput

8.16 The sizing of the filtration plant is obviously dependent upon water throughput, and is usually specified in litres or cubic metres per hour. This requirement can give rise to gross over estimation since design estimates using the relevant CIBSE guides or SHTM 2027, yield data in litres per second. A problem arises therefore in deriving hourly rates from this data, since appropriate outlet diversity factors for each type of hospital would be required to enable extrapolation to hourly demand rates. Such extrapolation may not be linear and would be most unlikely to be a constant of the value of 3,600.

8.17 Until more appropriate design data is available it is proposed that conventional estimates be compared with the consumption data presented in Figures 8.1 to 8.6. The data shown has been taken from the annual water consumption records for Scottish hospitals for the years 1995 to 1998 and has been sorted to show annual consumption versus numbers of staffed beds.

8.18 The data presented does not differentiate between hospitals with laundries, or laboratories and those without. These special facilities will need to be taken into account bearing in mind that laboratories often include constant demand devices such as coolers.

8.19 Also the data is provided as a guide to assist checking that estimated values are reasonable, e.g. Fig. 8.6 indicates that hospitals having between 400-600 beds might consume about 100,000 cubic metres of water annually, i.e. around 11 cubic metres/hour on average over a 24 hour period. However, peak hourly demands may reach 50 cubic metres/per hour.

NOTE: Where filtration plant is to be installed within existing premises/ refurbishment projects, the existing water metering device should be accurately monitored to provide the designer with data to prepare overall water usage profile and peak hourly demands to enable selection of the most economical plant to achieve the required filtrate flow rate.

Design features

8.20 The filtration equipment supplied should satisfy the filtration levels stated in paragraph 8.13.

8.21 Where possible filtration plant should be capable of providing fully automatic operation. It should include self cleaning and 'back-washing' modes so that the filter medium itself does not become a reservoir of bacteria capable of contaminating the service pipework.

8.22 Where air compressor and associated equipment are used, these should conform to the Code of Practice set out in BS 6244 and be mounted within or adjacent to the main filtration unit framework. All control and operating functions should be fully integrated with, and operated from, the main filtration plant control console.

8.23 Filtration plant support framework (when fitted) should be manufactured from a suitable quality steel adequately protected against deterioration from atmospheric corrosion. In addition suitably identified lifting points and attachments should be provided, so that when the complete unit is lifted, no distortion or transference of external loads to the contained filtration plant piping or its components takes place.

8.24 The filtration plant should be fitted with suitable by-pass connections (blanked off) connecting outlet piping. In addition, a suitable by-pass connecting pipe should be supplied but **not** fitted. Such a by-pass must be disinfected before being put into use.

8.25 Consideration should be given to the provision of flow meters directly connected to hospital computerised Building Management Systems where fitted.

8.26 Consideration should also be given to ensuring that any electronic micro-chip equipment is protected against supply voltage surges. The filtration plant should be connected to the 'essential' electricity supply busbar, supported by a standby generator.

8.27 The installation of all electrical equipment should comply with BS 7671, the Electrical Wiring Regulations, SHTM 2011, SHTM 2020 and equipment containing 'live' parts or components in accordance with BS 2754. The equipment supply and operation parameters should be in accordance with the Electricity Supply Regulations (1988). All specific items of electrical equipment should conform to the relevant British Standard.

Materials

8.28 All materials should comply with the requirements specified in Section 2. Advice on such materials is available from the Healthcare Engineering and Environment Unit, on behalf of the NHS in Scotland, Estates Environment Forum, based on criteria and advice provided by WRc plc.

Operational experience

8.29 The introduction of domestic water systems filtered water supplies is a recent innovation in SHPs and to provide assistance to designers and hospital engineers in the selection, choice, and design of future systems, some examples of the experience gained to date in the design and operation of plant already installed in Scottish hospitals is given below.

8.30 The simplest form of filter is the 'strainer' type which is a perforated metal sheet, the size of perforation being determined by the size of debris the filter or strainer is designed to remove. The early perforated metal sheets have now been generally replaced by more sophisticated designs using paper or plastic felt sheets or membranes designed to withstand the range of fluid pressures pertaining to the particular water or gas system involved. These type of filters are often referred to as 'dead end' filters since they do not normally incorporate 'backwash' facilities. Collected debris is retained and the filter must be replaced when blocked and giving rise to unacceptable pressure losses and correspondingly reduced water flows.

8.31 'Dead end' filters are therefore the best suited for use in systems in which the water particulate content is low, or in conjunction with other units to act as pre-filters for the removal of larger particulate. It is also important to note that filters can harbour and spawn bacteria and must therefore be cleaned and disinfected on a regular basis to avoid infection of the total water system.

8.32 In addition to the above, Local Authority mains water systems and in particular those using old cast iron or mild steel pipework systems, are often subject to spasmodic flurries of iron oxide corrosion debris. This can occur when mains isolating valves are adjusted to alter system mains water pressures. The effect of these flurries is to 'swamp' water storage cisterns and inline filters with heavy depositions of debris, causing blocked filters and considerable expense.

8.33 To meet the levels of filtration called for in this SHTN requires the provision of suitably designed equipment of proven performance, capable of running unattended for long periods of time and fitted with automatic backwashing and self cleaning facilities.

8.34 The availability of cross-flow units incorporating automatic back flushing and self cleaning facilities, providing particulate filtration down to the required level greatly influenced the practicality of achieving high quality clean water for use in hospitals. These units have proved very successful and it is of particular note that much of this success has been due to the proven reliability of the unit control pack.

8.35 In addition, as mentioned in paragraph 8.24 above, it was initially considered necessary to ensure continuity of domestic water services in the event of failure of the filtration plant, to provide but not fit a by-pass between the filter plant inlet and outlet water supply points. This requirement was maintained in spite of manufacturer's statements that all key items of the filtration units could be replaced well within the timescale dictated by the filtered water reserve storage capacity.

8.36 Since then, experience has shown that rather than adopt the extreme remedy outlined in paragraph 8.34 above, in which the water systems could be contaminated with 'dirty' water, (thus undoing all the initial care and expense to provide clean water pipework systems), alternative arrangements of filters can be made to maintain the integrity and cleanliness of the water pipework systems and these are briefly discussed below.

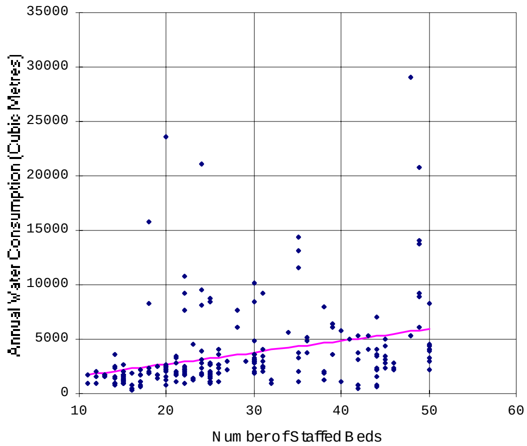
8.37 One possibility is to incorporate a series of 'dead end' filters into the proposed by-pass loop identified in paragraph 8.35 above. In this instance the emergency by-pass system would be isolated using locked double non-return valves, so that the by-pass system and filters cannot be accidentally brought into use.

NOTE: In this arrangement drains and vents require to be fitted and commissioning procedures should comply with those outlined in paragraph 2.65 of this SHTN.

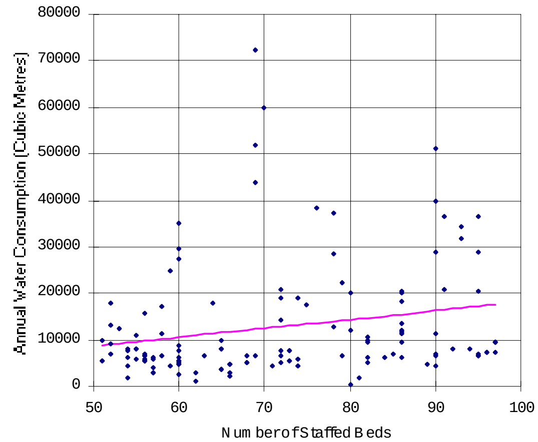
8.38 Alternatively and although not the cheapest option, on occasion two units have been installed. These units can be designed on the basis of say 2 x 100% or 2 x 75% duty machines depending upon the design considerations. In this arrangement it has been found best to run the machines alternately and to design the control circuitry such that for normal water demand rates one machine runs to meet the demand, but in the event that this is not enough then the second machine is also automatically brought into operation.

8.39 These units discharge the backwash products at high pressure. These waste products should be discharged to drain via a small closed tank, so that no aerosol dispersion of infected water takes place. Where twin filtration units are installed a common waste tank should be used.

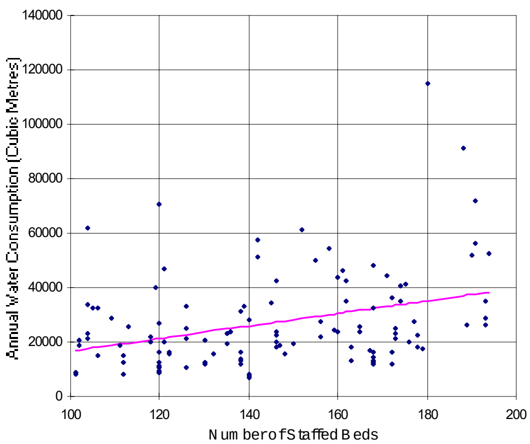
Water Regression Analysis Charts for 1995-96 to 1997-98



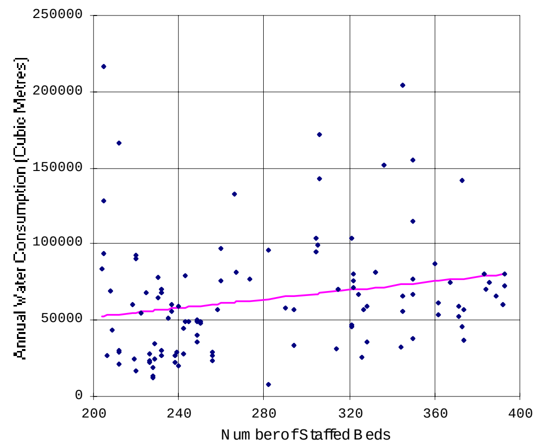
Annual Water Consumption 1995-96 to 1997-98 (10 to 50 Beds)



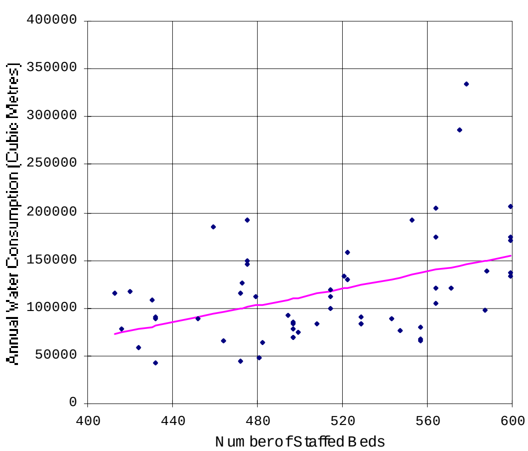
Annual Water Consumption 1995-96 to 1997-98 (50 to 100 Beds)



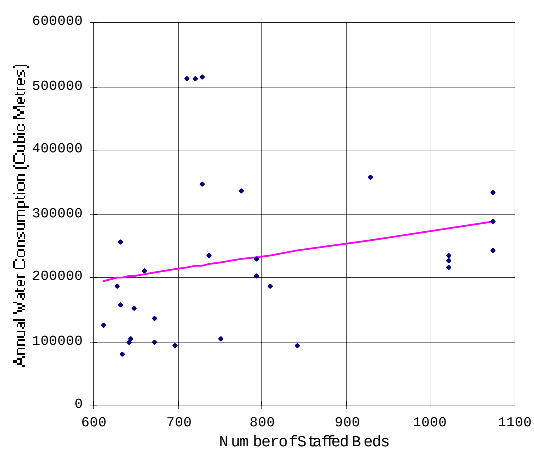
Annual Water Consumption 1995-96 to 1997-98 (100 to 200 Beds)



Annual Water Consumption 1995-96 to 1997-98 (200 to 400 Beds)



Annual Water Consumption 1995-96 to 1997-98 (400 to 600 Beds)



Annual Water Consumption 1995-96 to 1997-98 (600 + Beds)

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References

NOTE:
Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
Acts and Regulations				
	Building (Scotland) Act	HMSO	1959	
	Clean Air Act	HMSO	1993	
	Electricity Act	HMSO	1989	
	Health and Safety at Work etc Act	HMSO	1974	
	Registered Establishments (Scotland) Act	HMSO	1998	
	The Water (Scotland) Act	HMSO	1980	
SI 2179 & 187	Building Standards (Scotland) Regulations	HMSO	1990	
	Building Standards (Scotland) Regulations: Technical Standards Guidance	HMSO	1998	
SI 1460	Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2)	HMSO	1997	
SI 437	Control of Substances Hazardous to Health Regulations (COSHH)	HMSO	1999	
SI 3140	Construction (Design and Management) Regulations	HMSO	1994	
SI 635	Electricity at Work Regulations	HMSO	1989	
SI 1057	Electricity Supply Regulations	HMSO	1988	
SI 2372	Electromagnetic Compatibility Regulations	HMSO	1992	
SI 3080	Electromagnetic Compatibility (Amendment) Regulations	HMSO	1994	
SI 2451	Gas Safety (Installation and Use) Regulations	HMSO	1998	
SI 1380	Health and Safety (Training for Employment) Regulations	HMSO	1990	
SI 917	Health & Safety (First Aid) Regulations	HMSO	1981	
SI 682	Health & Safety (Information for Employees) Regulations	HMSO	1989	

Publication ID	Title	Publisher	Date	Notes
SI 2792	Health and Safety (Display Screen Equipment) Regulations	HMSO	1992	
SI 341	Health and Safety (Safety Signs and Signals) Regulations	HMSO	1996	
SI 2307	Lifting Operations and Lifting Equipment Regulations (LOLER)	HMSO	1998	
SI 2793	Manual Handling Operations Regulations	HMSO	1992	
SI 3242	Management of Health and Safety at Work Regulations	HMSO	1999	
SI 1790	Noise at Work Regulations	HMSO	1989	
SI 3139	Personal Protective Equipment (EC Directive) Regulations	HMSO	1992	
SI 2966	Personal Protective Equipment at Work (PPE) Regulations	HMSO	1992	
SI 2306	Provision and Use of Work Equipment Regulations (PUWER)	HMSO	1998	
SI 3163	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	HMSO	1995	
SI 3004	Workplace (Health, Safety and Welfare) Regulation	HMSO	1992	
United Kingdom Water Byelaws Scheme				
Byelaw 30	Cisterns storing water for domestic purposes			
Byelaws 51 & 52	Materials and construction of water fittings			
British Standards				
BS 3605	**Austenitic stainless steel pipes and tubes for pressure purposes**	BSI Standards		
	Part 1: Specification for seamless tubes		1991	
	Part 2: Specification for longitudinally welded tubes		1992	
BS 864	**Capillary and compression tube fittings of copper and copper alloy**	BSI Standards		
	Part 2: Specification for capillary and compression fittings for copper tubes		1983	

Publication ID	***Title***	***Publisher***	***Date***	***Notes***
BS 4504	**Circular flanges for pipes, valves and fittings (PN designated)**	BSI Standards		
	Part 3: Steel, cast iron and copper alloy flanges Section 3.1: Specification for steel flanges		1989	
BS 4368	**Compression couplings for tubes**	BSI Standards		
	Part 3: Specification for light series couplings (metric)		1974 (1984)	
BS 4346	**Joints and fittings for use with unplasticized PVC pressure pipes**	BSI Standards		
	Part 1: Injection moulded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply		1969	
	Part 3: Specification for solvent cement		1982	
BS 2754	**Memorandum. Construction of electrical equipment for protection against electric shock**	BSI Standards	1976	
BS 1415	**Mixing valves** Part 1: Non-thermostatic, non-compensating mixing valves	BSI Standards	1976	
	Part 2: Specification for thermostatic mixing valves		1986	
BS 1400	**Specification for copper alloy ingots and copper alloy and high conductivity copper castings**	BSI Standards	1985	
BS 4127	**Specification for light gauge stainless steel tubes**	BSI Standards	1994	
	Part 2: Metric Units		1972	
BS 10	**Specification for flanges and bolting of pipes, valves and fittings**	BSI Standards	1962	Obsolescent
BS 2971	**Specification for Class II arc welding of carbon steel pipework for carrying liquid**	BSI Standards	1991	
BS 3505	**Specification for unplasticized polyvinyl chloride (PVC0U) pressure pipes for cold potable water**	BSI Standards	1986	
BS 2494	**Specification for elastomeric seals for joints in pipework and pipelines**	BSI Standards	1990	

Publication ID	Title	Publisher	Date	Notes
BS 5154	**Specification for copper alloy globe, globe stop and check, check and gate valves**	BSI Standards	1991	
BS 5257	**Specification for horizontal and end-suction centrifugal pumps (16 bar)**	BSI Standards	1975	
BS 5970	**Code of practice for thermal insulation of pipework and equipment (in the temperature range -100°C to +870°C)**	BSI Standards	1992	
BS 6244	**Code of Practice for Stationery Air Compressors**		1982	
	ISO Quality Systems **Principal concepts and applications**	British Standards		
BS EN ISO 9000-1	Guide to selection and use		1994	
BS EN ISO 9004-1	Guide to quality management and quality system elements		1994	
BS EN ISO 9001	Specification for design/development, production, installation and servicing		1994	
BS EN ISO 9002	Specification for production and installation		1994	
BS EN ISO 9003	Specification for final inspection and test		1994	
BS 7671	**Requirements for electrical installation IEE Wiring Regulations 16th Edition**	BSI Standards	1992	
BS 5779	**Specification for spray mixing taps**	BSI Standards	1979	
BS 5955	**Specification for Plastic Pipework (thermoplastic material) Part 8**	BSI Standards	1990	
BS 6700	**Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages**	BSI Standards	1997	
BS 6920	**Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water**	BSI Standards		
	Part 1: Specification		1996	
	Part 2: Method of Test		1996	
	Section 2.1 Samples for testing			
	Section 2.2 Taste of water		1996	
	Subsection 2.2.1 General method of test,		1996	
	Subsection 2.2.2 Method of testing tastes imparted to water by hoses		1996	

Publication ID	Title	Publisher	Date	Notes
	Subsection 2.2.3 Method of testing tastes imparted to water by hoses for conveying water for food and drink preparation, Section 2.3 Appearance of water Section 2.4 Growth of aquatic micro-organisms Section 2.5 The extraction of substances that may be of concern to public health Section 2.6 The extraction of metals Part 3 High temperature tests Part 4 Method of test. Identification of water leachable organic substances Part 8 Plastic Pipework (Thermoplastic Material) Specification for the installation of thermoplastics.		 1996 1996 1996 1996 1996 1996 1990	
BS 7475	**Specification for fusion welding of austenitic stainless steels**	BSI Standards	1991	
BS 7291	**Thermoplastic pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings** Part 1: General requirements Part 2: Specification for polybutylene (PB) pipes and associated fittings Part 3: Specification for crosslinked polyethylene (PE-X) pipes and associated fittings Part 4: Specification for chlorinated polyvinyl chloride (PVC-C) pipes and associated fittings and solvent cement	BSI Standards	1990 1990 (1995) 1990 (1995) 1990 (1995)	
British Standards - Codes of Practice				
CP 312	**Code of practice for plastic pipework (Thermoplastics material)** Part 2: Unplasticized PVC pipework for the conveyance of liquids under pressure	BSI Standards	1973	
British Standards - European				
BS EN 287-1	**Approval testing of welders for fusion welding: Steels**	BSI Standards	1992	
BS EN 10088-2	**Stainless Steel Technical Delivery conditions**	BSI Standards	1995	

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Publication ID	Title	Publisher	Date	Notes
German Industrial Standards				
DIN 8079	Chlorinated Polyvinylchloride pipe measurements			
DIN 1988	Codes of practice for drinking water installations(TRWI); planning, operation, component parts, apparatus, materials DVGW		1988	
DIN 16892	Crosslinked polyethylene (VPE) pipes; general quality requirements, testing		1985	
DIN 2353	Non-soldering compression fitting with cutting ring			
DIN 8063	Part 4: Pipe joint assemblies and fittings for unplasticized polyvinyl chloride (PVC-U) pressure pipes; bushings, flanges, seals, dimensions		1983	
DIN 3441	Part 5: Unplasticized polyvinyl chloride (PVC-U) valves, PN 6 and PN 10 wafer type butterfly valves		1984	
DIN 8080	Pipes made of Chlorinated Polyvinylchloride; General Quality requirements and testing			
DIN 4726	Pipelines of plastic materials used in warm water floor heating systems; general requirements			
DIN 16968 & 16969	Pipes of polybutylene (PB)			
DIN 2463	Relating to stainless steel pipework systems			
International Standards Association (ISO)				
ISO 2536	Unplasticized polyvinyl chloride (PVC-U) pressure pipes and fittings, metric series - Dimensions of flanges		1974	
ISO 7508	Unplasticized polyvinyl chloride (PVC-U) valves for pipes under pressure - Basic dimensions - metric series		1985	

Publication ID	Title	Publisher	Date	Notes
Scottish Health Technical Guidance				
SHTM 2045	Acoustics	EEF	1999	CD-ROM
SHTM 2023	Access and accommodation for engineering services	EEF	1999	CD-ROM
SHTM 2005	Building management systems	EEF	1999	CD-ROM
SHTM 2040	Control of legionellae in healthcare premises – a code of practice	EEF	1999	CD-ROM
SHTM 2020	Electrical safety code for low voltage systems (Escode – LV)	EEF	1999	CD-ROM
SHTM 2007	Electrical Services Supply & Distribution	EEF	1999	CD-ROM
SHTM 2011	Emergency electrical services	EEF	1999	CD-ROM
SHTN 4	General purpose safe system of work	EEF	1997	
SHPN 1	Health service building in Scotland	HMSO	1991	
SHPN 2	Hospital briefing and operational policy	HMSO	1993	
SHTM 2027	Hot and cold water supply, storage and mains services	EEF	1999	CD-ROM
Letter ref. BHE/1/1	Healthcare Premises: Copper Corrosion in Hot and Cold Water Services NHS in Scotland	NHSiS	12/10/ 1990	
	NHS in Scotland – Scotconcode	EEF	1999	Version 3
SHTN 1	Post commissioning documentation for health buildings in Scotland	HMSO	1993	
SHGN	'Safe' hot water and surface temperatures	EEF	1999	CD-ROM
NHS in Scotland Firecode				
HTM 82	Alarm and detection systems	EEF	1998	CD-ROM
Fire Practice Note 6	Arson prevention and control in NHS healthcare premises	EEF	1998	CD-ROM
Fire Practice Note 5	Commercial enterprises on hospital premises	EEF	1998	CD-ROM
Fire Practice Note 3	Escape bed lifts	EEF	1998	CD-ROM
HTM 84	Fire safety in NHS residential care properties	EEF	1998	CD-ROM
HTM 85	Fire precautions in existing hospitals	EEF	1998	CD-ROM
HTM 86	Fire risk assessment in hospitals	EEF	1998	CD-ROM
HTM 81	Fire precautions in new hospitals	EEF	1998	CD-ROM
HTM 83	Fire safety in healthcare premises: general fire precautions	EEF	1998	CD-ROM

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
Fire Practice Note 7	Fire precautions in patient hotels	EEF	1998	CD-ROM
Fire Practice Note 4	Hospital main kitchens	EEF	1998	CD-ROM
Fire Practice Note 10	Laboratories on hospital premises	EEF	1998	CD-ROM
HTM 87	Textiles and furniture	EEF	1998	CD-ROM
Miscellaneous References				
B 280-86	ASTM Designation: Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service			
C01	Common Services Mechanical, NHS Regional Estates Managers' Group			
EH 40	HSE Occupational Exposure limits	HSE Books	Annual	
	Hospital Engineering Data Sheets Water Consumption	DoH	1973	
MES	Model Engineering Specifications	NHS Estates	1997	As required
	Model Water Byelaws: Dept. of the Environment	HMSO	1986	
Engineering Specification	NHS Model Specification (for Building Services in Healthcare Buildings)	NHS Estates	1992	
HS(G) 70	Prevention or Control of Legionellosis (including Legionnaires' Disease) - Approved Code of Practice Health and Safety Executive ISBN 0 11 885659 6	HMSO	1991	
	Scottish Infection Manual. Guidance on core standards for the control of infection in hospitals, healthcare premises and at the community interface.	The Scottish Office	1998	
	Water Fittings and Materials Directory Water Research Centre	Richard Joseph Publishers	Annual	
	Water Supply Byelaws Guide Editors: S F White and G D Mays ISBN 0 950395 1	WRC plc	1989	

Appendix 1: Case Outline Histories

Monklands DGH. (571 beds)
(Full Replumb of the DHCW Services)
Health Board:Lanarkshire
Design Consultants: DSSR, Glasgow
Main Contractors: Parkinson-Twaddle
Materials:
Cold Water Services: PVC-U (FIP. Ltd)
Hot Water Services: Copper (various)
Hot Water Services: (Experimental): PVC-C (FIP Ltd)
Filtration: Membrane (0.2 Micron) 2 x 30 module units – MEMCOR Ltd.

Inverclyde Royal Hospital (473 beds)
(Experimental Stainless Steel DHCW Services in Laboratory Block leading to Full Replumb of Hospital)
Health Board: ....Argyll and Clyde
Design Consultants: Davie & McCulloch
Main Contractors: Lab – James Frew
Phase 1, Main Risers – Parkinson Twaddle
Phase 1, Ward F, Balfour Beatty/James Frew
Materials:
Laboratory, 304 & 316 Stainless steel with NDZ copper alloy fittings; Risers, 316 Stainless steel; Wards Mannesmann stainless steel system.
Filtration: Membrane (0.2 micron) – MEMCOR Ltd.

Oban DGH. (160 beds)
Health Board: ....Argyll & Clyde
Main Contractor: Henry Boot Ltd
Design Consultants: CSA-BD/DSSR Glasgow
Plumbing Contractor: Parkinson Twaddle
Materials:
Domestic Cold Water: PVC-U (FIP)
Domestic Hot Water: PVC-C (FRIATEC)
Filtration: Membrane (0.2 micron) – MEMCOR Ltd

Lockhart Hospital (30 beds)
Health Board: ....Lanarkshire
Design Consultants: DSSR, Glasgow
Main Contractor: James Frew Ltd
Materials:
DCHW services (replumb): PVC-C (FRIATEC) Filtration: None

Roadmeetings Hospital (110 beds)
Health Board: ....Lanarkshire
Design Consultants: DSSR, Glasgow
Contractors: James Frew Ltd
Materials:
DHCW services (replumb): Mannesmann Stainless Steel System
Filtration: None

Kello Hospital (16 beds)
Health Board: .... Lanarkshire
Design Consultants: Davie & McCulloch
Contractors: James Frew Ltd
Materials:
DHCW services (replumb): PVC-C (FRIATEC Ltd)
Filtration: none

Lady Home Hospital (21 beds)
Health Board: ....Lanarkshire
Design Consultant: Davie & McCulloch
Contractor: James Frew Ltd
Materials:
DHW services (replumb): PVC-C (FRIATEC Ltd)
Filtration: none

Crosshouse Hospital (700 beds)
Health Board: .....North Ayrshire & Arran NHS Trust
Main Contractor: Henry Boot Ltd
Design Consultant: DSSR, Glasgow
Contractor: James Frew/Meadowline Services and ECG
Materials:
Domestic Cold Water Mains: PVC-U (Durapipe)
Domestic Hot and Cold Distribution to various depts: PVC-C (Friatec Ltd) with localised connections and Plant Rooms in stainless steel (Mannesman)
Filtration: Cartridge Plant (5 Micron)

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Glossary

ASTM	American Society or Testing Materials
BS	British Standard
CIBSE	Chartered Institution of Building Services Engineers
DGH	District General Hospital
DHCW	Domestic hot and cold water
DIN	Deutsche Industrie-Norm (German Industrial Standards)
DoH	Department of Health
HSE	Health and Safety Executive
ISO	International Organisation for Standardisation
Legionella	name given to a genus of bacteria of which Legionella pneumophila is one species
Legionellosis	term used for infections caused by legionella pneumophila and other bacteria from the family of Legionellaceae
Legionnaires'	An atypical pneumonia disease caused by Legionella pneumophila and other sero-bacteria
MEK	methyl ethyl ketone
NHS	National Health Service
PCD	Post Commissioning Documentation
ppm	parts per million
PTFE	Polytetrafluoroethylene
PVC-U	Unplasticized polyvinyl chloride
PVC-C	Post chlorinated polyvinyl chloride
PB	Polybutylene
PE-X	Crosslinked Polyethylene
SHP	Scottish Healthcare Premises
SHTM	Scottish Health Technical Memorandum
SHTN	Scottish Hospital Technical Note
TIG	tungsten inert gas (welding process)
UK WBS	United Kingdom Water Byelaws Scheme
WHO	World Health Organisation

NHS National Services Scotland

Scottish Health Technical Memorandum 64

SHTM Building Component Series

Sanitary Assemblies

Health Facilities Scotland
Property and Capital Planning

December 2009

Contents

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Disclaimer

The contents of this document are provided by way of general guidance only at the time of its publication. Any party making any use thereof or placing any reliance thereon shall do so only upon exercise of that party's own judgement as to the adequacy of the contents in the particular circumstances of its use and application. No warranty is given as to the accuracy, relevance or completeness of the contents of this document and Health Facilities Scotland shall have no responsibility for any errors in or omissions therefrom, or any use made of, or reliance placed upon, any of the contents of this document.

1. Introduction

Background

1.1 This is one of a series of Scottish Health Technical Memoranda (SHTMs) which provides specification and design guidance, not adequately covered by current British Standards (BS), on building components for health buildings. The guidance given in this document applies to all new capital projects and whenever refurbishment or repair is required to existing facilities.

A full Reference schedule is provided at the end of this document, including Acts and Regulations, Health Facilities Scotland (HFS) guidance, DoH Resources and British Standards.

1.2 The numbers and titles of the SHTMs:

- 54 User manual;
- 55 Windows;
- 56 Partitions;
- 57 Internal glazing;
- 58 Internal doorsets;
- 59 Ironmongery;
- 60 Ceilings;
- 61 Flooring;
- 62 Demountable storage system;
- 63 Fitted storage system;
- 64 Sanitary assemblies;
- 66 Cubicle curtain track;
- 67 Laboratory fitting out systems;
- 69 Protection.

1.3 The technical information in this series is the result of research and development funded by the Department of Health as part of collaborative working arrangements over a number of years between the Department, the NHS and industry.

Scope and status

1.4 This SHTM contains guidance to assist the design team in the selection, specification and application of sanitary assemblies in healthcare buildings.

1.5 The content of this SHTM does not diminish either the manufacturer's responsibility for fitness for purpose of products or the team's responsibility for selection and application of products to meet project requirements. Design teams are also are reminded of their obligations under The Construction (Design and Management) Regulations 2009 to ensure safe construction. It does not diminish the manufacturer's responsibility for supplying goods fit for purpose nor the design team's responsibility for selecting assemblies to meet project requirements.

Relationship to other data

1.6 This SHTM was prepared for publication in September 2009 and is adapted from core text provided by the Estates and Facilities Division of the Department of Health, England. The main sources of data used in its preparation are listed in the References section. Readers should ensure they use the latest edition of all building legislation, British Standards, Health and Safety Regulations etc, and give first preference to products and services from sources which have been registered under a quality assurance procedure.

1.7 Suppliers offering products other than to British Standards should provide test evidence to show their products are at least equal to such standards. Reference should also be made to the acceptability of water fittings as approved by the Water Regulations Advisory Scheme (WRAS) and published in the 'Water Fittings and Materials Directory' (www.wras.co.uk).

1.8 This SHTM is intended to be read in conjunction with SHTM 2040: 'The control of Legionella, hygiene, 'safe' hot water, cold water and drinking water systems', Health Building Note (HBN) 00-02: 'Sanitary spaces' and Scottish Health Facilities Note (SHFN) 30: 'Infection control in the built environment' in addition to SHTMs 56: 'Partitions', 62: 'Demountable storage system', 63: 'Fitted storage system' and 67: 'Laboratory fitting out systems' in this series and also HTM 69: 'Ducts and panel assemblies'. The design team should make reference to this SHTM and give early consideration to sourcing sanitary assemblies and duct panels for their project. Some manufacturers offer complete pre-assembled units.

1.9 This guidance should be used in conjunction with sections of the National Building Specification (NBS) relevant to sanitary assemblies. NBS is a library of standard specification clauses covering most kinds of building work and comprising a wide range of clauses with accompanying guidance notes. All clauses are optional, and their combination into a job specification is left to the specifier. NBS has great flexibility and it can be adapted to suit the technical needs and preferences of different projects, organisations and specifiers. Specifications go out of date as a result of technical innovation or major review of a key BSI document. As NBS sections become affected by such major changes, they are re-issued to members of the subscription service. Users are advised to ensure that they refer to the current edition. Refer to the NBS website at www.thenbs.com

1.10 Any enquiries regarding the technical content of this SHTM should be e-mailed to nss.hfsenquiries@nhs.net

Terminology

1.11 Throughout this SHTM the following definitions apply:

- **General pattern -** for use by hospital staff, patients and the public in general i.e. in other words, non-clinical use;
- **Hospital pattern -** for use by clinical staff in connection with clinical procedures.
- **Sanitary assembly -** an assembly comprising a soil or waste appliance and appropriate supply and waste fittings;
- **Soil appliance -** an appliance for the reception and discharge of excretory matter;
- **Supply fitting -** a fitting to control or regulate the supply of water, commonly used with an appliance;
- **Waste appliance -** an appliance for the reception of water for ablutionary, cleansing, or culinary purposes and its discharge after use;
- **Waste fitting -** a fitting to conduct the discharge from an appliance and to connect to pipework.

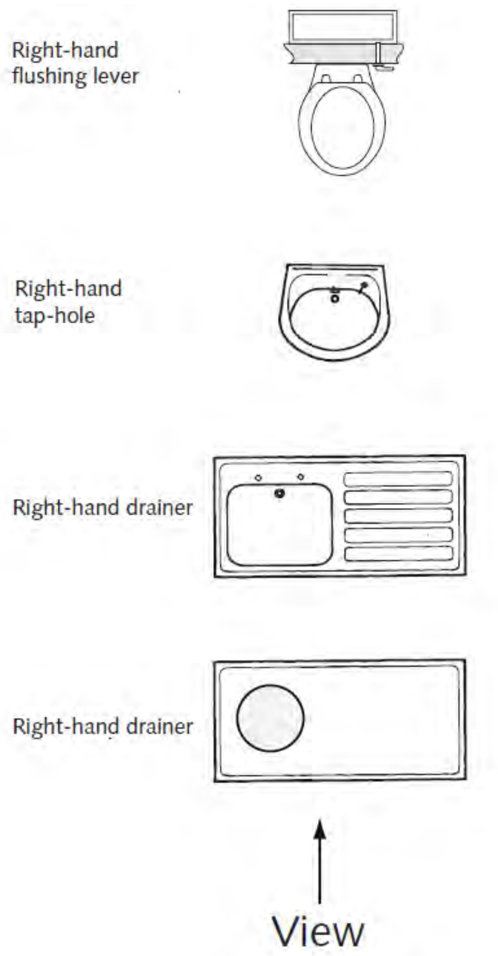

Figure 1: Handing of an appliance is determined from the front of the appliance

2. Design and specification notes

User requirements

2.1 The design team should identify user requirements for sanitary assemblies from Activity DataBase (ADB) and then use the data sheets in Section 4 of this SHTM to identify appropriate assemblies.

Soil assemblies

Relationship between appliances and fittings

2.2 The relationship between soil appliances and the fittings that make up the complete assembly is critical.

2.3 Therefore, disposal units, urinals and WCs should be treated as assemblies for the purposes of design, specification, procurement and installation.

Disposal units

2.4 A hospital pattern disposal unit should be provided in clinical areas for the disposal of solid and liquid waste, the contents of vomit bowls, drainage bags and urine bottles.

2.5 The unit can also act as a standby in the event of the failure of a bed-pan disposal unit (macerator).

Urinals

2.6 Bowl urinals are more hygienic and easier to install than slabs.

2.7 Assemblies of one, two and three bowls are available in the hospital pattern assembly with concealed services and cistern.

2.8 Water economy should be considered when choosing urinals.

2.9 Additionally, waterless urinals could be considered. Using an appropriate cleaning regime, waterless urinals can eliminate all supply services (resulting in better hygiene), reduce duct depth and eliminate the splashing, spray and medium for bacteria associated with water-fed urinals.

WCs

2.10 Hospital pattern WCs should be rimless, wash-down pans and be of the 'back-to-wall' or 'wall-hung' type with concealed cistern and services.

2.11 Access for sanitary chairs and wheelchairs should be carefully considered. This will involve coordinating the dimensions of chairs with those of WC assemblies and any necessary adjustment to the location of the WC in relation to the wall behind it, or to the height from floor level, to facilitate transfer of patients to and from the chair.

2.12 The Building (Scotland) Regulations require adequate provision of, and the maximum travel distance to, accessible WC facilities. Consideration will be required for suitable provision of such facilities in all areas/departments for use by patients and staff and also general areas where they may be required for use by visitors.

2.13 For further information refer to HBN 00-02: 'Sanitary spaces', the Building (Scotland) Regulations, and BS 4751 'Mobile sanitary chairs'.

2.14 All pans should have a horizontal or 'P' outlet so that the soil pipe can be connected above floor level. This gives flexibility in setting out pans and pipework and allows access to the joint for both installation and maintenance.

2.15 A variety of WC connectors are available which can accommodate different configurations between the outlet and the soil pipe (see BS 5627:1984 'Specification for plastics connectors for use with horizontal outlet vitreous china WC pans').

2.16 Suitable access must be provided to allow the fitting of the WC connector to be carried out properly. This can be provided either from the rear within a duct or by access panels on the room side.

2.17 Flushing arrangements are traditionally lever-operated. However, dual-flush, anti-vandal pneumatic push-buttons, flush plates or sensor operation may also be considered. Designers and specifiers must always consider people with disabilities and what will suit them.

2.18 In all areas, a visual contrast between WC seat and pan should be provided (see HBN 00-02).

Note: WC pans for use in prison hospitals and mental health facilities are not covered by this SHTM.

For WCs in acute facilities where children and young people receive treatment and care, see SHPN 23: 'Hospital accommodation for children and young people' (forthcoming).

Basins

2.19 Basins should have a smooth form and easily cleaned surfaces. Overflows should not be provided for infection control reasons.

2.20 Three sizes of basin should fulfil most of the user requirements in health buildings:

- large basins - for use in clinical areas for ‘scrub-up’ purposes, and for use by seated or wheelchair patients, for which wide shallow basins should be selected;
- medium basins - for use in clinical procedures and in general areas/domestic services;
- small basins - for use inside WC cubicles/stalls, food preparation areas and similar locations. Generally described as being for hand rinsing, or hand washing, under running water only.

Hospital pattern

2.21 Hospital pattern basins should be used in clinical procedures with safe, integral thermostatically (TMV3 D08) controlled water and wall-mounted single lever-action or sensor taps with concealed/ducted services.

2.22 Washing of hands and forearms is carried out under running water, and therefore a medium, or often a large, integral back-outlet basin with no plug is recommended. This assembly should maintain the level of hygiene required in clinical areas. See also SHFN 30: ‘Infection control in the built environment’, which gives additional guidance.

General pattern

2.23 General pattern basins with tap-holes should only be used for general areas/domestic services with thermostatically (TMV3 D08) controlled maximum hot water temperature and concealed/ducted services.

2.24 Washing is in a reservoir of water; therefore a bowl with plug is recommended. Plugs should be attached to an open-link chain which should be panel-mounted.

2.25 Where medium or small basins are selected with a monobloc pillar mixer tap (TP6) the basin should be specified with a single 35mm tap-hole. Care must be taken when considering a small basin to ensure that the basin and tap size allow adequate room for washing hands.

Basin selection

2.26 When selecting taps for clinical procedures, and certain activities in food-preparation and laboratory areas, taps and supply fittings will be required to be operated without the use of hands.

2.27 Fittings actuated by a proximity sensor are now a preferred alternative to lever-action taps.

2.28 The design team should select the appropriate combinations of basins and taps illustrated on the assembly data sheets for:

- clinical procedures (see Sheet 7);
- personal washing (see Sheet 8);

- hand-rinsing (see Sheet 9).

2.29 No physical barriers should exclude people with disabilities from using the appropriate service or equipment.

Baths

2.30 General baths (that is, baths used for non-assisted personal bathing) have no tap-holes and should be used with wall-mounted mixer taps offering a safe and thermostatically (TMV3 D08) controlled maximum temperature (see Sheet 14).

2.31 Mechanically operated variable-height baths are recommended for assisted bathing. These types of bath are not covered in this guidance. See HBN 00-02 for spatial requirements, size and position of components used in assisted bathing.

Waste appliances

Bidets

2.32 Bidets (see Sheet 10) are generally used by patients in clinical areas. The appliance should be rimless with an over-rim supply, preferably with sensor operation. The water supply should be controlled by a TMV3 D08 thermostatic mixer valve to prevent scalding.

Floor outlets

2.33 The general pattern floor outlet consists of a drainage outlet plus grating for use with a flexible hose fitted with appropriate back-siphonage protection.

2.34 This is used to rinse areas or to dispose of the contents of floor-washing machines.

2.35 The hospital pattern floor outlet consists of a drainage outlet covered by a small grating. It is intended mainly for use in showers in clinical areas. The floor finish should be dressed into the flange of the grating.

Plaster sinks

2.36 Plaster sinks in clinical areas have a lift-out strainer basket and wall-mounted taps. A plaster sink assembly is described in Sheet 2.

Scrub-up troughs

2.37 Scrub-up troughs should be provided to enable one or more surgeons and nurses to scrub their hands and forearms.

2.38 Troughs should be wall-hung and fitted with a single waste outlet.

2.39 Taps should be wall-mounted and deliver safe, thermostatically (TMV3 D08) controlled hot water. A scrub-up trough assembly is described in Sheet 4.

2.40 For infection control reasons sensor-controlled fittings are generally required for controlling the flow of water at scrub-up troughs and these can also offer the additional benefit of controlled run times. The relationship between the taps and the trough is critical in order to avoid splashing.

Showers

2.41 Showers in clinical areas should be provided in shower rooms with wheelchair access. The floor should be laid to falls to a waste outlet set into the floor. Supply fittings should be wall-mounted.

2.42 Flexible hose to hand-held showerheads should be provided, and the design of the unit should be such that the head cannot become immersed in water, to accord with back-siphonage prevention requirements. It must be constrained to give a type AUK3 air gap above the spillover level of the bath or shower tray, and any other fluid Category 5 risk (for example a WC), by a robust means that cannot be removed without destroying the fitting.

2.43 Shower controls should be positioned so as to allow manipulation without the operator, and/or assistant, getting wet (see HBN 00-02). Showers in clinical areas must be thermostatically controlled (TMV3 D08) to reduce the risk of scalding or thermal shock should either water supply fail.

2.44 Showers in general areas for use by staff should be provided with shower trays. These must take into account their suitability for use by disabled staff (including appropriate supply fittings and grab rails). See also HBN 00-02.

2.45 Deluge showers will generally be supplied via their own dedicated storage tank, which should be flushed weekly. Such installations to comply with the recommendations of SHTM 2040: 'The control of legionellae in healthcare premises' (to be replaced by SHTM 04-01). Details of supply fittings and assemblies are not covered by this SHTM, and advice should be sought from specialists/manufacturers.

2.46 Where filters are provided, the recommended maintenance procedures should be followed.

Sinks and sinktops

2.47 A range of single-bowl and double-bowl sinks with or without integral drainers and/or worktops are available. They should have a smooth form and easily-cleaned surfaces. Overflows are not provided, as they are unhygienic. Sinks and sinktops are available in various sizes and materials to suit the recommendations in this SHTM and the specific dimensional recommendations of SHTM 62: 'Demountable storage systems', SHTM 63: 'Fitted storage systems' and SHTM 67: 'Laboratory fitting-out systems'. Sinks with integral tops are available in a variety of materials as well as stainless steel, and the appropriate material should be selected to reflect the intended use. SHTM 67 offers further guidance on selection of materials.

2.48 In clinical procedures, sinks or sinktops (without tap-holes) with wall-mounted lever-action bib taps and concealed/ducted services should be used.

2.49 Sinks or sinktops with tap-holes should be used for general use/domestic services together with separate lever-action pillar taps (TP3). These sinks should take a plug (with screw-stay to the panel).

2.50 The design team should select the appropriate combination of sink integral drainer or worktop and taps illustrated on the assembly data sheets for:

- janitorial units, (see Sheet 3);
- clinical procedures, (see Sheet 5);
- general use/domestic services, (see Sheet 6).

2.51 All sinks (with or without tap-holes) should be supplied via separate bib or pillar taps (see also SHTM 2040).

2.52 Kitchen sinks should be subject to a 'duty of care' risk assessment. When temperatures are in excess of 46°C, 'scald risk' warning notices will require to be displayed.

Overflows

2.53 Overflows to sinks, basins, baths and bidets are not recommended, as they constitute a constant infection control risk. This is much more significant than the possible risk of damage due to water overflowing (WCs have an internal overflow). This recommendation does not apply to staff residential accommodation, but does apply to patient areas including en-suite and general public toilet areas.

Most of the components in this SHTM are specified with no overflow. In situations where an overflow is required, such as in a plaster sink, a standing waste which incorporates an overflow may be used.

Supply fittings

Source of supply

2.54 All installations must comply with the Water Supply (Water Fittings) Regulations, framed to avoid the risk of contamination of the mains water supply. In residential buildings, the regulations require a direct connection to the cold connection on a tap for drinking water – normally that to the kitchen sink.

2.55 For further information see SHTM 2040 and the 'Water Regulations Guide' published by WRAS.

Water conservation

2.56 The need to conserve water must always be considered when selecting sanitary assemblies and supply fittings.

2.57 Considerable savings of both hot and cold water can be made by specifying showers rather than baths and taps that include flow regulation or self-closing for hand rinsing. Use of compliant dual flushing WC cisterns and waterless urinals in public general toilet areas constitutes a major contribution to water saving.

Pipework

2.58 Pipework should be planned to avoid dead-legs that can become stagnant. This is hazardous, as it can create conditions suitable for organisms like Legionella to multiply. In addition, they are wasteful of heat and can cause corrosion of pipes and fittings by allowing sediment to be deposited. For further guidance, see SHTM 2040.

2.59 Isolating valves should be provided to isolate each individual appliance.

2.60 Pipe clips on exposed pipework should be specified and installed to avoid injury to staff and patients from sharp edges or the like.

Water pressure

2.61 As far as possible, the engineering services installation should be designed to ensure minimum pressure differential between hot and cold water supply pipes at the point of connecting the control fitting. This will improve the performance of sanitary assemblies, helping to avoid the use of expensive supply fittings such as pressure-regulating valves.

Water temperature

2.62 The water temperature at point of delivery should be controlled by one of the methods described below as appropriate to user requirements. Provided certain requirements are met (notably that hot and cold pressures are balanced and from a common source, and that the outlet air gap is appropriate), the Water Supply (Water Fittings) Regulations permit blending within the supply fitting.

2.63 Where the requirements cannot be met, but the hot supply is ‘wholesome’, mixing within the fitting is still acceptable providing appropriate inlet backflow prevention protection is employed.

2.64 An alternative solution is the use of supply fittings that maintain separate hot and cold water up to the point of discharge.

Manual control

2.65 Separate hot and cold water taps or valves that the user controls manually.

Individual thermostatic control

2.66 Thermostatic mixing of hot and cold water is by a valve at a fitting. The maximum water temperature required may be set and locked on the valve.

2.67 The design team should refer to SHTM 2040 when considering the problems of safety, particularly the risk of scalding young children and older people.

2.68 To reduce the risk of an outbreak of Legionnaires' disease occurring, cold water should be stored and distributed at a temperature below 20°C and hot water should be stored at a temperature of a minimum of 60°C and distribution controlled to a temperature of a minimum of 55°C.

2.69 The safety of users, particularly some children and older people, would be compromised if they were allowed to use washing or bathing facilities supplied with water at this temperature (that is, immersion in, or exposure to, running hot water). This risk can be reduced by the installation at each hot outlet of a locally adjustable thermostatic mixing valve (see SHTM 2040 for guidance on safe water temperatures).

Valves of this type are unaffected by changes in water pressure and should automatically and quickly close the hot or cold supply if either supply fails.

2.70 Vigilance will still be required to ensure that vulnerable patients using sinks in kitchens are not in prolonged contact with water that could be in excess of these temperatures.

Water delivery

2.71 The control of water delivery at point of use – on/off and hot/cold – may be achieved in several ways and in several different combinations.

2.72 Supply fittings are more normally controlled by hand manipulation of a tap head, which may be press-down-shroud or a lever.

2.73 Fittings are now available in which the flow of water is initiated by means of a sensor switch. Such devices may well have considerable application in high-risk areas such as operating theatres and burns units. These are also effective in reducing water waste and therefore running costs.

2.74 Other fittings are now available in which the flow of water is initiated and terminated by an integral, thermostatic single lever.

Positioning supply fittings

2.75 Supply fitting services should be concealed. Consideration should be given to fittings that can be serviced and/or maintained without the need to remove any panels.

Back-siphonage

2.76 Water regulations now differentiate the level of back-siphonage protection required by the class of risk associated with the receiving vessel. As a general rule, hospital applications of even domestic ablutionary arrangements are elevated to class 4 or class 5 risk and as such, require that supply fittings on baths, basins and sinks etc. with fixed outlets shall be arranged so that the discharge point creates an AUK3 air gap of twice the inlet diameter and never less than 25 mm above the spill-over level of the appliance.

2.77 Concealed showers with fixed-position adjustable heads are recommended, but when flexible hoses with sliding and hand-held spray attachments are unavoidable, special measures must be taken to prevent back-siphonage. The proximity of any adjacent sanitaryware should be considered. The 'Water Regulations Guide' is the best source of information on this issue.

Waste fittings

2.78 The waste fittings included in this SHTM are outlets and traps.

2.79 All outlets are unslotted for use with appliances without overflows. There are two types: one with a flush grating and the other with a recessed grating, plug, chain and stay. Plugs are recommended only where it is necessary to retain water in an appliance. This includes basins for general use, baths and sinks. Where this is not recommended, plugs should be omitted and the flush-grating type used.

2.80 Bottle traps for use with waste appliances should be plastic with a white finish.

Special requirements

2.81 This SHTM does not cover special requirements for such as squatting WC pans, variable height baths, autopsy tables, birthing pools and drinking fountains.

Accessories

2.82 Accessories such as toilet-roll holders, grab rails, mirrors, soap dispensers and towel rails are not included in this SHTM. However, they should be subject to a set of minimum standards, with medical/clinical issues at the core of the criteria.

2.83 For the spatial relationships for the above accessories and the positioning of grab rails in accessible WCs, see HBN 00-02: 'Sanitary spaces'.

Cleaning and disinfection

Hygiene and cleaning

2.84 Control and Prevention of Healthcare Associated Infection (HAI) is a priority issue for NHSScotland, both in respect of the safety and well being of patients and staff and also the resources consumed by potentially unavoidable infections.

Healthcare Associated Infection (HAI) is a complex issue involving the many different elements of patient care and provision. Due to its multi-factorial nature there is a need to develop a holistic approach to combating the spread of infection within the built environment.

It is imperative that those involved in the design and planning, construction and refurbishment and on-going maintenance of the healthcare facility have a sound knowledge of prevention and control of infection in the built environment.

SHFN 30 and HAI-SCRIBE aim to provide information on the prevention and control of infection, and on the prevention of cross-infection and cross contamination in healthcare facilities, to those responsible for the planning, design and maintenance of such facilities.

Cleaning is an essential part of the multi-disciplinary approach in improving patient, staff and public safety. Safe clinical care is supported through ensuring high standards of hygiene and related measures to tackle HAI in the healthcare environment.

Cleaning regimes including frequency of cleaning should be addressed in line with current national guidance together with any additional Local Management requirements.

Relevant Provisions of current guidance, standards and Codes of Practice for cleaning of healthcare premises and including the latest technical requirements are embodied in the following documents:

- SHFN 30: Infection Control in the built environment: Design and Planning NHSScotland Property and Environment Forum August 2005;
- HAI-Scribe (Healthcare Associated Infection System for Controlling Risk in the Built Environment) NHSScotland Property and Environment Forum August 2005;
- The NHSScotland National Cleaning Services Specification SEHD/CMO (2004) 8;
- NHS Quality Improvement, Scotland – Healthcare Associated Infection (HAI) Cleaning Services Standards CSBS / NHSQIS. 2002 ISBN 1 903766 12 5;
- The NHSScotland Code of Practice for the Local Management of Hygiene and Healthcare Associated Infection Healthcare Associated Infection Task Force CMO (2004) 09;

- The NHSScotland national Cleaning Services Specification: HAI task Force ISBN 1-903766-12-5.

Components should be easy to clean. There should be no inaccessible recesses, rough surfaces or connections, projections, sharp edges, unnecessary joints or exposed threads etc. which may retain dirt, snag cleaners' hands or equipment, or be difficult to reach.

2.85 Hospital cleaning policies must ensure that care is exercised in cleaning sanitary assemblies, particularly those that are new. The manufacturer's instructions must always be referred to.

2.86 To avoid damaging surfaces only approved cleaning cloths, neutral detergent solutions and cream cleansers should be used. Materials such as scouring powders and abrasive pastes and pads can cause irreparable damage and should be avoided. Abrasive scouring powders can cause considerable damage by removing glaze, and should be avoided.

2.87 A de-scaling fluid should be used to remove lime deposits in WCs and other appliances.

2.88 The infection control team must be consulted and their recommendations strictly applied where it is necessary to disinfect baths and other appliances. See also SHTM 2040.

2.89 All components require to be sealed at junctions with floors and walls with a suitable sealant.

Maintenance and replacement

2.90 Planned maintenance of sanitary assemblies must be included in maintenance manuals and programmes to ensure that supply and waste fittings are in full working order; for example, TMV3 D08 valves to hot outlets and shower valves have a six-monthly audit.

2.91 This necessitates regular access to parts of fittings that require maintenance, adjustment or checking, including connections and elbows.

2.92 Some components such as tap and valve washers, flexible hoses, and plugs and chains become worn with use. They should be examined regularly and replaced before they affect the operation of the entire assembly.

Concealed services

2.93 In clinical areas, pipework and cisterns should always be concealed.

2.94 Exposed services are visually unattractive, can be unhygienic, and are difficult to clean and decorate. Indeed, the additional cost of the latter over a number of years may well exceed any savings in initial capital costs.

2.95 In all cases, the objectives of design and specification must be an installation which is neat, easy to clean and maintain, and durable.

Bacterial growth

2.96 Components and accessories should not sustain the growth of bacteria. The design team should refer to SHTM 2040 and SHFN 30 for guidance on the control of Legionella and other bacteria.

Fixings and loadings

2.97 All appliances should accept live loadings in use. This depends on the strength of the appliance, its fixing devices and the construction to which it is fixed. The assembly should sustain a load of 140 kg.

3. Product selection criteria

3.1 The assembly data sheets provide the design teams with a set of product selection criteria in graphic and text form for each of the soil and waste appliances and assemblies covered by the guidance in Section 2. They are intended for use in evaluating manufacturers' trade literature, and communicating requirements to manufacturers and to merchants.

3.2 The component references may be used by the design team to identify each appliance when preparing layout drawings, schedules and product lists. The references are made up in sequence of:

- appliance/fitting;
- type;
- material (where applicable).

Soil appliances

- DU (disposal unit);
- UR (urinal);
- WC (water closet).

Waste appliances

- LB (lavatory basin);
- BA (bath);
- BD (bidet);
- FO (floor outlet);
- PS (plaster sink);
- SU (scrub-up);
- SH (shower);
- SK (sink);
- ST (sinktop);

Supply fittings

- TP (pillar tap);
- TPP (pillar tap, press action);
- TB (bib tap);
- TM (thermostatic mixer shower).

Waste fittings

- WT (waste).

Traps

- TRR (trap resealing).

Type

- H (hospital pattern);
- HD (hospital pattern for assisted ambulant disabled/wheelchair users);
- G (general pattern).

Material

- M (metal);
- P (plastic).

Size

- L (large);
- M (medium);
- S (small).

4. Assembly and component data sheets

Sheet 1: Disposal unit assemblies for the disposal of liquid and solid waste in connection with clinical procedures

The typical assembly requirements are:

1. Hospital pattern disposal unit (including cistern).
2. Hospital pattern (lever-action) taps to avoid contamination – located over sink (or hopper if no sink).
3. Separate manual control of hot and cold water.
4. Open nozzle and flow straightener with minimal restriction connected to concealed services.

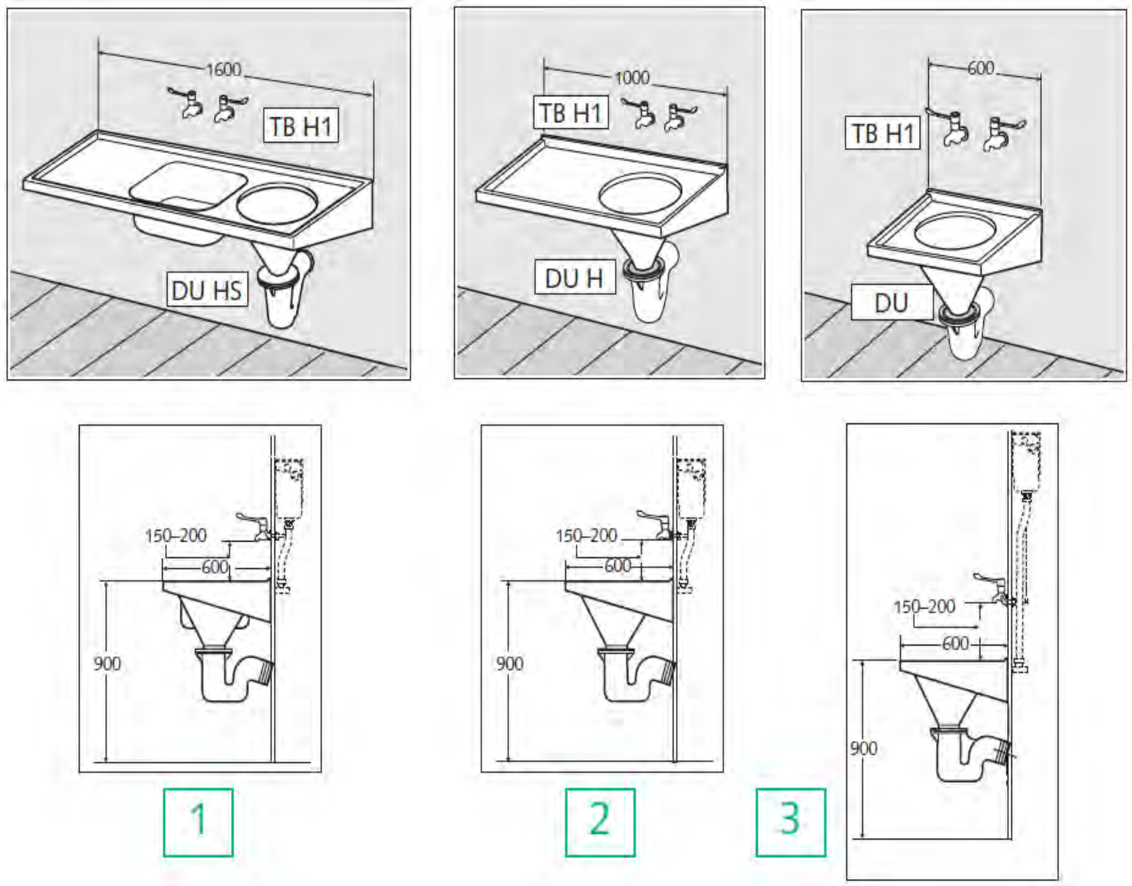

Figure 2: Disposal unit assembly

Components used in Figure 2:

(1) DU HS assembly:

- **DU HS** (Hospital pattern disposal unit with sink);
- **TB H1** (Pair, lever-action bib taps);
- **WT4** (1½in unslotted grated waste);
- **TRR2/P** (1½ in. plastic resealing bottle trap).

(2) DU H assembly:

- **DU H** (Hospital pattern disposal unit with plain top);
- **TB H1** (Pair, lever-action bib taps).

(3) DU assembly:

- **DU** (Hospital pattern disposal unit without plain top);
- **TB H1** (Pair, lever-action bib taps).

DU HS

Identification

A stainless steel plain top incorporating a sink and a hopper (a left-hand drainer is shown in the diagram).

Standards

Stainless steel type 1.4301 (304) as BS EN 10088; Copper tube as BS EN 1057; Flushing cistern as BS 1125; Float-operated valves – Diaphragm type as BS 1212; Floats (plastics) for ball valves as BS 2456 and Stainless steel tube as BS EN 10217.

Description

- a plain top of stainless steel (min. 1.5 mm or, where press formed, 1.2 mm) with no tap-holes, no upstand, edges rimmed and turned down, underside sound-deadened with smooth, impermeable, easily cleaned material and/or underlined with stainless steel;
- the top incorporates a rectangular sink bowl without overflow and a hopper with continuous flushing rim and concealed connection plus 'P' trap with 110 mm O/D outlet;

- a single-flush, reversible, 6–9 L plastic cistern (for mounting in duct) with ½ in. LP valve, plastic float, flush-pipe and CP metal flushing lever handle;
- 1½ in unslotted, flush-grated waste (CP on brass);
- stainless steel support frame with all exposed stainless steel having a 240S polish finish (excluding legs, if supplied);
- finish (excluding legs, if supplied);
- outside of sink and hopper with bead blast finish;
- earthing terminal.

Options

- right-hand drainer available;
- ½ in HP valve;
- exposed cistern and pipework plus ‘S’ trap;
- removable splashback for access to services;
- pneumatic push-button flush;
- front leg supports.

Application

For the disposal of liquid and solid waste and to used with concealed services and used with wall-mounted supply fittings.

Fixing/installation

- disposal unit mounted on brackets and/or fixings suitable for screw-fixing to wall or duct panel. Provision for screw-fixing concealed cistern and pipework;
- to be fed only from a cistern;
- use HP valve option when connecting to water supply pressure in excess of 1.35 bar.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned and with no sharp edges.

Design and specification notes

See paragraphs 2.4–2.5, and 2.93–2.95.

DU H

Identification

A stainless steel plain top incorporating a hopper (a left hand drainer is indicated in the diagram).

Standards

See DU HS.

Description

- a plain top of stainless steel (min. 1.5mm or where press formed 1.2mm) with no tap-holes, no upstand, edges rimmed and turned down, underside sound-deadened with smooth, impermeable, easily cleaned material and/or underlined with stainless steel;
- the top incorporates a hopper with continuous flushing rim and concealed connection and ‘P’ trap with 110 mm O/D outlet;
- a single-flush, reversible, 6–9 L plastic cistern (for mounting in duct) with ½ in. LP valve, plastic float, flush-pipe and CP metal flushing lever handle;
- stainless steel support frame with all exposed stainless steel having a 240S polish finish (excluding legs, if supplied);
- outside of plain top and hopper with bead blast finish;
- earthing terminal.

Options

- right-hand drainer available;
- ½ in HP valve;
- exposed cistern and pipework plus ‘S’ trap;
- removable splashback for access to services;
- front edge profiles may be square, as shown, or with roll front edge (and with upstand at rear) to suit profile shown in SHTM 62 and SHTM 63;
- 650mm deep when matching SHTM 63 profile;
- pneumatic push-button flush;
- front leg supports.

Application

For the disposal of liquid and solid waste and to be used with concealed services and wall-mounted supply fittings.

Fixing/installation

- disposal unit mounted on brackets and/or fixings suitable for screw fixing to the wall or duct panel. Provision for concealed cistern and pipework;
- should be fed only from a cistern;
- use HP valve option when connecting to water supply pressure in excess of 1.35 bar.

Cleaning/maintenance

Exposed surfaces to be smooth and easily cleaned and with no sharp edges.

Design and specification notes

See also paragraphs 2.4 – 2.5 and 2.93 – 2.95.

DU

Identification

A stainless steel hopper.

Standards

See DU HS.

Description

- a stainless steel (min. 1.5 mm) hopper with no tap holes, no upstand, edges rimmed and turned down, and with continuous flushing rim and concealed connection plus 'P' trap with 110 mm O/D outlet;
- a single-flush, reversible, 6–9 L plastic cistern (for mounting in duct) with ½ in. LP valve, plastic float, plastic flush-pipe and CP metal flushing lever handle;
- stainless steel support frame with all exposed stainless steel having a 240S polish finish (excluding legs, if supplied);
- outside of hopper with bead blast finish;
- earthing terminal.

Options

- ½ in. HP valve;
- high level exposed cistern and pipework, flush-pipe to be plastic;

- enclosed and floor-mounted if mechanical floor-cleaning equipment is not used;
- pneumatic push-button flush;
- front leg supports.

Application

For the disposal of liquid and solid waste and to be used with concealed services and wall-mounted supply fittings.

Fixing/installation

- disposal unit mounted on brackets and/or fixings suitable for screw-fixing to wall or duct panel. Provision for screw-fixing concealed cistern and pipework;
- should be fed only from cistern;
- use HP valve option when connecting to water supply pressure in excess of 1.35 bar.

Cleaning/maintenance

Exposed surfaces smooth and easily cleaned with no sharp edges.

Design and specification notes

See also paragraphs 2.4–2.5, and 2.93–2.95.

Tap, trap and waste

For details see Sheet 15:

- TB H1, see Sheet 15 item 15.1;
- TRR2/P, see Sheet 15 item 15.11;
- WT4, see Sheet 15 item 15.15.

Sheet 2: Plaster sink assembly for use in connection with plaster preparation

The typical assembly requirements are:

1. Hospital pattern plaster sink.
2. Hospital pattern (lever-action) taps to avoid contamination.
3. Separate manual control of hot and cold water.
4. Open nozzle and flow straightener with minimal restriction.
5. Connecting to concealed services.

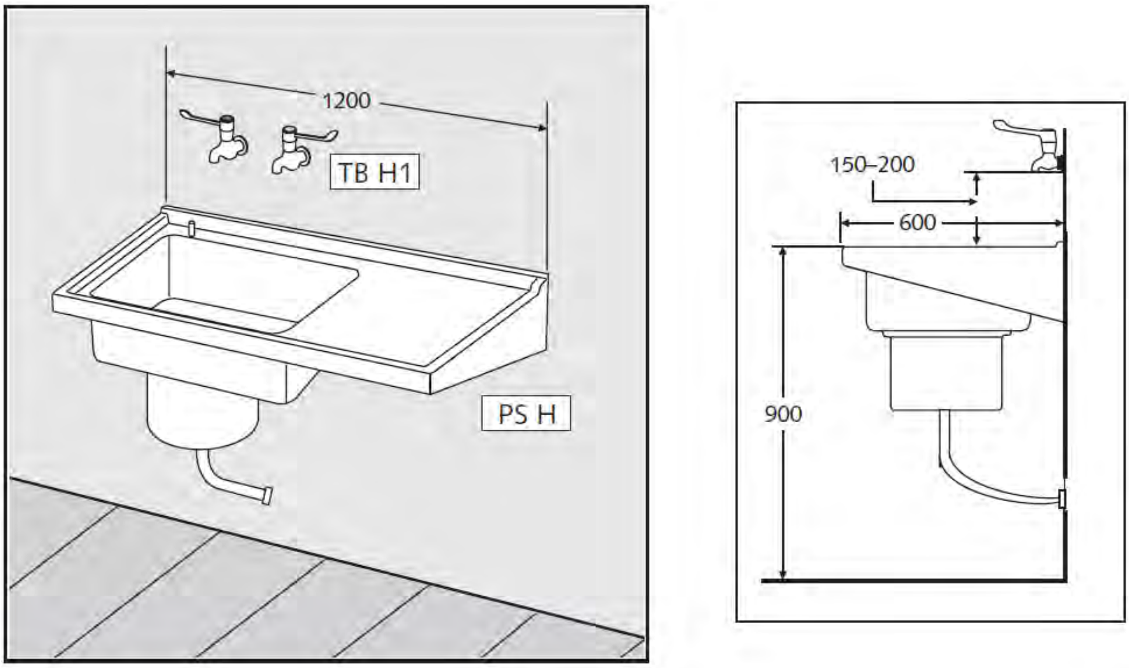

Figure 3: Plaster sink assembly

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 3 (see next page for more details):

- **PS H** (Hospital pattern plaster sink);
- **TB H1** (Pair, lever-action bib taps);
- **TRR2/P** (1½ in. resealing bottle trap, plastic).

PS H

Identification

Stainless steel plaster sink with integral plain top (right hand drainer shown in diagram).

Standards

- stainless steel type 1.4301 (304) or 1.4404 (316) to BS EN 10088;
- wastes to BS EN 274.

Description

- a plain top of stainless steel (min. 1.5 mm or where press-formed 1.2 mm) with no tap-holes, no upstand, edges rimmed (minimum 13 mm high) and turned down, underside sound-deadened with smooth, impermeable, easily cleaned material and/or underlined with stainless steel. The top incorporates a rectangular sink bowl, without overflow, with a round sump, containing a partially perforated stainless steel basket and covered by a close-fitting stainless steel cover with recessed handle;
- stainless steel support frame with all exposed stainless steel having a 240S polish finish (excluding legs, if supplied);
- outside of sink and sump with bead blast finish;
- earthing terminal.

Options

- left-hand drainer available;
- front leg supports;
- front edge profiles may be square, as shown, or with roll front edge (and with upstand at rear) to suit profile shown in SHTM 63 and SHTM 71;
- the unit requires to be 650 mm deep when matching SHTM 63 profile.

Application

- for use with concealed fittings and with bib taps. Suitable for mounting on wall brackets, stand supports or base unit.

Fixing/installation

Concealed fixing clips.

Cleaning/maintenance

Exposed surfaces smooth and easily cleaned, no sharp edges, all internal corners radiused.

Design and specification notes

See paragraph 2.36.

Taps and traps

For details see Sheet 15:

- TB H1, see Sheet 15 item 15.1;
- TRR2/P, see Sheet 15 item 15.11.

Sheet 3: Janitorial unit

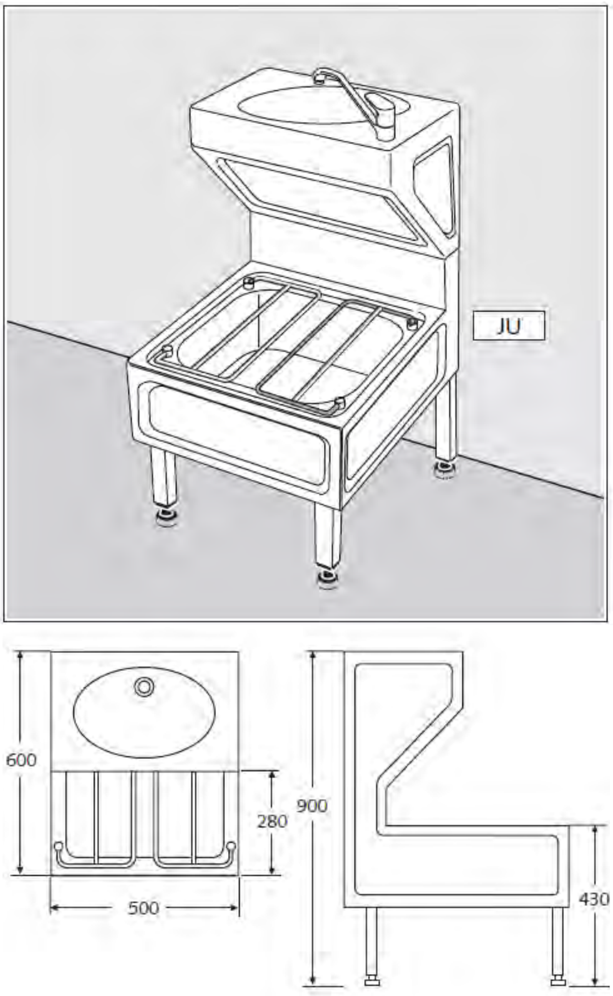

Figure 4: Janitorial unit

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 4:

- **JU** (Combination sink and basin janitorial unit);
- **WT1** (1¼ in. flush strainer waste);
- **WT2** (1½ in. flush strainer waste);
- **TRR1/P** (1¼ in. resealing bottle trap, plastic);
- **TRR2/P** (1½ in. resealing bottle trap, plastic).

JU

Identification

Stainless steel combination sink and basin janitorial unit.

Description

- combined sink and hand-wash basin in 1.2mm stainless steel;
- lever-operated monobloc mixer tap with swivel nozzle;
- tamper-proof concealing panel for basin trap;
- hinged bucket grating to sink;
- stainless steel legs and adjustable feet with earthing tag;
- fitting(s) to supply basin and sink.

Application

For disposal of liquid waste by domestic services staff.

Cleaning/maintenance/safety

Exposed surfaces smooth and easily cleaned with no sharp edges.

Sheet 4: Scrub-up trough assemblies for use in connection with surgical washing of forearms and hands

The typical assembly requirements are:

1. Hospital pattern scrub-up trough.
2. Washing under running water therefore no plug.
3. Hospital pattern lever-action tap(s) or automatic operated by sensor to avoid contamination.
4. Open nozzle and flow straightener with minimal restriction.
5. Water temperature to be controlled via integral thermostat.
6. Connecting to concealed services.

The point of discharge relative to front rim of trough is critical to ensure:

- that there is no water discharge or spillage outside the trough;
- that water falls onto inclined surface of trough;
- that users are able to operate lever/s if supplied;
- that there is sufficient space for users to wash their hands and forearms under running water.

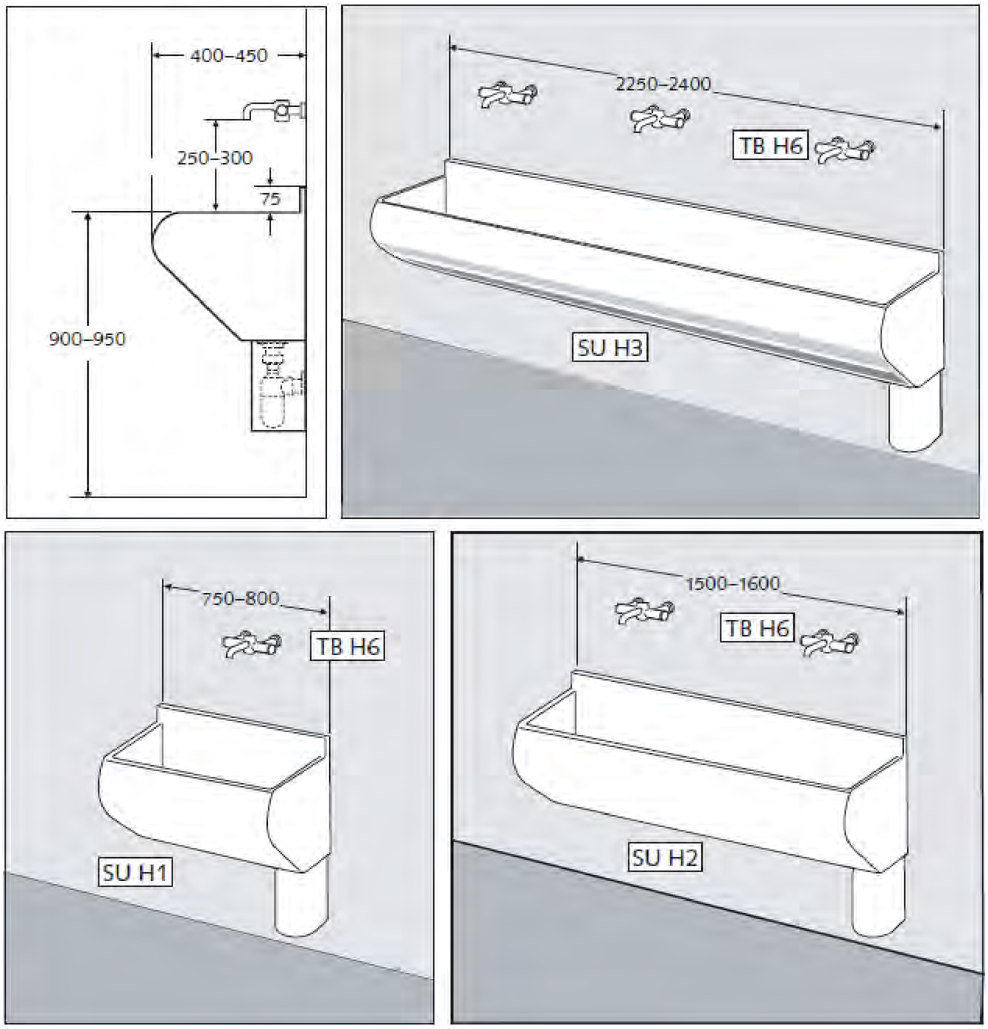

Figure 5: Scrub up trough assemblies

Components used in Figure 5:

- **SU H 1/2/3** (Hospital pattern scrub-up trough);
- **TB H6** (Hospital pattern bib mixer automatic action, integral sensor, with integral thermostat)with option to use;
- **TB H2a** (Hospital pattern bib combination tap, fixed horizontal spout, single lever, with integral thermostat);
- **TRR2/P** (1½ in. resealing bottle trap, plastic);
- **WT2** (1½ in. flush strainer waste).

Note: See also HBN 00-02: ‘Sanitary spaces’, which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

SU H 1/2/3

Identification

Wall-mounted stainless steel scrub-up trough (right-hand outlet shown in diagram).

Standards

Stainless steel – type 1.4301 (304) as BS EN 10088.

Description

- stainless steel trough (min. 1.5mm) in three sizes: single, double and triple person, shaped to avoid splashing, with all internal corners radiused, outlet at one end to suit;
- 1½ in. connection to concealed pipework in duct;
- any necessary fixing devices. All exposed stainless steel with 240S polish finish; outside of trough with bead blast finish;
- shrouded bottom outlet;
- earthing terminal.

Options

- left hand outlets available;
- for a high backed upstand dimensions have to be specified.

Application

For use with concealed services and with wall-mounted supply fittings.

Fixing/installation

Concealed fixings suitable for duct panels and masonry.

Cleaning/maintenance

Exposed surfaces to be smooth, easily cleaned and with no sharp edges.

Design and specification notes

See paragraphs 2.37 to 2.40.

Taps, traps and waste

For details see Sheet 15:

- TB H2a, see Sheet 15 item 15.2;
- TB H6, see Sheet 15 item 15.3;
- TRR2/P, see Sheet 15 item 15.11;
- WT2, see Sheet 15 item 15.13.

Sheet 5: Sink and sink top assemblies for use in connection with clinical procedures

The typical assembly requirements are:

1. Sink or sink tops.
2. Hospital pattern lever-action tap(s).
3. Separate manual control of hot and cold water.
4. Flush-grated waste with no plug.

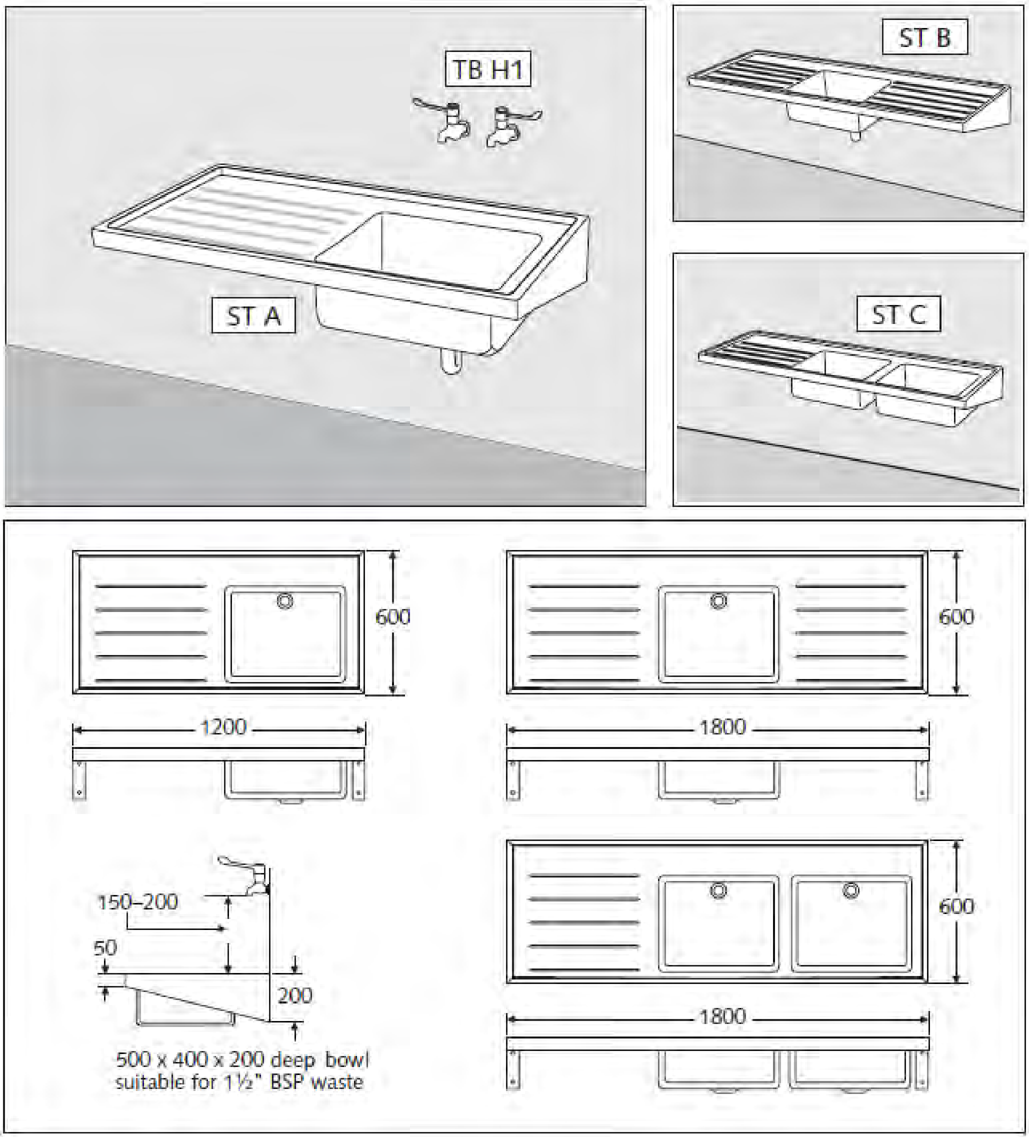

Figure 6: sink and sink top assemblies for use in connection with clinical procedures

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 6:

- **ST A/B/C** (Sinktops);
- **TB H1** (Pair, lever-action bib taps);
- **WT2** (1½ in. flush strainer waste);
- **TRR2/P** (1½ in. resealing bottle trap, plastic).

ST A/B/C

Identification

Sink top with integral drainer (left hand drainer shown in diagram).

Standards

- stainless steel – type 1.4301 (304) S16 as BS EN 10088.
- metal sinks for domestic services as BS EN 13310.

Description

- a stainless steel sink top (min. 1.2mm). Type A with ribbed drainer, no tap-holes, no overflow, no chain hole, no upstand, edges rimmed and turned down, incorporating a rectangular sink bowl (min. 0.9 mm);
- underside sound-deadened with smooth, impermeable, easily cleaned material and/or underlined with stainless steel;
- concealed fixing clips;
- stainless steel support framework;
- all exposed stainless steel with 240S polish finish;
- outside of sink with bead blast finish;
- earthing terminal.

Options

- right hand drainer available;
- type B with single bowl and double drainer;
- type C with double bowl and right or left hand single drainer;
- front leg supports;
- plug and chain with screw stay (panel-mounted);

- front edge profiles may be square as shown, or with roll front edge (and with upstand at rear) to suit profile shown in SHTM 63;
- 650mm deep when matching SHTM 63 profile;
- sink tops with integral drainer may be manufactured with integral worktops from cast resins or stainless steel.

Application

- for use with concealed services and wall mounted supply fittings.
- use option with tap-holes only when impractical to conceal pipework, then supply pipework is surface mounted below sink.
- suitable for mounting on base unit, wall brackets or stand support.

Fixing/installation

Set on base and secure with fixing clips.

Cleaning/maintenance

Exposed surfaces smooth, easily cleaned and with no sharp edges.

Design and specification notes

See paragraphs 2.47 to 2.52.

Tap, trap and waste

For details see Sheet 15:

- TB H1, see Sheet 15 item 15.1;
- TRR2/P, see Sheet 15 item 15.11;
- WT2, see Sheet 15 item 15.13.

Sheet 6: Sink and sink top assemblies for use in connection with domestic services procedures

The typical assembly requirements are:

1. Sink or sink top.
2. Separate manual control of hot and cold water.
3. Open nozzle and flow straightener with minimal restriction.
4. Lever-action taps.
5. Recessed grated waste with plug.

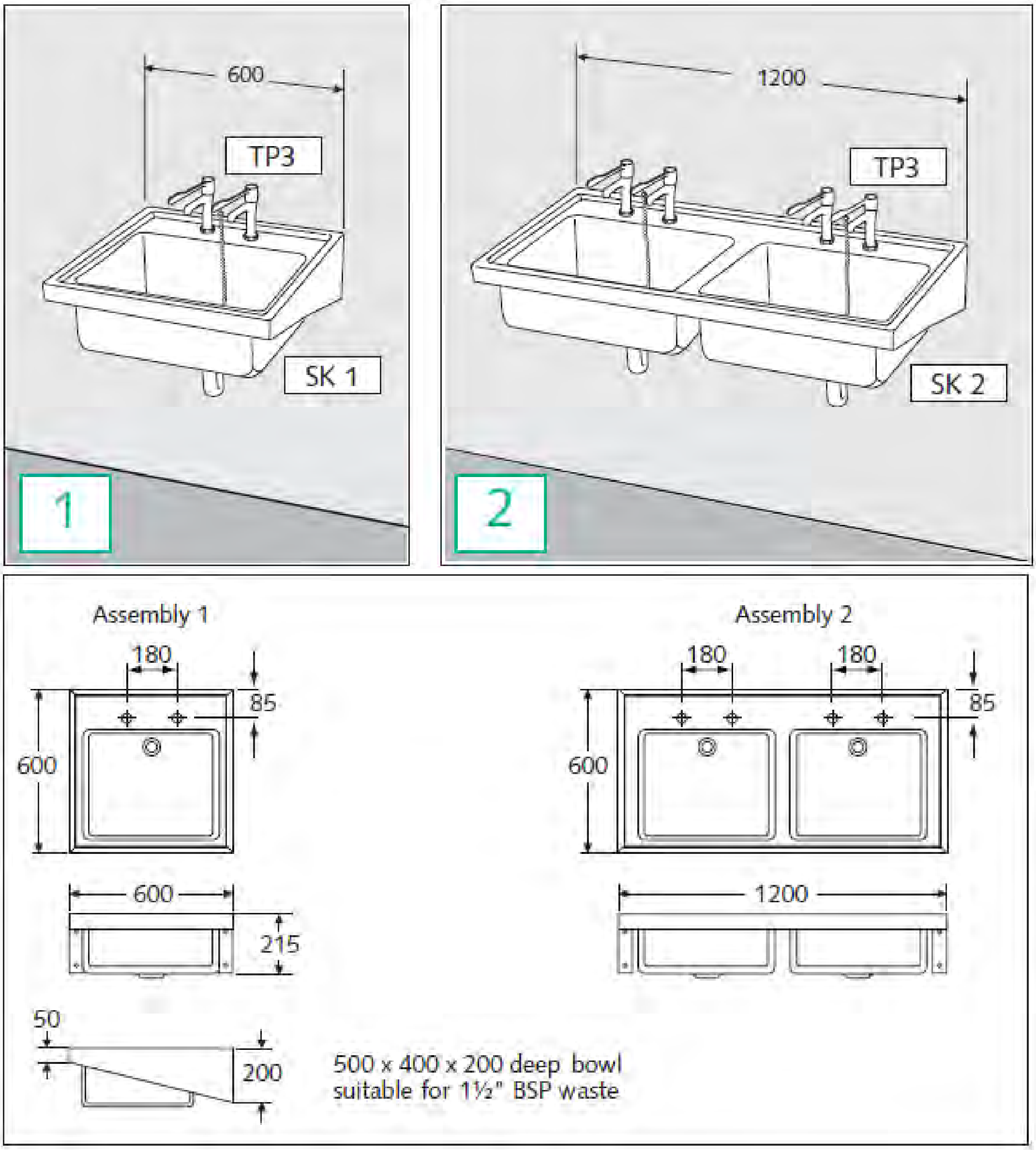

Figure 7: Sink and sink top assemblies for use in connection with domestic services procedures

Note: See also HBN 00-02: ‘sanitary spaces’, which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 7:

Assembly 1:

- **SK 1** (Single bowl sink);
- **TP3** (Pair, pillar taps, ½in. high neck);
- **WT4** (1½ in. waste with plug and chain);
- **TRR2/P** (1½ in. resealing bottle trap, plastic).

Assembly 2:

- Same as assembly 1 except **SK 2** (double bowl sink) used instead of **SK 1.**

SK 1/2

Identification

Sink bowl.

Standards

- stainless steel type 1.4301 (304) S16 as BS EN 10088;
- metal sinks for domestic services as BS EN 13310.

Description

- a rectangular stainless steel sink bowl (min. 0.9 mm) with tap-holes, no overflow, no upstand, no chain-hole, edges rimmed and turned down;
- concealed fixing clips;
- stainless steel support framework;
- all exposed stainless steel with 240S polish finish;
- outside of bowl with bead blast finish;
- earthing terminal.

Options

- sink bowls may be located in stainless steel worktops, as shown in SHTM 63;
- front leg supports;
- front edge profiles may be square as illustrated or with roll front edge (and upstand at rear) to suit profile shown in SHTM 63;
- 650 mm deep when matching SHTM 63 profile;
- sinks may be manufactured with integral worktops from cast resins, sold surfacing materials or stainless steel type 1.4404 (316).

Application

- for use with concealed services and wall mounted supply fittings;
- suitable for mounting on base unit, wall brackets or stand support.

Cleaning/maintenance

Exposed surfaces smooth, easily cleaned and with no sharp edges.

Fixing/installation

Set on base and secure with fixing clips.

Design and specification notes

See paragraphs 2.47–2.52.

Tap, trap and waste

For details see Sheet 15:

- TP3, see Sheet 15 item 15.5;
- TRR2/P, see Sheet 15 item 15.11;
- WT4, see Sheet 15 item 15.15.

Sheet 7: Basin assemblies for use in connection with clinical procedures

The typical assembly requirements are:

1. Hospital pattern basin, integral back outlet, large or medium.
2. Washing hands and forearms under running water (therefore no plug).
3. Hospital pattern (lever-action) tap or automatically by sensor to avoid contamination.
4. Single horizontal spout, open nozzle and flow straightener.
5. Thermostatic mixer in hot supply (TMV3 D08-approved).
6. Connecting to concealed services.

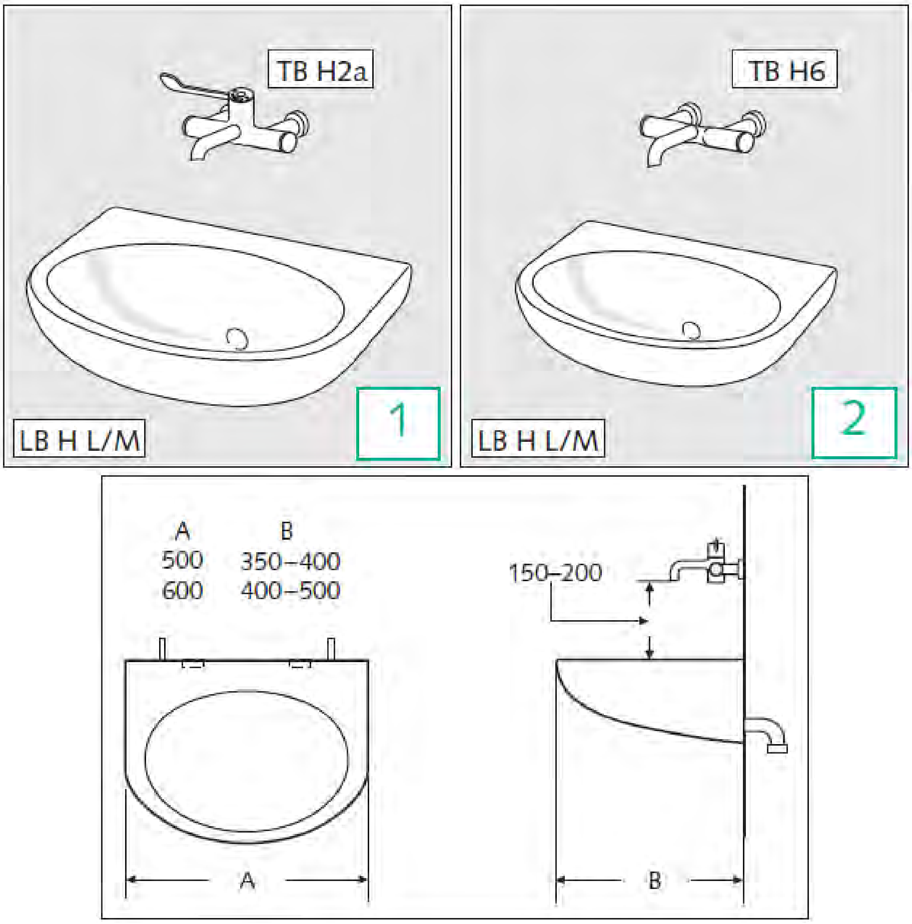

Figure 8: Basin assemblies for use in connection with clinical procedures

Note: See also HBN 00-02; 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 8:

Assembly 1:

- **LB H L/M** (Hospital pattern basin);
- **TB H2a** (Integral thermostatic hospital pattern bib combination mixer tap with single lever, fixed horizontal nozzle);
- **TRR1/P** (1¼ in. resealing bottle trap, plastic).

Assembly 2:

- same as Assembly 1 except **TB H6** (Hospital pattern bib mixer, automatic action with sensor) used instead of **TB H2a.**

LB H L/M

Identification

Wall mounted basins are available in two sizes, medium or large, both with integral back outlet. Infection control team to confirm which size to be used for the proposed project.

Standards

- vitreous china as BS 3402;
- Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’.

Description

- white vitreous china basin with concealed fixings, no tap holes, no overflow and no chain holes;
- integral back outlet to connect to concealed services;
- all necessary support brackets.

Application

- for use in all clinical areas;
- for use with concealed services and wall mounted supply fittings.

Fixing/installation

Basin-mounted on concealed brackets and fixings suitable for duct panels.

Cleaning/maintenance

Exposed surfaces to be smooth and easily cleaned.

Design and specification notes

See paragraphs 2.19–2.29, 2.53 and 2.93–2.95.

Taps and trap

For details see Sheet 15:

- TB H2a, see Sheet 15 item 15.2;
- TB H6, see Sheet 15 item 15.3;
- TRR1/P, see Sheet 15 item 15.10.

Sheet 8: Basin assemblies for use in connection with personal washing (face, forearms and hands etc)

The typical assembly requirements are:

1. General basin (medium and large).
2. Washing in reservoir of water (therefore a basin with plug and chain with screw stay).
3. Combined or separate nozzle with flow straightener.
4. Lever-action taps.
5. All assemblies shown below are suitable with medium and large general basins.

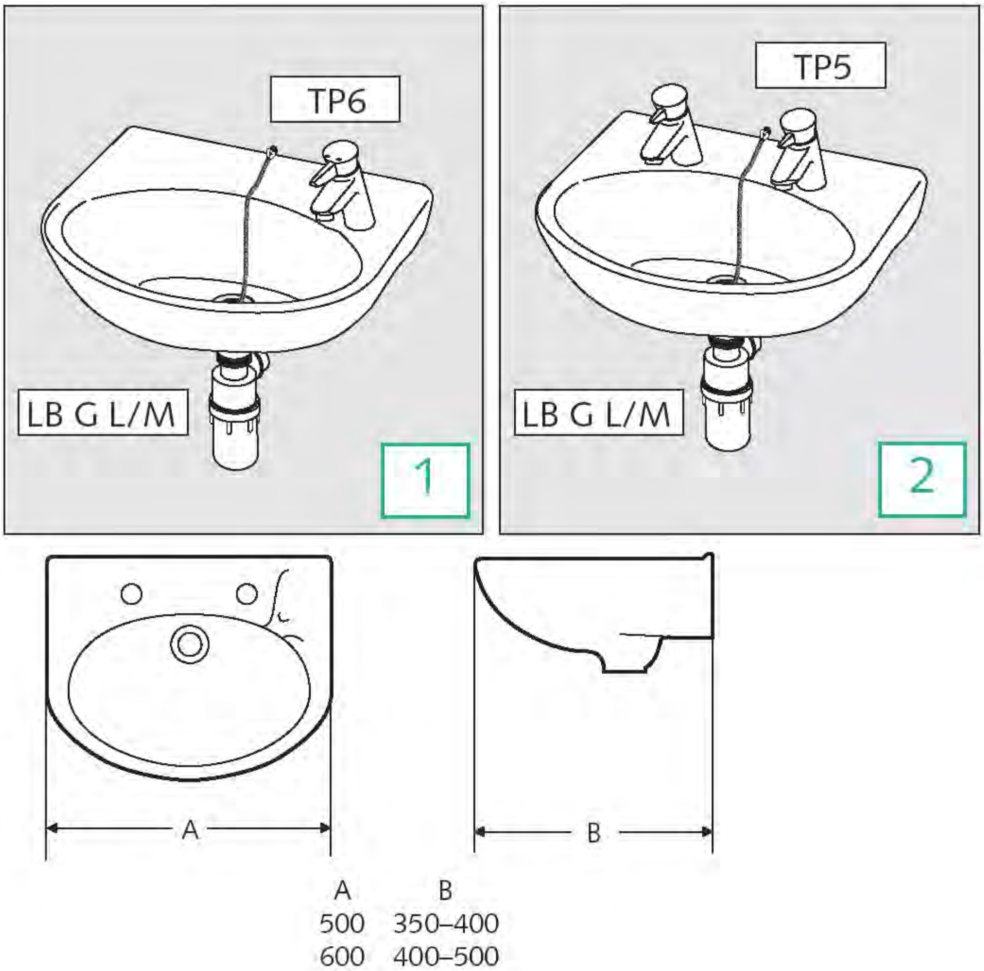

Figure 9: Basin assemblies for use in connection with personal washing

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 9:

Assembly 1:

- **LB G L/M** (General basin);
- **TP6** (Integral thermostatic monobloc pillar mixer tap)
- **TRR1/P** (1¼ in. resealing bottle trap, plastic);
- **WT3** (1¼ in. waste with plug and chain).

Assembly 2:

- Same as Assembly 1 except use **TP5** (½ in. pillar taps – short lever action, thermostatic mixer on hot supply)

LB G L/M

Identification

Wall-mounted basin available in two sizes: medium or large with bottom outlet.

Standards

Vitreous china as BS 3402.

Description

- white vitreous china basin with concealed fixings, right-hand tap-hole or two tap-holes, no overflow, no chain-hole and bottom outlet;
- all necessary support brackets.

Application

- for use in areas other than clinical areas;
- for use with concealed services.

Fixing/installation

Basin mounted on concealed brackets and fixings suitable for duct panels.

Cleaning/maintenance

Exposed surfaces to be smooth and easily cleaned.

Design and specification notes

See paragraphs 2.19–2.29, 2.53 and 2.93–2.95.

Taps and trap

For details see Sheet 15:

- TP5, see Sheet 15 item 15.6;
- TP6, see Sheet 15 item 15.7;
- TPP1 , see Sheet 15 15.8;
- TRR1/P, see Sheet 15 item 15.10;
- WT3, see Sheet 15 item 15.14.

Sheet 9: Basin assemblies for hand-rinsing only

The typical assembly requirements are:

1. General basin (small).
2. Washing/rinsing under running water (therefore no plug).
3. Hand rinse only, therefore small basin.
4. Combined manual control of flow and temperature of water or automatic control of thermostatically mixed water with single flow spout.
5. Either lever-action tap or press tap.
6. Thermostatic mixer on hot supply (TMV3 D08-approved).

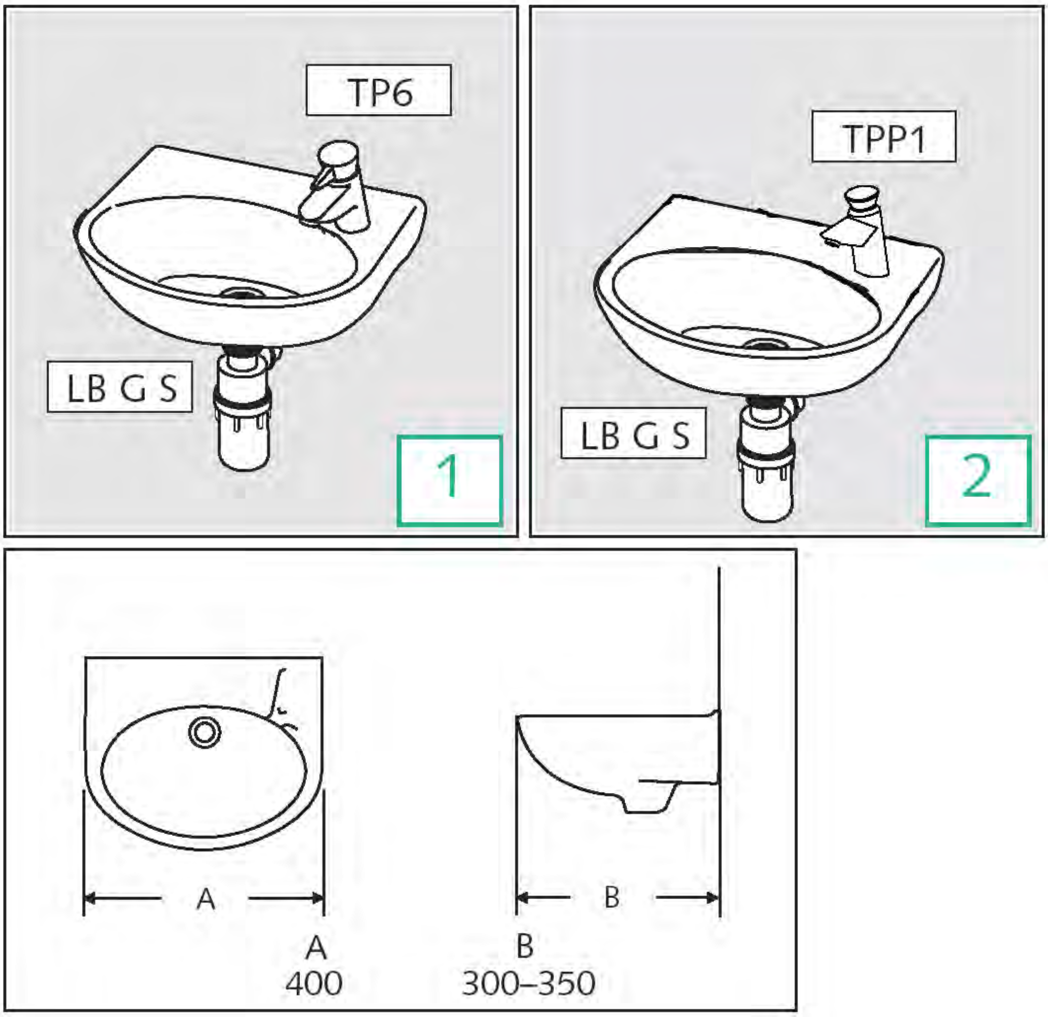

Figure 10: Basin assemblies for hand rinsing only

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 10:

Assembly 1:

- **LB G S** (Small general basin);
- **TP6** (Integral thermostatic monobloc pillar mixer tap);
- **TRR1/P** (1¼ in. resealing bottle trap, plastic);
- **WT1** (1¼ in. flush strainer waste).

Assembly 2:

- Same as Assembly 1 except use **TPP1** (monobloc pillar mixer tap, self-closing, press action) instead of **TP6**

LB G S

Identification

Wall mounted basin available in one size, small with bottom outlet.

Standards

- vitreous china as BS 3402;
- Model Engineering Specification D08: 'Thermostatic mixing valves (healthcare premises)'.

Description

- white vitreous china basin with concealed fixings, with single right hand tap hole, no overflow, no chain hole and bottom outlet;
- all necessary support brackets.

Application

- for use other than for clinical procedures or personal washing;
- for use with concealed services.

Fixing/installation

Basin to be mounted on concealed brackets with suitable fixings for duct panels or wall construction.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

Design and specification notes

See paragraphs 2.19–2.29, 2.53 and 2.93–2.95.

Taps, traps and waste

For details see Sheet 15:

- TB H6, see Sheet 15 item 15.3;
- TP6, see Sheet 15 item 15.7;
- TRR1/P, see Sheet 15 item 15.10;
- WT1, see Sheet 15 item 15.12.

Sheet 10: Bidet assembly for use in connection with clinical procedures

The typical assembly requirements are:

1. Hospital pattern bidet with flush-grated waste therefore no plug required.
2. Sensor operated over-rim supply.
3. Water temperature thermostatically controlled (TMV3-approved).
4. All service connections to be concealed.

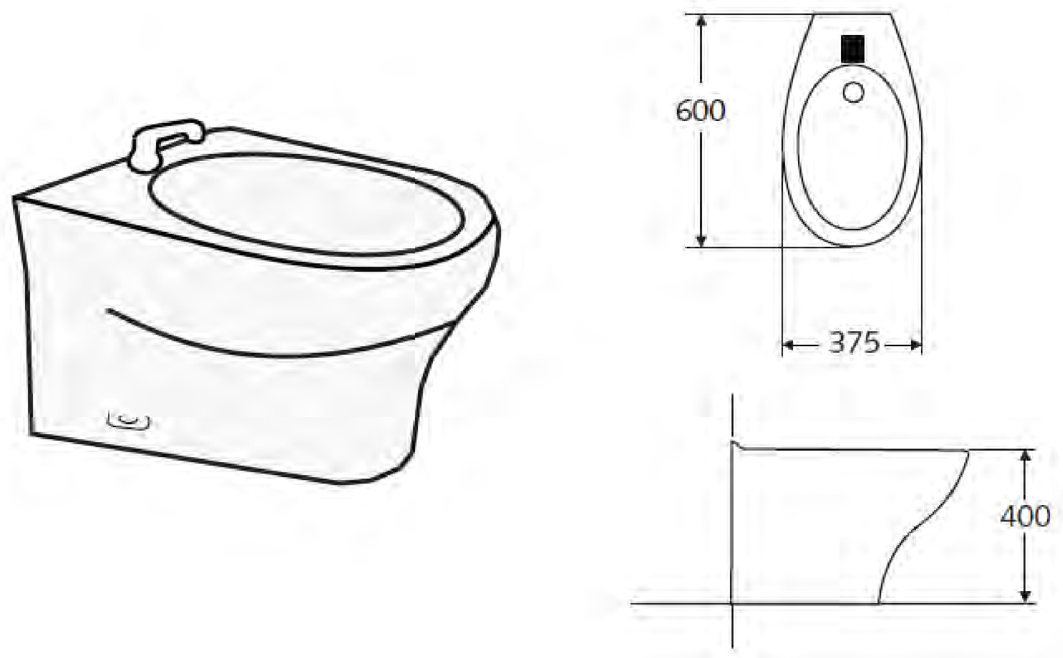

Figure 11: Bidet assembly

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 11:

- **BD H** (Hospital pattern bidet)
- **WT1** (1¼ in. unslotted flush-grated waste)

BD H

Identification

Back-to-wall pedestal bidet with sensor-operated spout.

Standards

- vitreous china as BS 3402;
- wastes as BS EN 274;
- Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’.

Description

White vitreous china bidet, rimless with one tap-hole, no overflow, with outlet to suit 1¼ in. waste and no plug.

Options

Spacer box.

Fixing/installation

Prepared for screw-fixing to floor. Special provision against back-siphonage is required [refer to the Water Supply (Water Fittings) Regulations 1999].

Cleaning/maintenance

All exposed surfaces must be smooth and easily cleaned. If a spacer box is used then all exposed surfaces must be finished with melamine or similar material.

Design and specification notes

See paragraph 2.32.

Waste

For details on WT1, see Sheet 15 item 15.12.

Sheet 11: Hospital pattern urinal

The typical assembly requirements are:

1. Concealed trap.

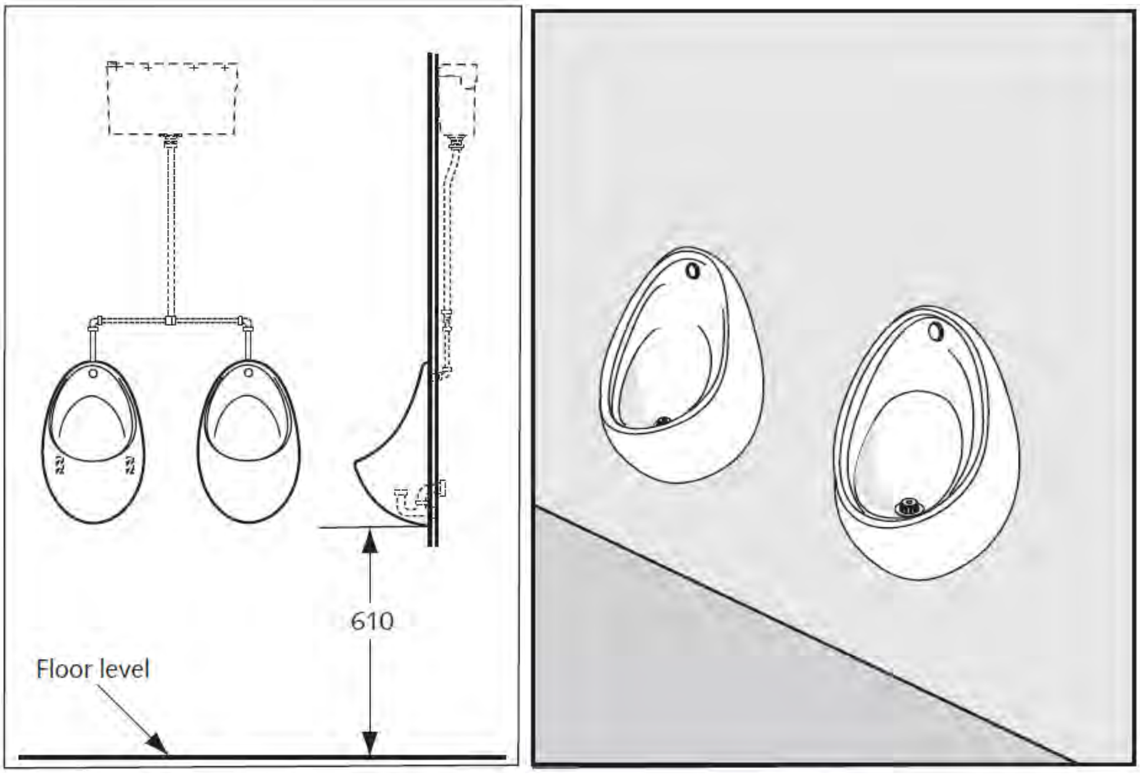

Figure 12: Hospital pattern urinal

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 12:

- **UR H 2** (Hospital pattern urinal);
- **WT2** (1½ in. unslotted flush-grated waste) ;

UR H 1/2/3

Identification

Wall mounted single, double or triple urinal with high level cistern and pipework for mounting in duct.

Standards

- vitreous china to BS 3402;
- Wastes to BS EN 274;
- copper tube to BS EN 1057;
- automatic flushing cistern to BS 1876.

Description

- white vitreous china bowl(s);
- wall mounted privacy screen panels;
- plastic reversible cistern and cover;
- 12mm pet cock and automatic siphon;
- metal flushing pipework and back inlet CP or stainless steel spreader;
- 1½ in. strainer waste outlet(s) and 'P' trap(s) with back outlet connection to concealed services;
- all necessary fixing devices.

Options

- plastic waste, trap and flush-pipe;
- waterless urinals (concealed drainage and supply).

Application

For use with concealed services.

Fixing/installation

- concealed brackets and fixings for bowls and screen panels. Provision for screw fixed concealed cistern and pipework;
- only to be fed from auto-cistern;
- auto-cistern should not exceed 10 L per hour for a cistern serving a single bowl or 7.5 L per hour per bowl on ranges of two or more [refer to the Water Supply (Water Fittings) Regulations 1999].

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

Design and specification notes

See paragraphs 2.6–2.9, and 2.93–2.95.

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Waste

For details Sheet 15:

- WT2, see Sheet 15 item 15.13.

Sheet 12: WC for fully ambulant and ambulant disabled users

The typical assembly requirements are:

1. Rimless pan for all back-to-wall hospital pattern pans.
2. Fully enclosed seat holes.
3. Seat only with no cover/lid.
4. WC suite to fully comply with the WC Suite Performance Specifications of the Water Supply (Water Fittings) Regulations 1999.
5. Cistern to include flushing arrangement (siphon) adjusted to deliver no more than 6 L full flush and, if dual flush, smaller volume not to exceed two-thirds of full-flush volume.

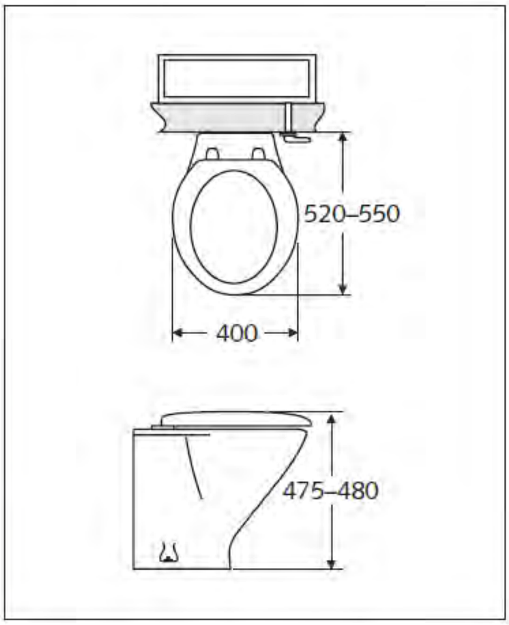


Figure 13: WC for fully ambulant and ambulant disabled users

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 13:

- **WC H** (Hospital pattern WC).

WC H

Identification

Back-to-wall rimless only WC pan with seat, and including cistern and pipework for mounting in duct.

Standards

- vitreous china as BS 3402;
- washdown WC pans with horizontal outlet, generally as BS EN 37 and BS EN 997;
- Water Supply (Water Fittings) Regulations 1999 – WC Suite Performance Specifications;
- float operated valves;
- diaphragm type as BS 1212;
- plastic floats for ball valves as BS 2456;
- plastic WC seats as BS 1254.

Description

- white vitreous china, 475–480mm with 520–550mm projection, rimless only, wash-down horizontal outlet pan with fully enclosed seat holes. Pan to be suitable for use with sanitary chairs compliant with BS 4751;
- plastic cistern with ½ in. valve, plastic float or diaphragm valve, siphon or flush valve, reversible CP metal flushing handle;
- plastic ring seat, set on easy clean metal hinges and visual contrast between seat and pan to be provided. No cover/lid and no exposed fixings;
- all necessary fixing devices.

Options

- dual flush siphon;
- pneumatic push-button or sensor operation;
- ½in. HP valve;
- 420mm rimless pan with raised seat;
- wall hung rimless back-to-wall pan.

Application

- for use by fully ambulant and ambulant disabled users;
- suitable for use with concealed services.

Fixing/installation

- pan for non ferrous screw fixings to the floor. Screws with domed covers to be used and pan sealed back to the wall or duct panels, therefore only top access seat fixings suitable;
- concealed cistern and pipework;
- should only be fed from the cistern;
- use HP valve option when connecting to water supply pressure in excess of 1.35 bar.

Cleaning/maintenance

Exposed surfaces must be smooth and easily cleaned. If a spacer box is used then all exposed surfaces must be finished with melamine or similar material.

Design and specification notes

See paragraphs 2.2–2.3, 2.10–2.18, and 2.93–2.95.

Sheet 13: WC for assisted ambulant disabled and wheelchair users

The typical assembly requirements are:

1. Rimless pan for all back-to-wall hospital pattern pans.
2. Fully enclosed seat holes.
3. Seat only with no lid/cover.
4. WC suite to fully comply with the WC Suite Performance Specifications of the Water Supply (Water Fittings) Regulations 1999.
5. Cistern to include flushing arrangement (siphon) adjusted to deliver no more than 6 L full flush and, if dual flush, smaller volume not to exceed two-thirds of full-flush volume.

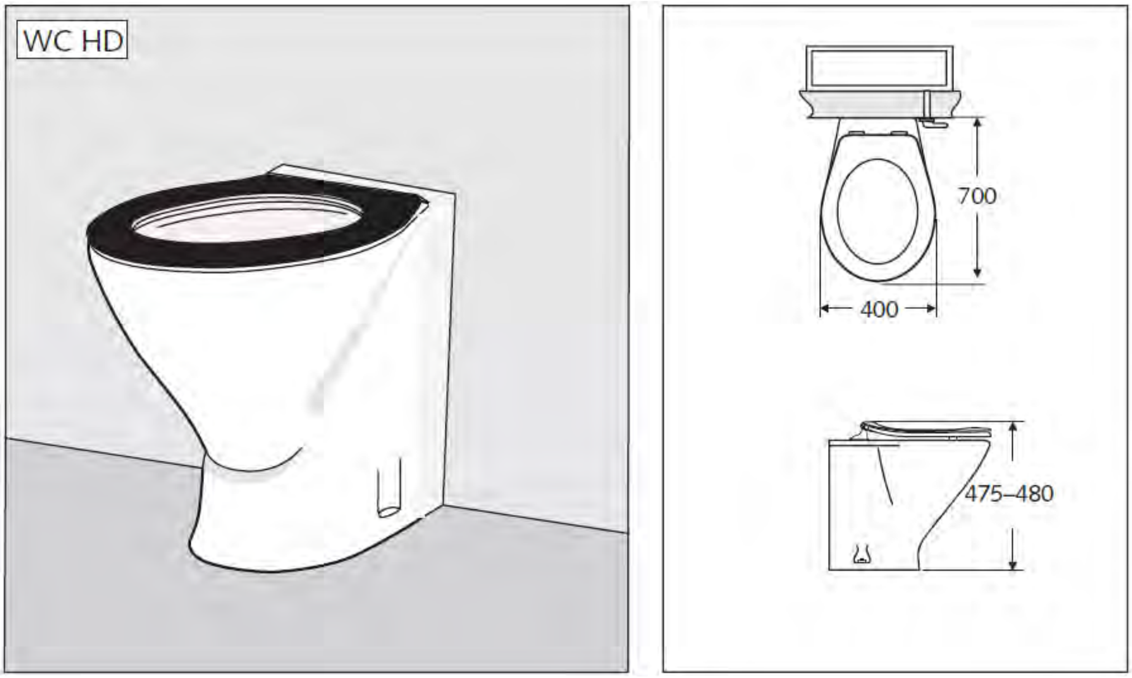


Figure 14: WC for assisted ambulant disabled and wheelchair users

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 14:

- **WC HD** (Hospital pattern WC for assisted ambulant disabled/wheelchair users)

WC HD

Identification

Low level back-to-wall rimless only WC pan with seat, and including cistern and pipework for mounting in duct.

Standards

- vitreous china as BS 3402;
- washdown WC pans with horizontal outlet, generally as BS EN 37and BS EN 997;
- Water Supply (Water Fittings) Regulations 1999 – WC Suite Performance Specifications;
- float operated valves;
- diaphragm type as BS 1212;
- plastic floats for ball valves as BS 2456;
- plastic WC seats as BS 1254.

Description

- white vitreous china, 475–480 mm with 700 mm projection, rimless only, wash-down horizontal outlet pan with fully enclosed seat holes. Pan to be suitable for use with sanitary chairs compliant with BS 4751;
- plastic cistern with ½ in. valve, plastic float or diaphragm valve, siphon or flush valve, reversible CP metal flushing handle;
- plastic ring seat set on easy clean metal hinges and visual contrast between seat and pan to be provided. No lid/cover and no exposed fixings;
- all necessary fixing devices.

Options

- associated back rest rail and cushion used to aid transfer of patients;
- dual flush siphon;
- pneumatic push-button or sensor operation;
- ½ in. HP valve;
- 420mm rimless pan with raised seat;
- wall hung rimless back-to-wall pan.

Application

- for wheelchair users and assisted ambulant disabled users;
- suitable for use with concealed services.

Fixing/installation

- pan for non-ferrous screw fixings to floor. Screws with domed covers to be used and pan sealed back to wall or duct panels, therefore only top access seat fixings;
- concealed cistern and pipework;
- should only be fed from cistern;
- use HP valve option when connecting to water supply pressure in excess of 1.35 bar.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned. If a spacer box is used then all exposed surfaces must be finished with melamine or similar material.

Design and specification notes

See paragraphs 2.2–2.3, 2.10–2.18, and 2.93–2.95.

Sheet 14: Bath assembly for use in connection with personal bathing

The typical assembly requirements are:

1. General bath, which is not for use in clinical areas.
2. Open nozzle and flow straightener with minimal restriction.
3. Thermostatic mixer on hot supply or integral thermostat (TMV3-approved).

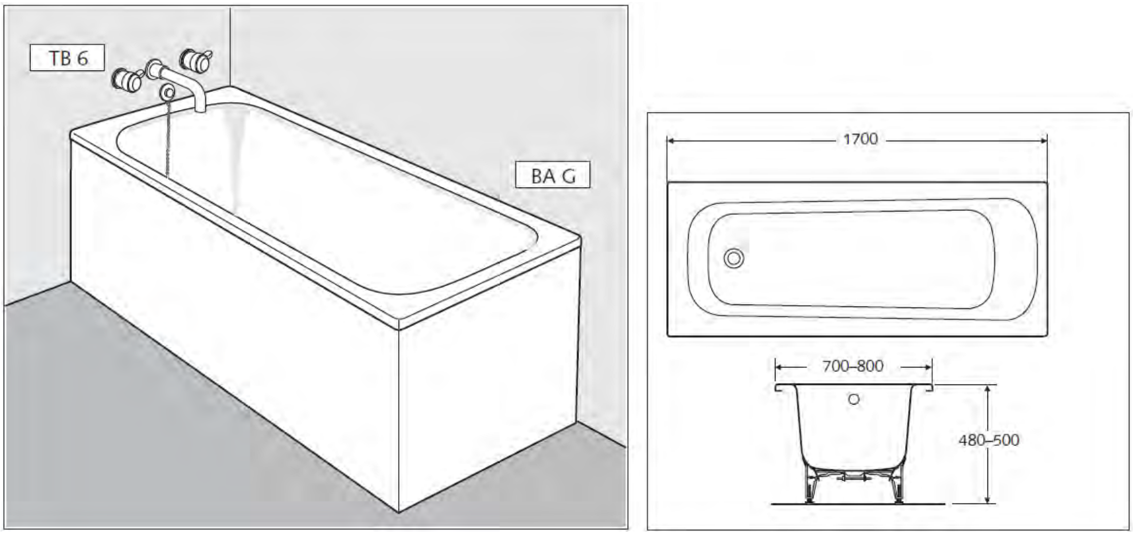


Figure 15: Bath assembly

Note: See also HBN 00-02: 'Sanitary spaces', which provides guidance on the ergonomic requirements for individual sanitary assemblies and room layouts in healthcare facilities.

Components used in Figure 15:

- **BA G** (General pattern bath);
- **TB6** (¾ in. bib combination tap assembly);
- **WT4** (1¼ in. waste with plug);
- **TRR2/P** (1½ in. resealing bottle trap, plastic).

BA G

Identification

Flat topped metal bath with no overflow.

Standards

- sheet steel baths for domestic purposes as BS 1390; BS EN 232;
- cast-iron baths for domestic purposes as BS 1189 and BS EN 232;
- vitreous enamel as BS 1344 and BS EN 14483-1;
- Model Engineering Specification D08: 'Thermostatic mixing valves (healthcare premises)';
- cast acrylic baths for domestic purposes as BS 4305-1, BS EN 198:1987 and BS EN 232;
- cast acrylic sheet for baths for domestic purposes as BS EN 263.

Description

- vitreous or porcelain enamelled bath pressed from steel of 2.5 mm overall thickness with slip-resistant bottom, no tap holes, no overflow, no chain-hole and no handgrips;
- supporting framework/legs with adjustable feet;
- all necessary fixing devices;
- earthing terminal.

Options

Minimum 5mm thick fully reinforced white plastic bath with supporting framework, adjustable feet and no tap-holes.

Application

Suitable for independent wheelchair users and ambulant disabled people but not suitable for patients who require assistance.

Fixing/installation

Supporting framework set on floor with side and end panels secured by concealed fixings.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

Design and specification notes

See paragraphs 2.30–2.31.

Tap, trap and waste

For details see Sheet 15:

- TB6, see Sheet 15 item 15.4;
- TRR2/P, see Sheet 15 item 15.11;
- WT4, see Sheet 15 item 15.15.

Sheet 15: Data sheets for taps, traps, wastes and floor outlets used in assemblies

Taps

Note: Swan-neck outlets must be avoided, as indicated in SHFS 30: 'Infection control in the built environment: design and planning'. Therefore, in existing facilities, when such an outlet has become damaged and is due for repair, this guidance recommends that it be completely replaced by an appropriate, alternative component described in this section.

15.1 TB H1

Identification

Lever-action ½ in bib tap with long lever.

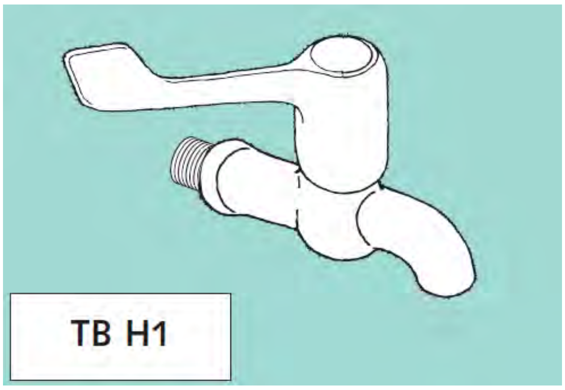


Figure 16: Tap assembly TB H1

Standards

- BS EN 200;
- BS 5412.

Description

- pair, metal bib taps with metal headwork, shrouded metal quarter-turn, lever-action top with colour temperature indicators;
- lever parallel to wall when tap closed;
- open nozzle and flow straightener with minimal restriction;
- tail with G ½ in. thread. Inlet for 15mm O/D supply pipe.

Options

- matching extension piece to give 200mm between wall and centre line of discharge;
- short lever pattern, approximately 75mm long.

Note: Spray and aerator outlet should not be used.

Application

Suitable for use with sinks and hoppers.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.2 TB H2a

Identification

Integral thermostatic hospital pattern bib combination mixer tap with a single lever, single flow, fixed horizontal nozzle and 2 x ½in. inlets with sequential operation.

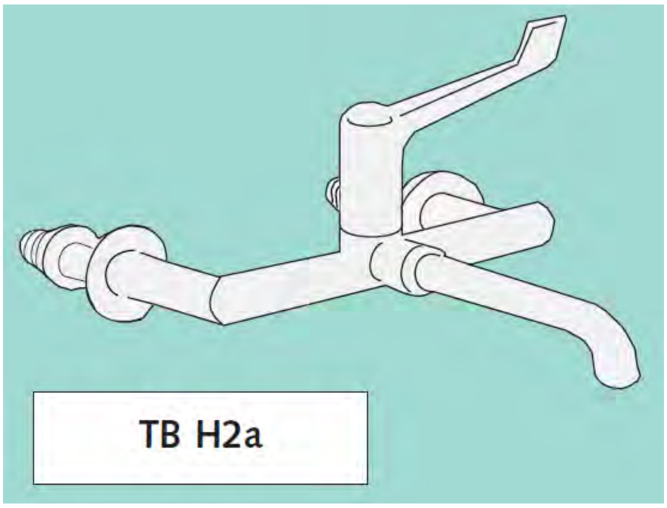


Figure 17: Tap assembly TB H2a

Standards

Performance to Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’.

Description

- integral thermostatic hospital pattern bib combination mixer with sequential operation via single lever through a minimum travel of 120 degrees cold into hot. Single flow fixed horizontal nozzle and 2 x ½ in. inlets;
- open nozzle and flow straightener with minimal restriction;
- open end, reach of nozzle 200–250 mm from wall;
- two threaded tails with brass backnuts and washers. Inlets for 15 mm supply pipe.

Options

- Remote thermostatic mixing valve;
- Dual lever control, one lever to operate flow rate and one lever to set temperature.

Application

Suitable for use in conjunction with scrub-up troughs and with medium and large hospital pattern integral back outlet basins.

Cleaning/maintenance/safety

All exposed surfaces to be smooth and easily cleaned. See also paragraphs 2.84–2.89.

Sensor located either below the fixed nozzle, to the side of the fitting or integral with the fitting.

Design and specification notes

See paragraphs 2.54–2.76.

15.3 TB H6

Identification

Integral thermostatic automatic action bib mixer tap.

Standards

Performance to Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’.

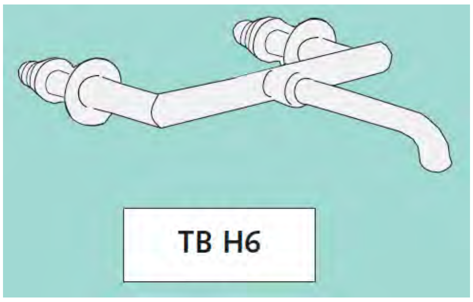


Figure 18: Tap assembly TB H6

Description

- integral thermostatic hospital pattern bib combination mixer with sensor operation;
- flow straightener with minimal restriction;
- single threaded tail with brass backnut, washer and two inlets.

Note: Spray and aerator outlet should not be used.

Options

- remote thermostatic mixing valve;
- approx. 200mm tubular spout;
- close proximity and timed flow sensor.

Application

Suitable for use in conjunction with hospital pattern basins and scrub-up troughs.

Cleaning/maintenance/safety

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.90–2.95.

Design and specification notes

See paragraphs 2.62–2.70.

15.4 TB6

Identification

Bib combination tap assembly, 2 x ¾ in. inlets and with single flow, fixed nozzle and short levers.

Standards

Performance of draw-off taps with metal bodies as BS 5412.

Description

- metal bib combination tap with all metal headwork, shrouded, rotating lever-action tops with coloured indicators;
- threaded tails to valves and nozzle, metal flange plates and combination pipework with threaded inlets for mounting in duct.

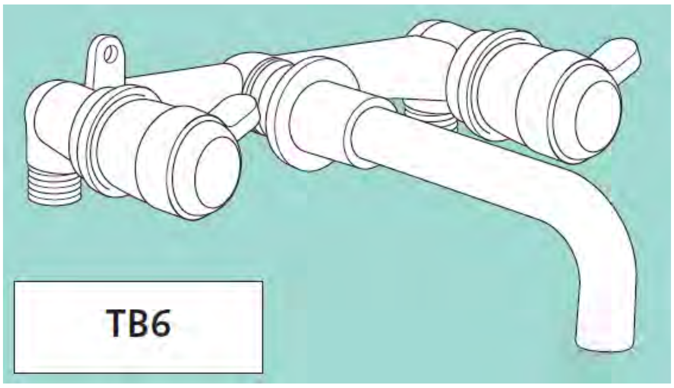


Figure 19: Tap assembly TB6

Options

Integral or upstream thermostat to be on the hot supply.

Application

Suitable for use with general baths.

Cleaning/maintenance/safety

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.84–2.89.

Design and specification notes

See paragraphs 2.62 – 2.70.

15.5 TP3

Identification

Pair of pillar taps, ½ in. high neck and long lever.

Standards

- Performance as BS 5412 and BS EN 200;
- Function as DDA and BS 8300.

Description

- metal pillar tap with metal headwork and shrouded metal top with colour temperature indicators;
- open nozzle and flow straightener with minimal restriction;
- spout-to-body connection clear of base;
- threaded tail with brass backnut and washer;
- inlet for 15 mm O/D supply pipe.

Note: Spray and aerator outlet should not be used.

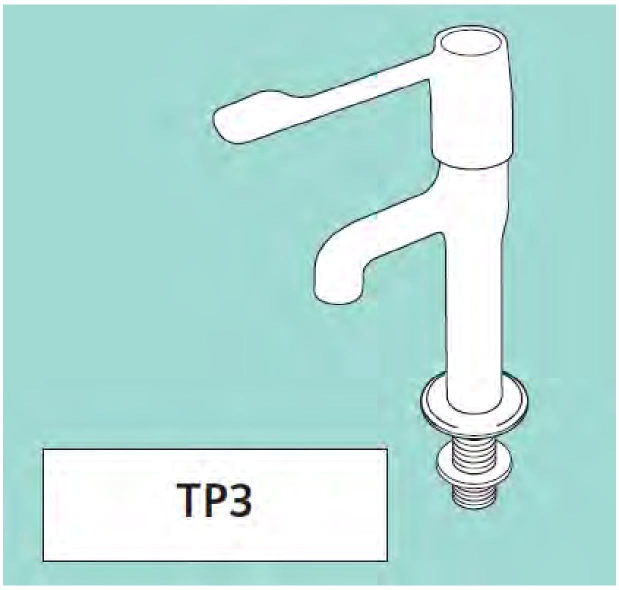


Figure 20: Tap assembly TP3

Application

For use with sinks and sink tops in domestic services procedures.

Options

Short lever.

Cleaning/maintenance/safety

Exposed surfaces smooth and easily cleaned, see also paragraphs 2.84–2.89.

Design and specification notes

See paragraphs 2.62–2.70.

15.6 TP5

Identification

Pair of pillar taps, ½ in. with short lever.

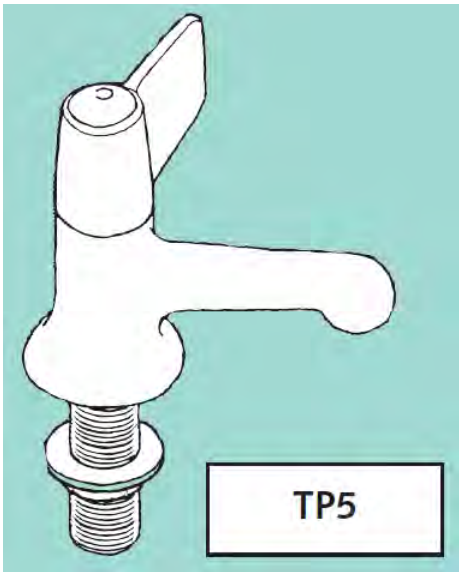


Figure 21: Tap assembly TP5

Standards

- performance as BS 5412 and BS EN 200;
- function as DDA and BS 8300.

Description

- metal pillar tap with metal headwork and shrouded metal top with colour temperature indicators;
- open nozzle and flow straightener with minimal restriction;
- spout-to-body connection clear of base;
- threaded tail with brass backnut and washer;
- inlet for 15 mm O/D supply pipe;
- thermostatic mixer on hot supply.

Note: Spray and aerator outlet should not be used.

Application

Suitable for use with medium and large general basins.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.84–2.89.

Design and specification notes

See paragraphs 2.66–2.74.

15.7 TP6

Identification

Integral thermostatic monobloc pillar mixer tap with short lever and sequential operation.

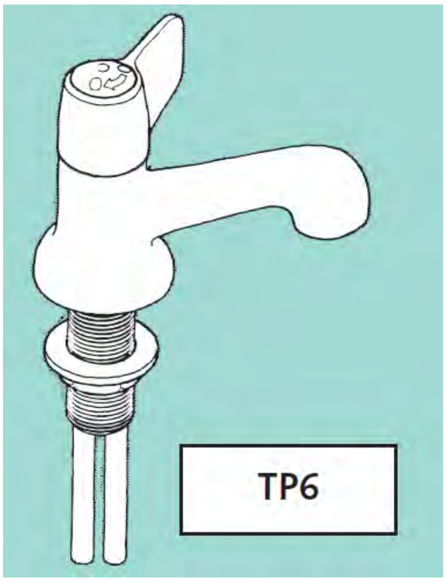


Figure 22: Tap assembly TP6

Standards

- performance to Model Engineering Specification D08: 'Thermostatic mixing valves (healthcare premises)';
- function as DDA and BS 8300.

Description

- metal pillar mixer tap with composite headwork and shrouded metal top with colour temperature indicators and short lever;

- progressive action from cold to hot through >120° travel;
- open nozzle and flow straightener with minimal restriction;
- spout-to-body connection clear of base;
- fixing or clamping mechanism that prevents rotation;
- two inlets for supply pipes.

Note: Spray and aerator outlet should not be used.

Application

For use with general pattern basins in WCs, both for hand-rinsing and personal washing.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.84–2.89.

Design and specification notes

See paragraphs 2.66–2.74.

15.8 TPP1

Identification

Monobloc, pillar mixer, self-closing press taps, non concussive and with two inlets.

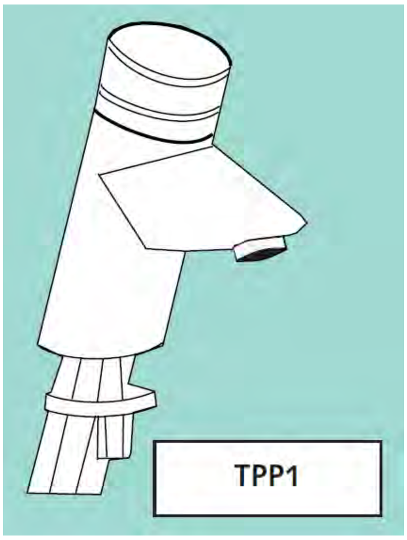


Figure 23: Tap assembly TPP1

Standards

- BS EN 816;
- performance to comply with Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’.

Description

- monobloc pillar mixer tap with metal headwork, shrouded metal top and colour temperature indicators;
- open nozzle and flow straightener with minimal restriction (run-time adjustable);
- spout-to-body connection clear of base;
- G ⅜ in. x 15mm connectors;
- thermostatic mixer on the hot supply.

Note: Spray and aerator outlet should not be used.

Application

- for hand washing when used in conjunction with medium and large general basins;
- for hand rinsing when used in conjunction with small general basins;
- water saving.

Cleaning/maintenance/safety

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.84–2.89. See also SHTM 2040: ‘The control of Legionella, hygiene, ‘safe’ hot water, cold water and drinking water systems’.

Design and specification notes

See paragraphs 2.62–2.70.

15.9 TM1

Identification

Concealed wall mounted thermostatic shower mixer valve, flexible hose and spray handset on a sliding rail kit.

Standards

- performance to Model Engineering Specification D08: ‘Thermostatic mixing valves (healthcare premises)’;
- shower heads as BS EN 1112;
- shower hose as BS EN 1113.

Description

- metal thermostatic mixer valve with fail-safe temperature control to TMV3 D08 and shrouded lever-operated metal top, to provide control of temperature and volume;
- metal elbow with flexible hose and outlet with smooth reinforced nylon hose spray handset with wall attachments (see paragraphs 2.76–2.77 for back-siphonage requirements);
- connecting pipework not included.

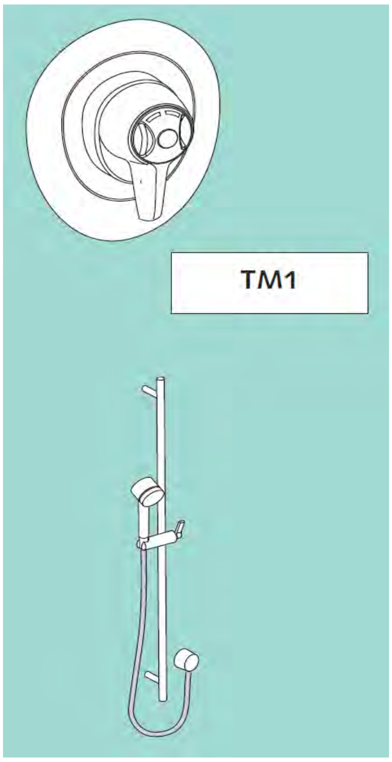


Figure 24: Shower assembly TM1

Options

Concealed fixed-height shower head with hose and handset at a fixed point.

Cleaning/maintenance/safety

All exposed surfaces to be smooth and easily cleaned, see also paragraphs 2.84–2.89 and SHTM 2040: ‘The control of Legionella, hygiene, ‘safe’ hot water, cold water and drinking water systems’.

Design and specification notes

See paragraphs 2.62–2.70.

15.10 TRR1/P

Identification

1¼ in. plastic resealing bottle trap.

Standards

BS EN 274.

Description

- 75mm seal plastic bottle trap with removable sump, and threaded outlet for connection to copper or plastic pipework and annular pattern resealing device;
- white.

Application

All basins.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.11 TRR2/P

Identification

1½ in. plastic resealing bottle trap.

Standards

BS EN 274.

Description

- 75 mm seal plastic bottle trap with removable sump and threaded outlet for connection to copper or plastic pipework and annular pattern resealing device;
- white.

Application

Sinks, scrub-up troughs and general baths.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.12 WT1

Identification

1¼ in. unslotted flush grated waste, CP on brass.

Standards

BS EN 274.

Description

All metal long waste with flush grated top and no exposed sharp areas. Threaded tail with brass backnut and gaskets.

Application

For use with small general basins and hospital pattern bidets.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.13 WT2

Identification

1½ in unslotted flush grated waste, CP on brass.

Standards

BS EN 274.

Description

All metal long waste with flush-grated top with no exposed sharp areas. Threaded tail with brass backnut and gaskets.

Options

Plastic option with urinals and removable top access shower wastes.

Application

For use with bottom outlet scrub-up troughs and sinks used for clinical procedures. Use plastic option with urinals and removable top access shower wastes.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.14 WT3

Identification

1¼ in unslotted recessed grated waste, CP on brass, plug with CP link chain and screw/bolt stay.

Standards

BS EN 274.

Description

All metal long waste with recessed grate and no exposed sharp areas. Plug with metal link chain and screw stay with threaded tail, brass backnut and gaskets.

Application

For use with medium or large general basins.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.15 WT4

Identification

1½ in unslotted recessed grated waste, CP on brass, plug with CP link chain and screw stay.

Standards

BS EN 274.

Description

All metal long waste with recessed grate and no exposed sharp areas. Plug with metal link chain, screw stay, threaded tail with brass backnut and gaskets.

Application

For use with domestic services sinks, sink tops and baths. Use slotted option for domestic baths.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned.

15.16 FO H

Identification

Hospital pattern floor drainage outlet and grating.

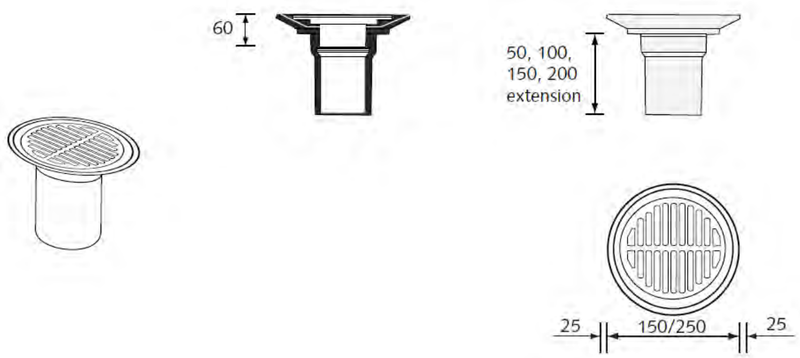


Figure 25: Floor outlet FO H

Standards

- cast-iron to BS EN 13835;
- stainless steel to BS EN 10088.

Description

- a non-rusting shower outlet with nickel-bronze screw-down grating, surface-clamping ring and 100 mm diameter outlet spigot with threaded tail;
- cast iron extension, specify length 50, 100, 150 or 200 mm, with internal thread for connection to outlet and plain tail.

Options

- stainless steel grating;
- polished bronze grating;
- rough bronze galvanised extension;
- threaded tail to extension piece.

Application

Suitable for use in connection with clinical procedures where showers are formed in builders' work.

Fixing/installation

Grout into floor, seal spigot to drain and seal floor finish to rim of outlet.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned, with no sharp edges.

15.17 FO G

Identification

General pattern floor drainage outlet and grating.

Standards

- cast-iron to BS EN 13835;
- stainless steel to BS EN 10088;
- galvanised coatings to BS EN ISO 1461.

Description

A non rusting drainage hopper used for the disposal of bulk liquids and liquid wastes from floor cleaning machines. To have 100mm diameter outlet spigot and flange to receive floor finishes and with lift-out non-rocking stainless steel grating.

Options

Galvanised cast-iron grating.

Application

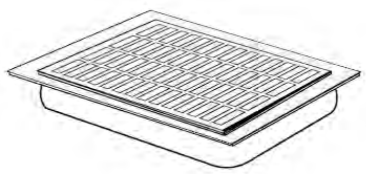
Suitable for domestic service use in main cleaners' rooms, service departments, etc. To be used with wall-mounted hot and cold taps and length of hose to hose down.

Fixing/installation

Grout into floor, seal spigot to drain and seal floor finish to rim of outlet.

Cleaning/maintenance

All exposed surfaces to be smooth and easily cleaned and with no sharp edges.



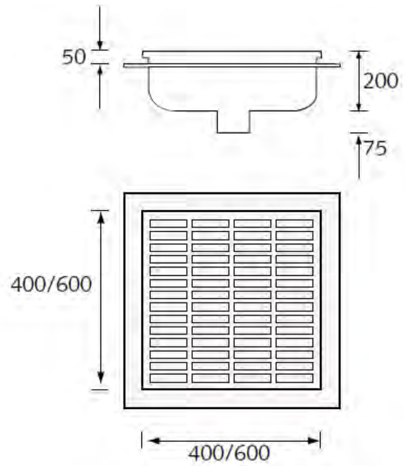


Figure 26: Floor outlet FO G

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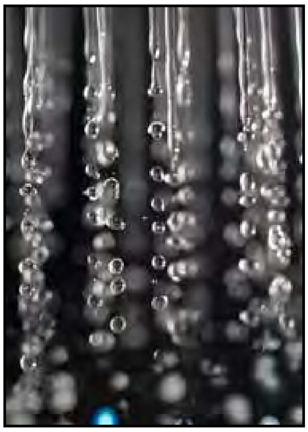
Activity database - http://www.adb.dh.gov.uk/

Health and Safety Executive

Legionnaires' disease

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



HSG274 Part 2
Published 2014

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

The guidance gives practical advice on the legal requirements of the Health and Safety at Work etc Act 1974, the Control of Substances Hazardous to Health Regulations 2002 concerning the risk from exposure to *Legionella* and guidance on compliance with the relevant parts of the Management of Health and Safety at Work Regulations 1999.

Contents

Introduction

1 This guidance is for dutyholders, which includes employers, those in control of premises and those with health and safety responsibilities for others, to help them comply with their legal duties. It gives practical guidance on how to assess and control the risks due to legionella bacteria.

2 Any water system that has the right environmental conditions could potentially be a source for legionella bacteria growth. There is a reasonably foreseeable legionella risk in your water system if:

- water is stored or re-circulated as part of your system;
- the water temperature in all or some part of the system may be between 20–45 °C;
- there are deposits that can support bacterial growth, such as rust, sludge, scale and organic matter;
- it is possible for water droplets to be produced and, if so, if they can be dispersed;
- it is likely that any of your employees, contractors, visitors etc could be exposed to any contaminated water droplets.

Health and safety law

3 *Legionnaires' disease: The control of legionella bacteria in water systems. Approved Code of Practice*[1] gives specific information on the health and safety law that applies. In brief, general duties under the Health and Safety at Work etc Act 1974 (the HSW Act)[2] extend to risks from legionella bacteria, which may arise from work activities. The Management of Health and Safety at Work Regulations 1999 provide a broad framework for controlling health and safety at work (see www.hse.gov.uk/risk for more information). More specifically, the Control of Substances Hazardous to Health Regulations 2002 (COSHH)[3] provide a framework of duties designed to assess, prevent or control the risks from hazardous substances, including biological agents such as legionella, and take suitable precautions.

4 The essential elements of COSHH are:

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

5 Under general health and safety law, dutyholders including employers or those in control of premises, must ensure the health and safety of their employees or others who may be affected by their undertaking. They must take suitable precautions to prevent or control the risk of exposure to legionella. They also need to either understand, or appoint somebody competent who knows how to identify and assess sources of risk, manage those risks, prevent or control any risks, keep records and carry out any other legal duties they may have.

Other relevant legislation

6 Employers must be aware of other legislation they may need to comply with, which includes the Notification of Cooling Towers and Evaporative Condensers Regulations 1992;[4] Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR);[5] the Safety Representatives and Safety Committees Regulations 1977 and the Health and Safety (Consultation with Employees) Regulations 1996.[6]

Notification of Cooling Towers and Evaporative Condensers Regulations 1992

7 These Regulations require employers to notify the local authority, in writing, if they operate a cooling tower or evaporative condenser and include details about where they are located. The Regulations also require notification when such devices are no longer in use. Notification forms are available from your local environmental health department.

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR)

8 These regulations require employers and those in control of premises to report accidents and some diseases that arise out of or in connection with work to HSE. Cases of legionellosis are reportable under RIDDOR if a medical practitioner notifies the employer; and the employee's current job involves work on or near cooling systems that are located in the workplace and use water; or work on water service systems located in the workplace, which are likely to be a source of contamination. For more information, see HSE guidance at www.hse.gov.uk/riddor/index.htm.

The Safety Representatives and Safety Committees Regulations 1977 and the Health and Safety (Consultation with Employees) Regulations 1996

9 These regulations require employers to consult trade union safety representatives, other employee representatives, or employees where there are no representatives, about health and safety matters. This includes changes to the work that may affect their health and safety, arrangements for getting competent help, information on the risks and controls, and the planning of health and safety training.

Identify and assess sources of risk

10 Carrying out a legionella risk assessment and ensuring it remains up to date is required under health and safety law and is a key duty when managing the risk of exposure to legionella bacteria. In conducting the assessment, the dutyholder must appoint a competent person or persons, known as the responsible person(s), to help them meet their health and safety duties, ie take responsibility for managing the control scheme. If the necessary competence, knowledge and expertise does not exist, there may be a need to appoint someone externally (see paragraphs 16-22).

11 The responsible person(s) appointed to take day-to-day responsibility for managing risks in their business will need to understand the water systems, any equipment associated with the system, and all its constituent parts. They should be able to identify if the water systems are likely to create a risk from exposure to legionella bacteria by assessing if:

- water is stored or re-circulated in the system;
- the water temperature in all or some parts of the system may be between 20–45 °C;
- there are deposits that support bacterial growth, including legionella, such as rust, sludge, scale, organic matter and biofilms;
- it is possible for water droplets to be produced and, if so, whether they can be dispersed;

- it is likely that any of your employees, contractors, visitors, the public etc could be exposed to contaminated water droplets.

12 The practical risk assessment should include a site survey of all the water systems and consider other health and safety aspects of undertaking such investigations, eg working at height or in confined spaces or the need for permits-to-work when doing this.

13 Appendix 2.1 provides information on the key requirements when assessing the risks associated with any water systems. Further information is also available in BS 8580 *Water quality. Risk assessments for Legionella control. Code of Practice*[7] and in The Water Management Society's *Guide to risk assessment for water services*.[8] In summary, the risk assessment should consider and evaluate:

- clear allocation of management responsibilities;
- competence and training of key personnel;
- a description of the water system, including an up-to-date schematic diagram;
- an evaluation of the risk;
- safe operating procedures for the water system, including controls in place to control risks;
- monitoring, inspection and maintenance procedures;
- results of monitoring, inspection and any checks carried out;
- limitations of the legionella risk assessment;
- arrangements to review the risk assessment regularly and particularly when there is reason to suspect it is no longer valid.

Info box: Schematic diagram

A schematic diagram is a simplified but accurate illustration of the layout of the water system, including parts temporarily out of use. While providing only an indication of the scale, it is an important tool as it allows any person who is not familiar with the system to understand quickly and easily their layout, without any specialised training or experience. These are not formal technical drawings but show what the systems comprise of, illustrating plant and equipment, including servicing and control valves, any components potentially relevant to the legionella risk, including outlets, strainers and filters or parts that are out of use.

14 If the risk assessment concludes there is no reasonably foreseeable risk or the risks are insignificant and are managed properly to comply with the law, the assessment is complete. Although no further action may be required at this stage, existing controls must be maintained. The assessment of risk is an ongoing process and not merely a paper exercise. Dutyholders should arrange to review the assessment regularly and specifically when there is reason to suspect it is no longer valid. An indication of when to review the assessment and what to consider should be recorded and this may result from, eg:

- a change to the water system or its use;
- a change to the use of the building where the system is installed;
- new information available about risks or control measures;
- the results of checks indicating that control measures are no longer effective;
- changes to key personnel;
- a case of legionnaires' disease/legionellosis associated with the system.

15 Communication is a key factor in the risk assessment process. The risk needs to be identified and communicated to management to allow them to prioritise remedial actions to control it.

Managing the risk

16 Inadequate management, lack of training and poor communication can be contributory factors in outbreaks of legionnaires' disease. It is important that those people involved in assessing risk and applying precautions are competent, trained and aware of their responsibilities.

17 The dutyholder should specifically appoint a competent person or persons to take day-to-day responsibility for controlling any identified risk from legionella bacteria. It is important for the appointed person, known as the responsible person(s), to have **sufficient authority, competence and knowledge of the installation** to ensure all operational procedures are carried out in a timely and effective manner.

18 The responsible person(s) appointed to implement the control measures and strategies should be suitably informed, instructed and trained and their suitability assessed. Regular refresher training should be given and the responsible person(s) should have a clear understanding of their role and the overall health and safety management structure and policy in the organisation.

19 If a dutyholder is self-employed or a member of a partnership, and is competent, they may appoint themselves. Many businesses can develop the necessary expertise in house and are well equipped to manage health and safety themselves. However, if there are some things they are not able to do, it is important to get external help. If there are several people responsible for managing risks, eg because of shift-work patterns, the dutyholder needs to make sure that everyone knows what they are responsible for and how they fit into the overall risk management of the system.

20 Identifying and deciding what help is needed is very important but it is the responsibility of the dutyholder to ensure those appointed to carry out the tasks given to them have adequate information and support.

21 Dutyholders can use specialist contractors to undertake aspects of the operation, maintenance and control measures required for their water system. While these contractors have legal responsibilities, the ultimate responsibility for the safe operation of the water system rests with the dutyholder. It is important they are satisfied that any contractors employed are competent to carry out the required tasks and that the tasks are carried out to the required standards. The contractor should inform the dutyholder of any risks identified and how the system can be operated and maintained safely.

22 There are a number of external schemes to help you with this, such as the Legionella Control Association's *A Recommended Code of Conduct for Service Providers*.[9]

Preventing or controlling the risk

23 First, consider whether the risk of legionella can be prevented by considering the type of water systems needed. Where the risk cannot be prevented, a course of action must be devised to manage the risk by implementing effective control measures. The written scheme should be specific and tailored to the systems covered by the risk assessment. Appendix 2:2 summaries the key information, which should include the following precautions:

- ensuring the release of water spray is properly controlled;
- avoiding conditions that support growth of microorganisms, including legionella;

- ensuring water cannot stagnate anywhere in the system by regular movement of water in all sections of the systems and by keeping pipe lengths as short as possible, and/or removing redundant pipework and deadlegs;
- avoiding using materials that harbour bacteria and other microorganisms or provide nutrients for microbial growth (the *Water Fittings and Materials Directory*[10] lists fittings, materials, and appliances approved for use on the UK Water Supply System by the Water Regulations Advisory Scheme. Those approved are tested against BS 6920);[11]
- keeping the system and the water in it clean;
- treating water to either control the growth of microorganisms, including legionella, or limit their ability to grow;
- monitoring any control measures applied;
- keeping records of these and other actions taken, such as maintenance and repair work.

Record keeping

24 Where there are five or more employees, the significant findings of the risk assessment must be recorded. If there less than five employees, there is no requirement to record anything although it is useful to keep a written record.

25 Records must be retained for the period they remain current and for at least two years afterwards, with the exception of records kept for monitoring and inspection, which should be kept for at least five years. It may be helpful to keep training records of employees; records of the work of external service providers, such as water treatment specialists; and information on other hazards, eg chemical safety data sheets.

26 Records, either written or electronic, should contain accurate information about who did the work and when it was carried out. All records should be signed, verified or authenticated by a signature or other appropriate means. Records should include details of the:

- person or people responsible for conducting the risk assessment, managing, and implementing the written scheme;
- significant findings of the risk assessment;
- written control scheme and details of its implementation;
- details of the state of operation of the system, ie in use/not in use;
- results of any monitoring, inspection, test or check carried out, the dates and any resulting corrective actions, as defined in the written scheme of precautions, such as:
  - results of chemical and microbial analysis of the water;
  - water treatment chemical usage;
  - inspections and checks on the water treatment equipment to confirm correct operation;
  - inspections and checks on the water system components and equipment to confirm correct and safe operation;
  - records of maintenance to the water system components, equipment and water treatment system;
  - the cleaning and disinfection procedures and the associated reports and certificates.

Types and application of hot and cold water systems

2.1 Hot and cold water systems are those that supply water for domestic purposes (drinking, cooking, food preparation, personal hygiene and washing). This section provides information on the different types, design and use of systems available to supply hot and cold water services.

2.2 Water systems in high risk locations (such as healthcare premises, care homes, residential homes and other situations where those exposed to the water systems are likely to be at high risk of infection) need particular consideration. The risk assessment should consider both the relative risks of legionella and scalding. See paragraphs 2.152–2.168, www.hse.gov.uk/healthservices/ and *Health and safety in care homes*[12] for more information for care settings. Healthcare premises should refer to *Water systems: Health Technical Memorandum 04–01*[13] (for England and Wales), or to *Scottish Health Technical Memorandum 04–01*[14] (for Scotland).

2.3 Those who provide residential accommodation or who are responsible for the water systems in premises must assess the risk from exposure to legionella to residents, tenants, guests and customers and implement control measures, if appropriate. It is also increasingly common for there to be several dutyholders in one building who may also have responsibilities for assessing and managing the risk from legionella. See paragraphs 2.138–2.151 for specific guidance.

2.4 Within hot and cold water systems, the risk areas that support growth of microorganisms, including legionella, are controllable with good design, operation, maintenance and water system management and include:

- the base of the water heater and storage vessel, particularly where incoming cold water reduces the temperature of the water within the vessel and where sediment collects and is distributed throughout the system;
- where optimum temperatures for microbial growth and stagnation occur, eg dead legs, capped pipes (dead ends), infrequently used outlets and areas of the system where there is poor circulation;
- where incoming cold water temperatures are above 20 °C, or there are areas within the cold water system that are subject to heat gain and areas of stagnation where there are deposits to support growth.

Safe operation and control measures

2.5 This guidance provides detailed information on types of water system, design considerations and commissioning systems to ensure risks from exposure to legionella are minimised or reduced as far as is reasonably practicable. There is also guidance on operational and control measures.

2.6 Temperature control is the traditional strategy for reducing the risk of legionella in water systems. Cold water systems should be maintained, where possible, at a temperature below 20 °C. Hot water should be stored at least at 60 °C and distributed so that it reaches a temperature of 50 °C (55 °C in healthcare premises) within one minute at the outlets. For most people, the risk of scalding at this temperature is low. However, the risk assessment should take account of susceptible ‘at risk’ people including young children, people who are disabled or elderly and to those with sensory loss for whom the risk is greater.

2.7 In addition to temperature control, eg in more complex systems such as large healthcare facilities, additional measures that encourage the regular movement of water are often used to manage the risk from legionella in water systems. The exact techniques may vary significantly in different water systems and operating conditions. Paragraphs 2.80–2.118 give further guidance on the use of water treatment techniques and control programmes.

2.8 The cleanliness of the system must be maintained, as legionella bacteria are more likely to grow in a system fouled with deposits. In hard water areas, softening of the cold water supply to the hot water distribution system should be considered to reduce the risk of scale being deposited at the base of the calorifier and heating coils, and to reduce the potential for scale build-up within the system pipework and components – see paragraphs 2.72–2.73. There is further guidance on cleaning and disinfection techniques and requirements for hot and cold water systems in paragraphs 2.126–2.137.

Hot and cold water systems

2.9 There are many types of water systems supplying hot and cold water services and these vary depending on the size and complexity of the building. Figures 2.1–2.11 are representative diagrams illustrating the range of different types of system or components and are not technical or design installation guides. Combinations and variations are possible, but these systems are broadly grouped as:

- **smaller hot and cold water systems**, eg directly fed mains cold water to outlets with localised point of use (POU) water heaters;
- **gravity-fed cold water systems** incorporating storage tanks (cisterns) and larger water heaters (calorifiers) for the provision of hot water. Hot water systems (HWS) typically operate without secondary hot water recirculation in smaller premises and with recirculation in larger premises. Cold water distribution systems (CWDS) do not normally recirculate cold water and require outlets to be operated to prevent stagnation in adjacent parts of the system;
- **pressurised systems** that can be directly mains fed or incorporate storage and booster pumps supplying cold water and unvented water heaters with or without secondary recirculation.

Smaller hot and cold water systems

2.10 These systems are typically found in smaller buildings such as domestic dwellings and small office buildings where cold water outlets are fed directly from the water supply without storage. Combination boilers or instantaneous water heaters (see Figure 2.1) provide hot water directly from the cold water supply by heating the water as it passes through the heater. These units supply continuous hot water at a rate that is usually limited by their power rating. High flow rates through the units can result in warm water leaving the heater before reaching the target temperature.

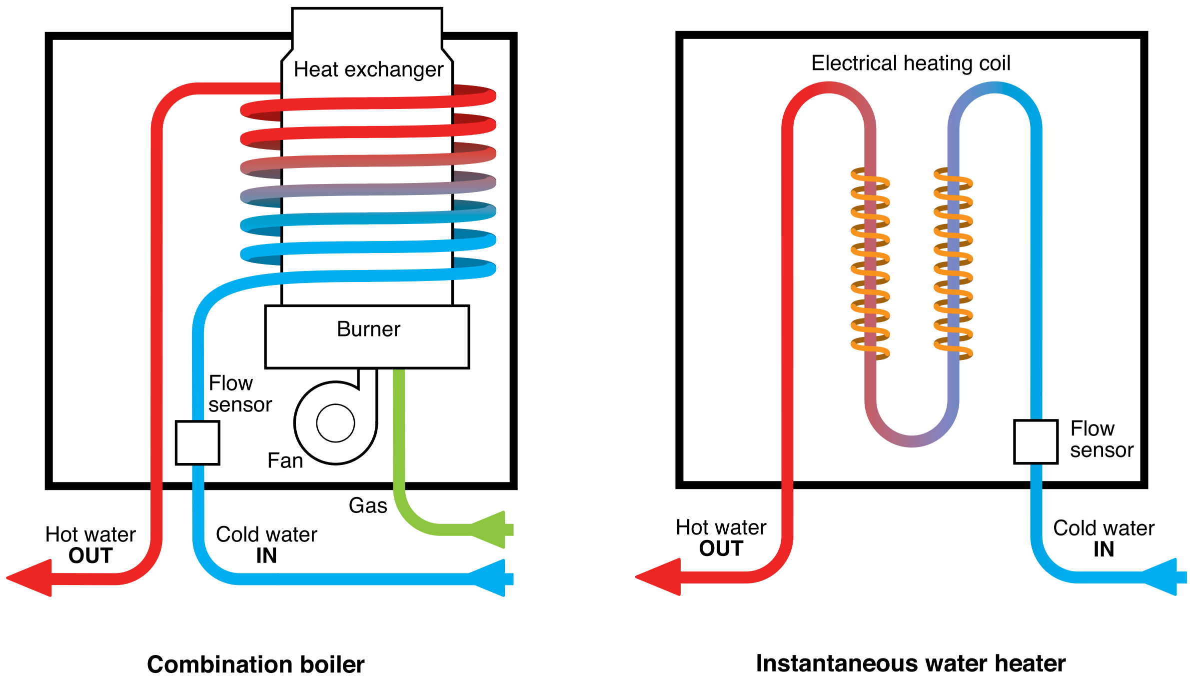


Figure 2.1 Non-storage water heaters

2.11 Low storage volume POU water heaters are those that store no more than 15 litres of hot water (see Figure 2.2). These systems generally heat water to a set point that is often variable via a simple dial on the unit. These systems deliver a small volume of stored hot water before they need to be left to recover and bring the temperatures back to the set point.

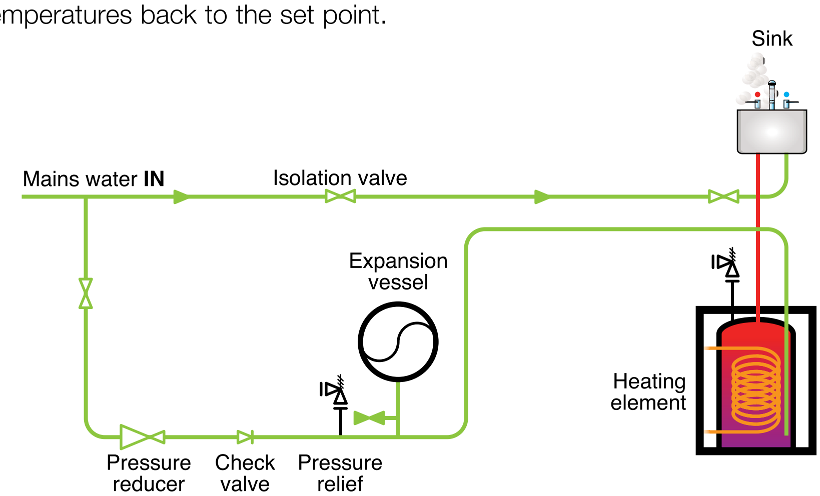


Figure 2.2 Low storage volume POU water heater

2.12 Combination water heaters store a volume of cold water (ranging from 10–200 litres) above the hot water storage unit (ranging from 15–150 litres). In these units (see Figure 2.3) the cold water header tank feeds the hot water storage vessel as hot water is drawn from the system on demand. The cold water header tank is topped up directly from the cold water supply, usually via a float-operated valve. The combination water heater is usually fitted with an expansion pipe so that any expanding hot water returns into the cold water header tank. Expansion may also occur by the cold feed pipe.

2.13 The design of a combination water heater may allow hot water to enter the cold water space. The Water Supply (Water Fittings) Regulations 1999,[15] the Scottish Water Byelaws 2004,[16] and BS 3198 *Specification for copper hot water storage combination units for domestic purposes*[17] recognise this and permit a maximum cold water storage temperature of 25 °C where it is serving other domestic outlets or 38 °C when serving the hot water vessel only. Careful consideration should be given to managing the risks from these types of systems and this should be reflected in the risk assessment. The thermostat should be set to as close to 60 °C as is practicable without exceeding it and hot water at the outlets should be at a minimum of 50 °C; correct setting of the thermostat and regular water usage is necessary to keep the temperature increase in the cold water to a minimum. Where this is not possible, eg during periods of low usage such as overnight or at weekends, fitting a timer which switches off the immersion heater may prove effective. The timer should be set to switch the immersion heater on again in time to ensure the water is heated sufficiently to achieve microbial control before use.

2.14 Electrical immersion heaters usually heat combination heaters but some units incorporate internal coils for primary boiler heating circuits.

2.15 In some combination units, the header tank is split into two sections: one feeding the water heater below and the other supplying cold water to the closed heating system. Possible cross-contamination and poor temperatures should be considered as part of the risk assessment.

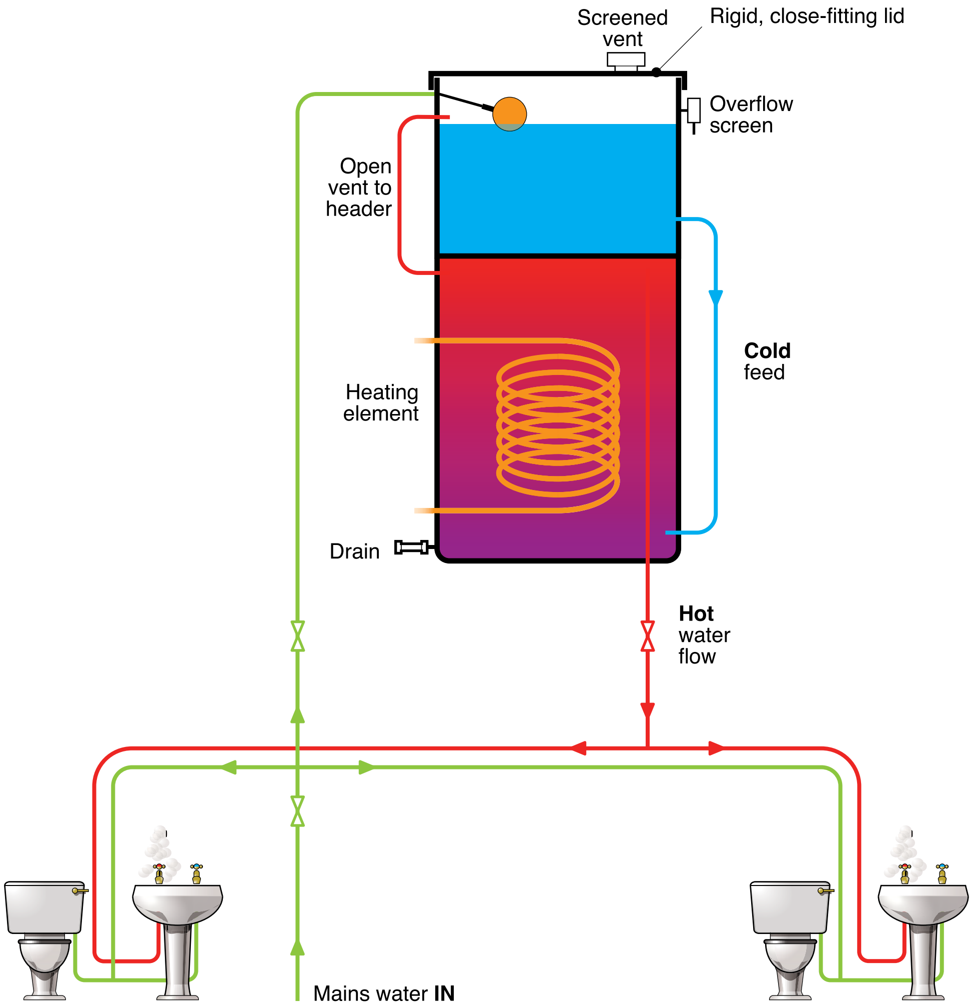


Figure 2.3 Combination water heater

Gravity-fed water systems

Gravity system without recirculation

2.16 Gravity systems without recirculation (Figure 2.4) are generally installed in domestic dwellings and small buildings. Cold water enters the building from a rising main and is stored in a cold water tank. The cold water tank provides backflow protection to the mains supply and a stable pressure and reserve in the system if the mains pressure fails or demand exceeds the capacity of the mains supply. Cold water from the tank is fed to the calorifier (hot water cylinder) where it is heated and drawn via pipes that branch to sinks, washbasins, baths, showers etc. In contrast to recirculating systems, the water only flows when it is being used and is usually allowed to become cool in the pipes after use.

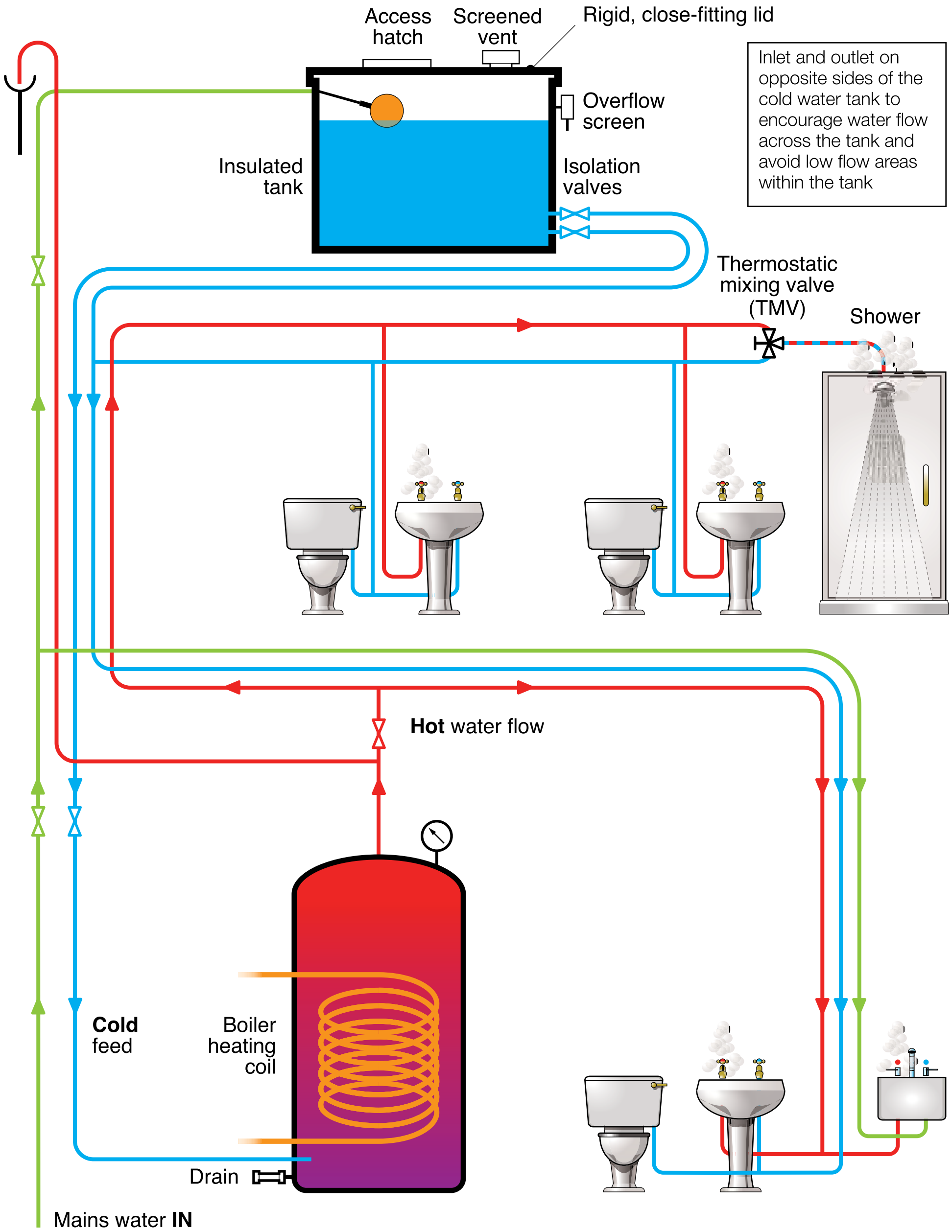


Figure 2.4 Gravity-fed hot and cold water system without recirculation

Gravity system with recirculation

2.17 Gravity systems with recirculation are typically installed in larger buildings such as commercial premises (Figure 2.5). Cold water enters the building from a rising main and is stored in a cold water storage tank or tanks. The tank provides backflow protection to the mains supply and a stable pressure in the system; it also provides a reserve if the mains pressure fails or demand exceeds the capacity of the mains supply. Cold water from this storage tank is fed to the calorifier.

2.18 There is a continuous circulation of hot water from the calorifier around the distribution circuit and back to the calorifier by means of one or more pumps, usually installed on the return to the calorifier, but it can be on the flow. This is to ensure that hot water is quickly available at any of the taps, independent of their distance from the calorifier and reduces the risk of localised temperature fluctuations. The circulation pump is sized to compensate for the heat losses from the distribution circuit so that the return temperature to the calorifier is not less than 50 °C.

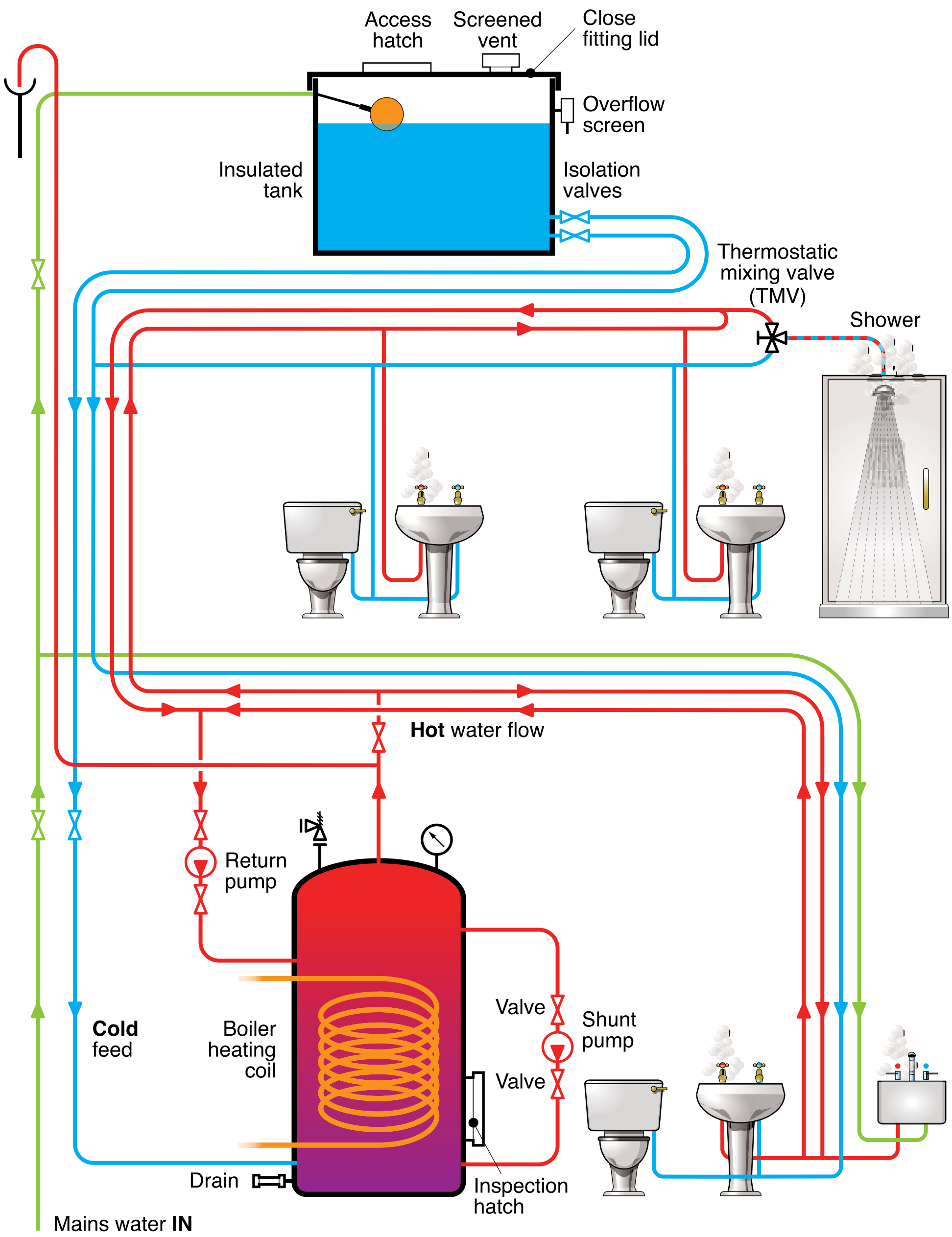


Figure 2.5 Gravity-fed system with recirculation

2.19 The pump has little effect on the pressure at the tap, which is determined by the relative height of the storage tank. 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. The vent pipe should be directed into a separate tundish/drain which discharges at a safe and visible point and acts as a warning pipe. Discharge into the cold water storage tank is not advised as this can result in warm storage water temperatures and increase the risk of microbial growth. In the cold water system, water is fed by gravity directly from the cold water storage tank to the points of use without recirculation.

Pressurised systems

2.20 These systems are fed directly by a pressurised supply (sometimes via a break tank and booster set) connected to the calorifier, water heater or heat exchanger (Figure 2.6). In these systems, water expands when heated, requiring an expansion vessel, safety temperature and pressure relief valve (in a pressurised hot water system there is no open vent to a high level). Hot water distribution can be a recirculating or non-recirculating system.

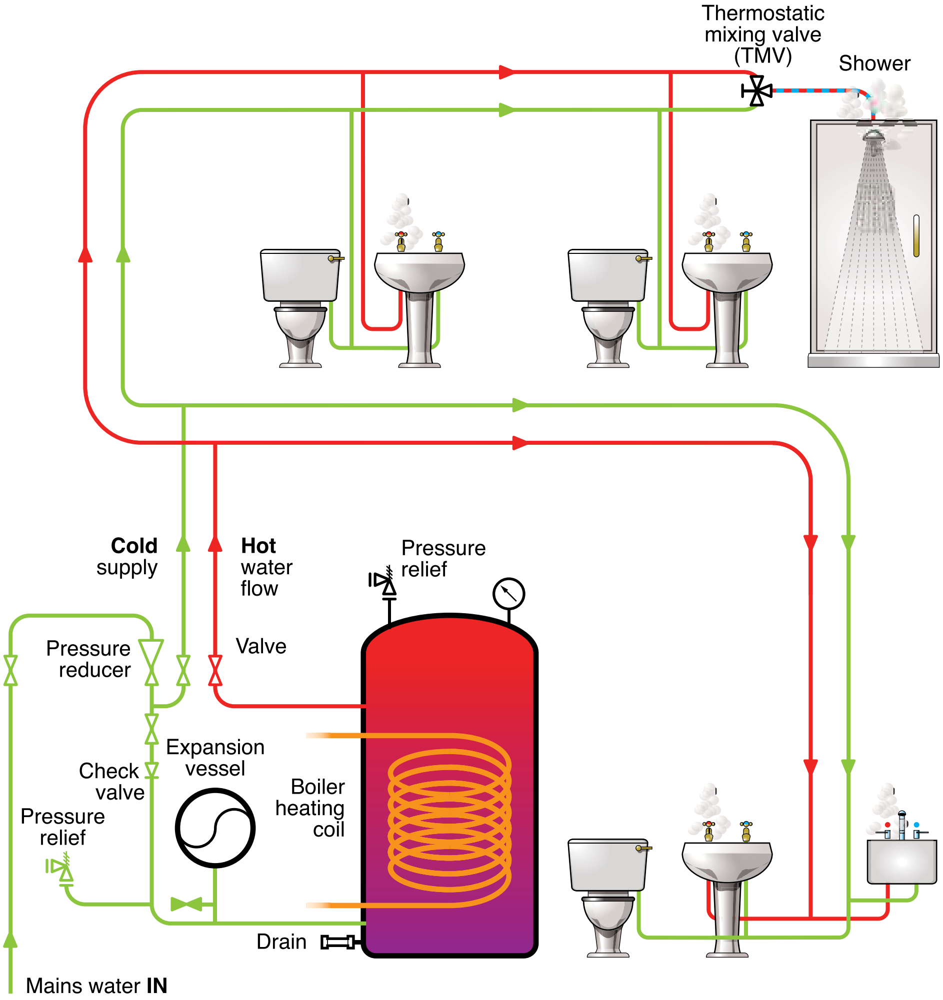


Figure 2.6 Pressurised mains-fed system with non-recirculating hot water distribution

2.21 Larger systems or those that require higher pressures to reach the top of the building often include break tanks and booster pumps, in place of direct mains water, that subsequently feed the water heater.

Hot water heaters: Calorifiers and hot water cylinders

2.22 There are varieties of hot water heaters available that comply with the Water Supply (Water Fitting) Regulations 1999 and for Scotland, the Scottish Water Byelaws 2004. The specification will depend on the size and usage of the system.

2.23 Hot water heaters are water storage vessels heated by:

- primary heating circuits of low pressure hot water or steam which is passed through a heat exchanger inside the vessel;
- gas or oil flame, directly;
- electricity, normally by means of an electric immersion heater within the vessel; or
- an external heat exchanger (sometimes returning to a holding 'buffer' vessel).

Direct-fired (gas) water heaters

2.24 Characteristic of this type of design is heating from below which avoids the reduced temperature areas found in indirect heating calorifiers; they also have lower storage volumes and even temperature distribution (Figure 2.7). This type of water heater has been shown to have a low incidence of colonisation by legionella.

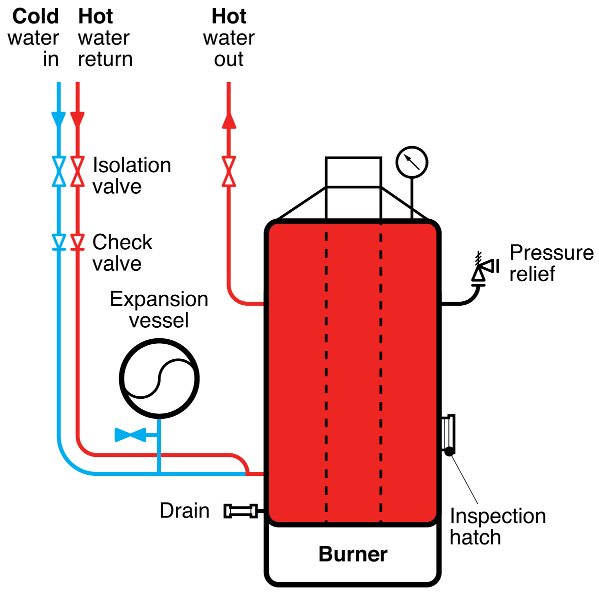


Figure 2.7 Direct-fired (gas) water heaters

Indirect heating calorifier vessel

2.25 In these vessels, the cold water typically enters at the base of the calorifier, creating an area below the coil where the initial blended water temperature may support microbial growth (Figure 2.8). Stratification, which may occur in large calorifiers, should be avoided and fitting a timer-controlled shunt pump to circulate the water from the top of the calorifier to the base during the period of least demand should be considered. The shunt pump should be activated when demand is at its lowest and the temperature within the calorifier is likely to be highest, this is often during the early hours of the morning. The boiler plant (or other calorifier heat source) should be heating while the shunt pump is active to ensure a temperature of at least 60 °C is achieved throughout the vessel for at least one continuous hour a day.

2.26 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 cold water feed may be used. Shunt pump operation should not be done or any alteration carried out before cleaning and descaling the calorifier, as operating the pump may disturb sludge or sediment. As an alternative to shunt pumps, some calorifiers are fitted with coils extending to the base to promote convective mixing during heating. Particulate matter can accumulate at the base of the calorifier so the design should incorporate an easily accessible drain valve.

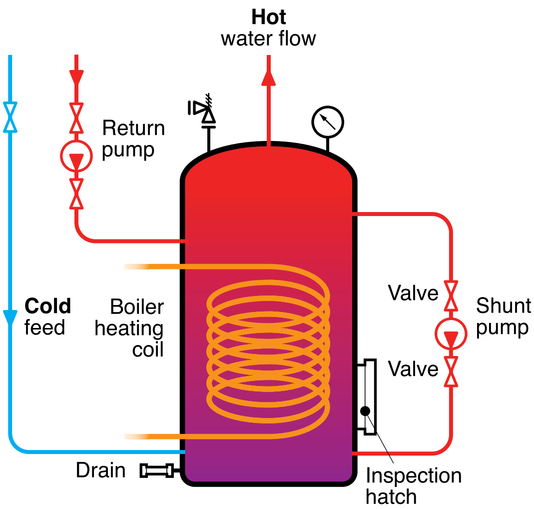


Figure 2.8 Indirect heating calorifier vessel

Calorifiers attached to solar heating systems

2.27 Hot water storage cylinders (calorifiers) attached to solar heating systems or other microgeneration systems (Figure 2.9) often have two heating coils one fed from the conventional heat source (boiler, heat exchanger etc) and one from the solar panels. The solar coil is usually positioned at the bottom of the cylinder and is used to pre-heat the 'dedicated solar volume' – the volume of water that can only be heated by the solar input. The boiler coil is fitted above the solar coil to raise the temperature of the water at the top of the vessel to 60 °C .

2.28 Calorifiers attached to solar heating systems should be managed, monitored and maintained to achieve the flow temperatures as for conventionally heated calorifiers throughout the year. As with conventional calorifiers, there will be temperature stratification providing favourable conditions for microbial growth including legionella at the base of the vessel. However, in times where there is little heat gain from the panels there may be a larger volume at a reduced temperature than in conventional systems. These systems should be designed so that the hot water temperature is not compromised during times when there is little heat gain from the solar panels. If the solar coil does not generate temperatures that bring about thermal inactivation of legionella bacteria; and the residence time for water in contact with the boiler coil at 60 °C is less than that required to effect thermal inactivation, a further level of control should be provided. For example, consideration should be given to programming the boiler coil to heat the entire contents of the solar hot water cylinder once daily, preferably during a period when there is little demand for hot water. A shunt pump may also be used to move hot water from the top of the calorifier to the base, however, it should not be used continuously except for about one hour daily and in all cases the pump should be controlled by a time clock. Where temperature control is not achieved, other measures such as using appropriate biocides should be considered.

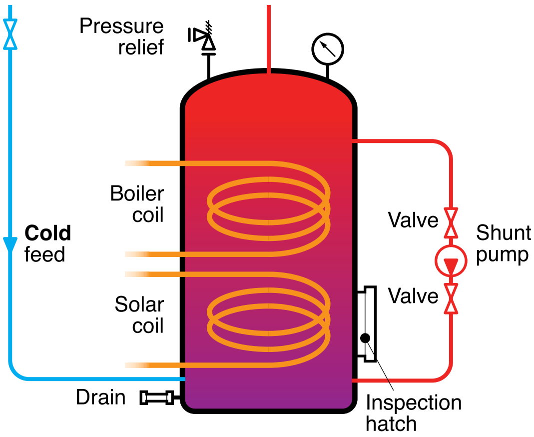


Figure 2.9 Solar-heated calorifiers

Water system design and commissioning

2.29 Plant or water systems should be designed and constructed to be safe and without risks to health when used at work. Such hazards maybe of a physical, chemical or microbial nature such as the risks associated with colonisation and growth of legionella bacteria within the water system. The type of system installed depends on the size and configuration of the building and the needs of the occupants but the water systems should be designed, managed and maintained to comply with:

- the Construction (Design and Management) Regulations 2007 (CDM);[18]
- the Building Regulations 2010 (and associated amendments);[19]
- for systems provided with water from the public supply – for England and Wales, The Water Supply (Water Fittings) Regulations 1999 and for Scotland, the Scottish Water Byelaws 2004;
- for systems provided with water from private sources – The Private Water Supplies Regulations 2009;[20] The Private Water Supplies (Wales) Regulations 2010;[21] or The Private Water Supplies (Scotland) Regulations 2006;[22]
- BS EN 806 (Parts 1–5) *Specifications for installations inside buildings conveying water for human consumption*;[23]
- BS 8558 *Guide to the design, installation, testing and maintenance of*
- *services supplying water for domestic use within buildings and their curtilages*;[24]
- CIBSE Guide G *Public Health and Plumbing Engineering*.[25]

2.30 Any subsequent changes within buildings may result in modifications to water systems that incorporate features from different design styles and materials. Any modifications should comply with the requirements and standards in paragraph 2.29 as if incorrectly designed, these can present a foreseeable risk of exposure to legionella.

Water system design considerations

2.31 The design of the water systems should identify and take into account the following factors:

- the source of the water must meet The Water Supply (Water Quality) Regulations 2000[26] or The Private Water Supplies Regulations 2009 and equivalent legislation for Wales and Scotland and must be wholesome at draw-off points;
- water components that may increase the risk of colonisation, eg blending valves, flexible hoses etc;
- the potential for stagnation leading to microbial growth where buildings are not to be fully occupied immediately or where systems are commissioned as occupation occurs, eg infrequently or intermittently used buildings.

2.32 A well-designed system should incorporate the following points:

- an adequate supply of hot and cold water available, particularly at periods of peak demand, while avoiding excessive storage. In buildings where stored water is not essential, consideration should be given to direct mains systems with local POU water heaters;

- all parts of the system including storage tanks, water heaters, pipework and components and associated equipment containing water are designed to avoid water stagnation by ensuring flow through all parts of the system. Low use outlets should be installed upstream of frequently used outlets to maintain frequent flow, eg an emergency shower installed upstream of a frequently used toilet. Consideration should be given to self-flushing fittings which are validated to show they are effective and do not introduce any additional risks;
- avoidance of temperatures in any water storage vessels, distributed water pipework and any associated equipment that support microbial growth, including legionella;
- single check valves are commonly used to prevent backflow of hot water to the cold feed. These valves should be rated for hot water use, as one side will be in contact with potentially hot water. Where applicable, an anti-gravity loop should be installed in the supply pipework as a failsafe mechanism should the single check valve fail;
- design measures to improve energy efficiency targets and reduce water usage should be assessed at the design stage to ensure the control of legionella is not compromised.

2.33 Materials used in building water systems must be compatible with the physical and chemical characteristics of water supplied to the building to reduce corrosion or prevent excessive scale formation of system pipework and components. Domestic water systems must not use materials that support microbial growth, such as those containing natural rubber, hemp, linseed oil-based jointing compounds and fibre washers. Similarly, any synthetic materials used should not adversely affect water quality by supporting microbial growth. Water fittings and components should be used that comply with the Water Regulations Advisory Scheme (WRAS) approval scheme[27] which lists products that have been tested and comply with BS 6920.

2.34 It is important that there should be ease of access to all parts of the system, components and associated equipment for management and maintenance purposes, eg tanks, calorifiers, thermostatic mixing valves (TMVs), blending valves, circulation pumps etc. Isolation valves should be included in all locations to facilitate maintenance and the implementation of control measures. The pipework and any components should be easy to inspect so that the thermal insulation and temperature monitoring can be checked.

2.35 In buildings where there are those with an increased susceptibility to infection or with processes requiring specific water characteristics, materials of an enhanced quality may be required. Healthcare buildings and care homes should specifically take note of alerts and advice from the Department of Health and Health Facilities Scotland. For example, healthcare premises are advised against the use of ethylene propylene diene monomer (EPDM) lined flexible hoses (tails) as these have been shown to be a risk of microbial colonisation. Such flexible connections should therefore only be used in healthcare premises where an installation has to move during operation or is subject to vibration.

Cold water systems

2.36 The general principles of design should be aimed at avoiding temperatures within the system that encourage the growth of microorganisms including legionella with the following taken into account:

- Cold water storage tanks should be installed in compliance with The Water Supply (Water Fittings) Regulations 1999 and Scottish Water Byelaws 2004. To prevent dirt and other potential nutrients getting in, they should have secure, tightly fitting lids (Figure 2.10). Insect and vermin screens should be fitted to protect any pipework open to the atmosphere, such as the overflow pipe and vent. Where screens are fitted, they should be installed so they do not hold water. To avoid stagnation, where multiple cold water storage tanks are fitted, they should be connected to ensure each tank fills uniformly and water is drawn off through each of the tanks. Access ports should be provided on cold water tanks for inlet valve maintenance, inspection and cleaning.

- All pipe branches to individual outlets should be capable of delivering cold water at a temperature that is as close to the incoming water temperature within two minutes of running.
- The volume of stored cold water should be minimised and should not normally exceed that required for one day's water use although in healthcare premises, a nominal 12 hours total onsite storage capacity is recommended.
- There should be a regular water flow throughout the system and all outlets to avoid stagnation. In cold water storage tanks this can be facilitated by locating inlet and outlet pipes on opposing sides of the tank at different heights (see Figure 2.10).
- Thermal gain should be kept to a minimum by adequate lagging and separation of cold water services pipework and components from hot water services and heating systems; ensuring higher use outlets are installed at the end of each branch to improve flow; and considering, where appropriate, ventilation of void spaces and risers.
- Systems that encourage the movement of cold water in areas of the distribution system that are prone to stagnation and heat gain should be considered.
- All pipework and components carrying fluids other than water supplied by the water supplier and components should be clearly labelled.
- System components and associated equipment which require maintenance are easily accessible.
- Water fittings should only be chosen where they are compliant with The Water Supply (Water Fittings) Regulations 1999 and Scottish Water Byelaws 2004. In the case of non-metallic materials, this will also include conformity with BS 6920. The best method to ensure compliance is to select products from the Water Regulations Advisory Scheme Water Fittings and Materials Directory.

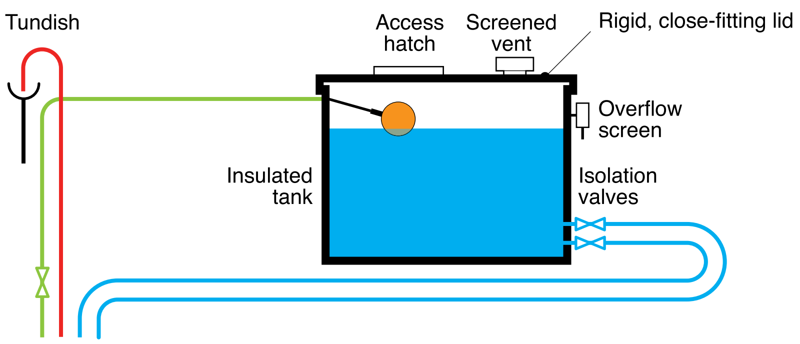


Figure 2.10 Acceptable tank design

Hot water systems

2.37 The general principles of design aim to avoid temperatures within the system that encourage the growth of legionella. Consideration should be given to the following:

- maintaining a supply temperature of at least 60 °C from the heat source and/or storage vessel (calorifier);

- the hot water circulating loop should be designed to give a return temperature to the calorifier from each loop of at least 50 °C (55 °C in healthcare premises);
- appropriate means for measuring temperature, eg thermometer/immersion pockets fitted on the flow and return to the calorifier and in the base of the calorifier;
- all pipe branches to individual outlets should be insulated and sufficiently short to enable the hot water at each outlet to reach 50 °C (55 °C in healthcare premises) within one minute of turning on the tap;
- the storage capacity and recovery rate of the calorifier should be selected to meet the normal daily fluctuations in hot water use without any significant drop in target supply temperature. The open vent pipe from the calorifier should be sufficiently raised above the water level and suitably sited in the water circuit to prevent hot water from being discharged in normal circumstances. The open vent should ideally discharge to atmosphere via a tundish providing a safe and visible warning of a fault condition;
- where more than one calorifier is used, they should be connected in parallel and deliver water at a temperature of at least 60 °C;
- to overcome localised failures in the distribution system, circulating pump design and the correct commissioning of balancing valves are key issues to ensure flow throughout all parts of the hot water system, particularly the hot water return legs. Balancing the hot water system flow and return circuits is critical to avoid long lengths of stagnant pipework that is likely to be at a lower temperature (see Figure 2.11);
- the calorifier drain valve should be located in an accessible position at the lowest point and as close as possible to the vessel, so that accumulated particulate matter can be safely drained;
- all types of water heaters, including storage calorifiers, should be designed and installed so that they are safe to use and maintain, and able to be inspected internally, where possible.

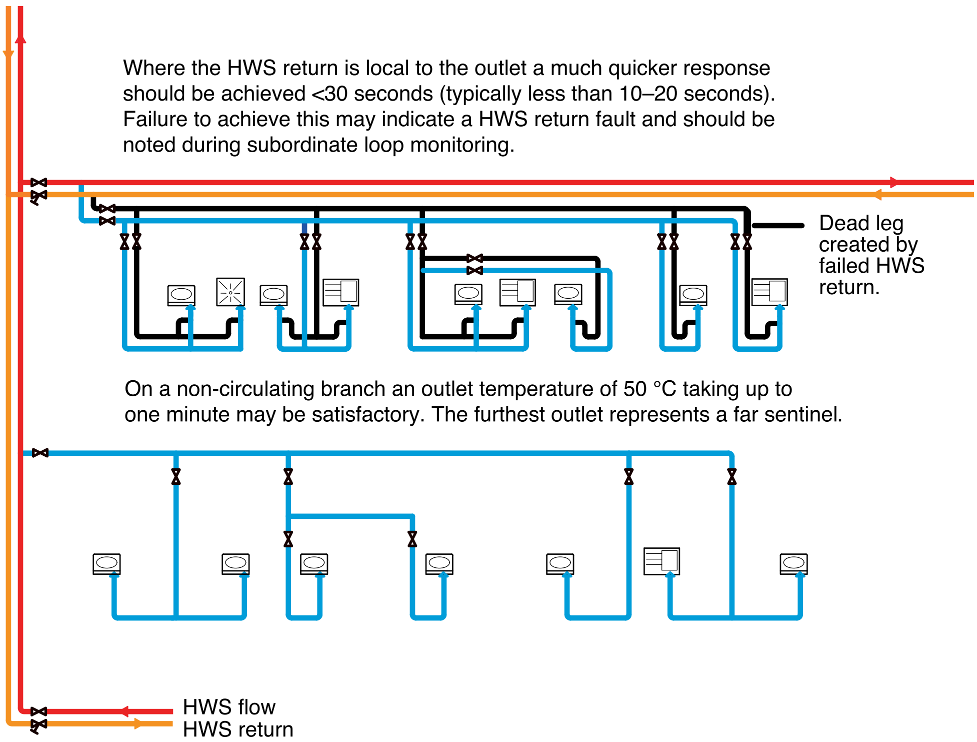


Figure 2.11 Hot water flow and return system showing a failure in the hot water system return

Expansion vessels

2.38 Expansion vessels in systems operating at steady temperature and pressure may have long periods without exchanging any significant amount of water and therefore can be at risk of aiding microbial growth.

2.39 To minimise the risk of microbial growth, expansion vessels should be installed:

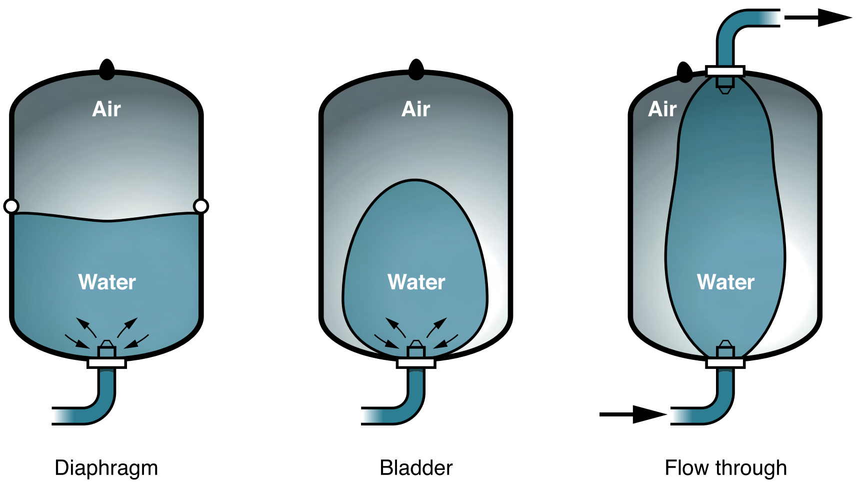
- in cool areas on cold flowing pipes;
- mounted as close to the incoming water supply as possible;
- mounted vertically on pipework to minimise any trapping of debris;
- with an isolation and drain valve to aid flushing and sampling;
- to minimise the volume retained within them;
- designed to stimulate flow within the vessel.

Info box 2.1: Hydraulic accumulators

Where water is boosted via pumps, hydraulic accumulators (pressurised vessels that buffer variations in pressure so acting like a shock absorber) are often used to reduce pressure surges from the pumps and may reduce the demand frequency. When correctly installed, hydraulic accumulators will partially fill and empty between each pump run and should exchange water at regular intervals, which will reduce the risk of stagnation.

In pressurised systems, a means of accommodating water expansion (caused by the water heating) is required. This is often achieved with the use of an expansion vessel. However, these may not fill and empty where the system pressure and temperature remains steady.

There are several types of vessel available including diaphragm or bladder type, with fixed and interchangeable (replaceable) bladders, as shown below. These internal bladders are often made of synthetic rubber such as EPDM and may support the growth of microorganisms including legionella, so check to see if these are approved against BS 6920. Vessels with a ‘flow through’ design should provide less opportunity for water to stagnate and become contaminated (as in the latter design).



Expansion vessels

Commissioning

2.40 Commissioning of a water system means the bringing of a new system into operation and applies to all component parts of a building water system including attached equipment. The aim of such commissioning is to check the system is performing to design specifications, that there are no leaks and that the flow of the hot water system is balanced. From a microbiological perspective, the period between filling the system and bringing it into normal use is potentially the most hazardous. A risk assessment should be performed before commissioning, to identify and take into account the potential for stagnation as this may lead to microbial growth where buildings are not to be fully occupied immediately or where systems are commissioned as occupation occurs, eg infrequently or intermittently used buildings.

2.41 Any new water system will require, as a minimum, flushing and disinfection before being brought into use, and larger more complex systems may also require disinfection. The building commissioning process should take into account the size and complexity of the water system. A new, correctly designed and installed water system should provide wholesome water at every outlet and where there are any problems, the design or installation defect should be identified and rectified.

2.42 Before commissioning, the nature of the incoming water supply must be determined. If it is a public water supply, the water supplier will be able to provide details of the testing carried out in the local water supply zone in which the building is situated. If there is any doubt about the condition of the underground supply pipe connecting the building to the public supply main, the water supplier should be contacted so that they can carry out an appropriate investigation and advise if any action is required by either them, or the premises owner. If the building has a private water supply, the local authority should be contacted to carry out a private water supply risk assessment, if this has not been done already. The building owner is responsible for complying with the regulatory requirements as notified by the water supplier or the local authority, as appropriate, irrespective of whether it is a public or private water supply, or a combination of both.

Small developments

2.43 Small developments (eg individual commercial or light industrial units, small offices, rented domestic houses) where water systems are simple, should be thoroughly flushed before use, but this should be done as close to occupation as possible to minimise the possibility of microbial growth.

Large developments

2.44 Before use, all water systems should be cleaned, flushed and disinfected as specified in BS EN 806 and BS 8558. This involves adding an effective disinfectant, such as chlorine or chlorine dioxide, drawing it throughout the system and leaving it for a specified time (the contact time) to take effect. It is important to monitor the levels of residual chlorine at selected outlets to ensure the minimum required concentration is maintained throughout the contact period. Where chlorine is used as the biocide, the pH of the water should be checked as the efficacy of chlorine can be adversely affected at pH values over 7.6.

2.45 If water turnover is anticipated to be low initially, it may be advisable not to commission certain parts of the system, such as cold water storage tanks, until the building is ready for occupation. This will ensure flushing during low use periods will draw directly on the mains supply rather than intermediate storage. The manufacturer of any component to be bypassed should be consulted for any requirements, such as whether it needs to be filled or can remain empty until it is brought into use.

2.46 In most cases, water systems will need to be pressure tested with water but once filled, wetted systems should not be drained down as this may not be fully effective and biofilm can develop in areas where there are residual pockets of water or high humidity. Alternatively, compressed air or an inert gas may be used, by trained and competent personnel, to pressure test water systems for leaks.

2.47 If there is a prolonged period between pressure testing using water and full occupation of the development, a procedure should be adopted to maintain water quality in the system. Weekly flushing should be implemented to reduce stagnation and the potential for microbial growth, keep temperatures below 20 °C and to ensure residual chemical treatment levels eg the low level of chlorine in the incoming water supply, is maintained throughout the system.

2.48 In large systems where a long period of time from filling to occupation cannot be avoided, continuous dosing with an appropriate concentration of biocide as soon as the system is wetted combined with regular flushing at all outlets can control the accumulation of biofilm more effectively than flushing and temperature control alone. While other disinfection methods could be used, maintaining 1–3 mg/l of chlorine dioxide is generally effective, however dosing at such high levels may reduce the life of the system pipework and components. This initial high-level disinfection should not be confused with ongoing dosing at lower levels in operational systems where the water is intended for human consumption. National conditions of use require that the combined concentration of chlorine dioxide, chlorite and chlorate in the water entering supply do not exceed 0.5 mg/l as chlorine dioxide.

2.49 Where biocide dosing is used, a regime of flushing and monitoring is required to ensure the disinfectant reaches all parts of the system and is maintained at an adequate concentration level, which should be recorded.

Buildings temporarily taken out of use (mothballing)

2.50 Where a building, part of a building or a water system is taken out of use (sometimes referred to as mothballing), it should be managed so that microbial growth, including legionella in the water, is appropriately controlled.

2.51 All mothballing procedures are a compromise between adequate control of microbial growth, the use of water for flushing (while avoiding waste) and degradation of the system by any disinfectant added. Where disinfectants are used, these should leave the system fit for its intended purpose.

2.52 In general, systems are normally left filled with water for mothballing and not drained down as moisture will remain within the system enabling biofilm to develop where there are pockets of water or high humidity. The water in the system also helps to avoid other problems associated with systems drying out, including failure of tank joints and corrosion in metal pipework. The systems should be recommissioned as though they were new (ie thoroughly flushed, cleaned and disinfected) before returned to use.

Operation and inspection of hot and cold water systems

2.53 The risks from legionella should be identified and managed and paragraphs 2.53-2.79 give guidance on the operation and maintenance of hot and cold water systems. Building water systems should be routinely checked where there is a risk from legionella to ensure that:

- there is a good turnover of water;
- adequate control parameters at outlets are achieved, ie temperature and/or biocide levels, and inspected for cleanliness.

Arrangements should be in place for the key control parameters to be monitored by those with the appropriate training and expertise. Alternatively, building management systems are increasingly used to provide an automated monitoring programme, allowing for early detection of failures in maintaining the control regime.

2.54 All inspections and measurements should be recorded with the following details:

- the name of the person undertaking the survey, verified or authenticated by a signature or other appropriate means, such as electronic verification;
- the date on which it was made;
- sufficient details of the sample location so that a repeat sample can be taken at the same location, if necessary.

Supply water

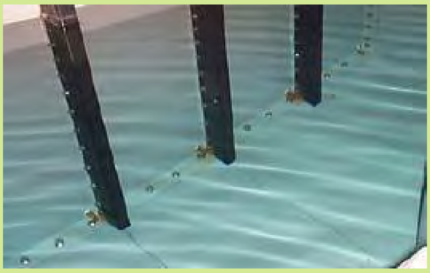
2.55 The water supply to the building will be from either a public or private supply, or a combination of both. In either case, it is a requirement that the supply is wholesome and suitable for all domestic purposes as set out in the Water Industry Act 1991[27] or in Scotland, the Water (Scotland) Act 1980.[28]

2.56 The temperature of the incoming water will depend on whether the supply originates from ground or surface water sources. The temperature of ground water in the UK is typically around 12 °C, whereas surface water temperatures can vary from 4 °C in a cold winter to 23 °C during a very hot summer. Accordingly, incoming water temperature should be well below 20 °C for most, if not all of the year. In an exceptionally hot summer, it may be necessary to review the risk assessment and take appropriate action to mitigate the risk to ensure regular water flow through tanks.

Cold water systems

2.57 An annual inspection of the cold water storage tank should be done to check its condition inside and outside, and the water within it. Figure 2.12 demonstrates the condition of cold water storage tanks and when action should be taken. The lid should be closely fitted and in good condition. The insect and vermin screen on the overflow and warning pipes and any vents should be intact and in good condition. The thermal insulation should be in good condition so that it protects from extremes of temperature. The water surface should be clean and free from any visible, significant contamination. The cold water storage tank should be cleaned, disinfected and any faults rectified. If debris or traces of vermin are found, the inspection should be carried out more frequently.

Figure 2.12 Cold water storage tank inspection



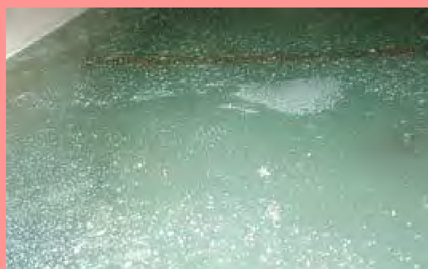
Clean tank but with slight corrosion on bolts

Light debris but corrosion to restraining bars

Moderate fouling suggesting cleaning should be conducted during the next 12 months

Slight to moderate level of debris, tank cleaning should be planned. Hollow tube supports should also no longer be used – see EFA/2013/004 at www.dhsspsni.gov.uk/efa-2013-004.pdf

Heavy debris and corrosion of internal parts that will require remedial works



Severe stagnation could indicate that the tank is oversized, or not being used

Unusually heavy scale formation requiring more than a regular clean and disinfection

Gel coat (glass reinforced plastic) failure resulting in local biological fouling (dark spots)

2.58 Whenever the building use pattern changes, a record of the total cold water consumption over a typical day should be established to confirm that there is reasonable flow through the tank and that water is not stagnating.

2.59 Monitoring for temperature or any disinfectant concentration in cold water should be carried out at sentinel draw-off points, selected to represent the overall building water system. In a simple cold water system, the sentinel points are typically the furthest tap (far sentinel) and the nearest (near sentinel) to the supply or storage tank. In deciding which outlets to identify as sentinels, the layout of the distribution system should be considered rather than the location of the outlet. More complex systems are likely to have several far sentinels, such as the extremity of each of several risers or down services. Any parts of the system not represented by far and near sentinels should be identified and additional outlets selected for monitoring that represent the excluded section.

2.60 Maintaining regular movement of cold water in sections prone to stagnation and guarding against excessive heat gain by using insulation on the cold water tanks and pipework is the most effective legionella control measure in CWDS. For most buildings, carrying out these measures is all that is required.

Hot water systems

2.61 Where standby units are provided, procedures should be in place to allow these units to be incorporated into routine use safely. Standby pumps should be used at least once each week to avoid water stagnation, and standby calorifiers need a suitable procedure to ensure the risk is controlled before they are brought back into service.

Non-circulating HWS

2.62 Monitoring temperature or any other control measure in hot water should be conducted at sentinel points, specifically selected to represent the condition of water in the system. In a non-circulating (single pipe) HWS, the sentinel points would typically be the taps furthest (far sentinel) and the nearest (near sentinel) to the hot water heater (calorifier). In branched systems, the outlets at the ends of significant spurs should be identified as additional far sentinel points. In either case, the layout of the distribution system should be considered rather than the location of the outlet, as they might not correspond.

Circulating HWS principal loops

2.63 In circulating systems the far sentinels are the return legs at a point towards the end of the recirculating loop. Where the system consists of several recirculating loops (demonstrated in Appendix 2.4), the end of each should be identified as far sentinel points for monthly monitoring. In either case, the layout of the distribution system should be considered rather than the location of the outlets, as they might not correspond.

Subordinate and tertiary HWS loops

2.64 Many larger circulating HWS have additional loops consisting of a smaller bore pipe branching from the flow leg of a principal loop to supply a group of outlets and connecting back to the return leg. In systems such as this, the smaller bore loops are the subordinate loops and the larger loops are the principal loops. Subordinate loops should be monitored ideally at a suitable return leg or from a representative outlet, in order to test all subordinate loops quarterly. However, large and complex HWS, eg in hospitals, often have localised loops that feed only one or two outlets and these can be identified as tertiary loops (demonstrated in Appendix 2.5).

Temperature profiling (representative outlet temperature monitoring)

2.65 Temperature profiling is a useful tool to verify a water distribution system is maintaining temperatures in all parts of the system in normal use, to control adequately any microbial growth, including legionellae. Rationalising the choice of where to monitor complex systems requires considering the layout to identify the principal loops. These are typically relatively few in number and will take hot water to and from parts of the building, eg toilets or other facilities, and will be one above another in a multi-storey building supplied by a vertical flow and return loop (often in a service void known as a riser and sometimes with access doors on each storey). In lower rise large buildings, the principal loops could run horizontally, typically above false ceilings in corridors.

2.66 As it may be impractical to monitor every part of a complex system, some form of rationalisation and prioritisation should be applied. As with cold water systems, any parts of the system not represented by sentinels should be identified, and additional outlets selected for less frequent monitoring to create a temperature profile of the whole system over a defined time.

2.67 HWS which supply outlets to high-risk users and incorporate tertiary loops, eg showers in healthcare premises, should be identified as areas for additional temperature monitoring.

Low storage volume heaters

2.68 Low storage volume heaters (ie no greater than 15 litres) such as instantaneous units and POU heaters, may be generally regarded as lower risk.

Info box 2.2: Low-risk systems

An example of a low-risk situation:

- in a small building without people especially ‘at risk’ from legionella bacteria;
- where daily water usage is inevitable and sufficient to turn over the entire system;
- where cold water comes directly from a wholesome mains supply (no stored water tanks);
- where hot water is fed from instantaneous heaters or low storage volume water heaters (supplying outlets at 50 °C);
- where the only outlets are toilets and hand washbasins (no showers).

2.69 Low storage volume heaters serving hot water outlets should be able to achieve a peak temperature of 50–60 °C and where the thermostat is set at these temperatures for this purpose, staff and other users should be informed not to adjust the heater. A unit which is not capable of achieving this, eg a preset thermostat, should only be used where there is a very high turnover or an alternative control measure is in place.

2.70 Low storage volume heaters, which includes electric showers, often have spray nozzle outlets and these should be inspected, cleaned and descaled as part of the showerhead and hose cleaning regime.

2.71 If these units are not regularly used or set to supply warm water, the risk from legionella is likely to increase dramatically and may increase further, where the units are supplied from a cold water storage tank. The risk assessment should take into account the usage of the units, the susceptibility of those using the units and include a suitable monitoring regime where the risk is considered significant.

Maintenance

Water softening

2.72 Light scale formation on the inner surfaces of pipes can be protective against the leaching of metals such as lead or copper, but heavier deposits are likely in hard water areas. These deposits increase the surface area and therefore the potential for microbial colonisation (biofilm formation) and can provide protection from the effects of biocides. In hard water areas, softening of the cold water supply to the hot water distribution system should be considered. This is to reduce the risk of scale being deposited at the base of the calorifier and heating coils, especially at temperatures greater than 60 °C, and the potential for scale build-up within the system pipework and components (eg TMVs) which may significantly reduce flow and adversely affect the efficiency of the system.

2.73 System materials need to be of a type that are resistant to corrosion (eg copper, stainless steel) as very soft water, natural or artificially softened, may lead to increased corrosion of the system pipework and materials. Where water softening systems are used, these should be fitted before any biocide treatment application. Suitable sample points should be fitted before and after the softener to allow for the operational testing of hardness and microbiological sampling if contamination is suspected.

Thermostatic mixing valves

2.74 TMVs are valves that use a temperature sensitive element and blend hot and cold water to produce water at a temperature that safeguards against the risk of scalding, typically between 38 °C and 46 °C depending on outlet use. The blended water downstream of TMVs may provide an environment in which legionella can multiply, thus increasing the risks of exposure.

2.75 The use and fitting of TMVs should be informed by a comparative assessment of scalding risk versus the risk of infection from legionella. Where a risk assessment identifies the risk of scalding is insignificant, TMVs are not required. The most serious risk of scalding is where there is whole body immersion, such as with baths and showers, particularly for the very young and elderly, and TMVs should be fitted at these outlets. Where a risk assessment identifies a significant scalding risk is present, eg where there are very young, very elderly, infirm or significantly mentally or physically disabled people or those with sensory loss, fitting TMVs at appropriate outlets, such as hand washbasins and sinks, is required.

2.76 Where TMVs are fitted, consider the following factors:

- where practicable, TMVs should be incorporated directly in the tap fitting, and mixing at the point of outlet is preferable;
- where TMVs are fitted with low flow rate spray taps on hand washbasins, the risk is increased;
- TMV valves should be as close to the POU as possible to minimise the storage of blended water;
- where a single TMV serves multiple tap outlets, the risk can be increased;
- where TMVs are designed to supply both cold and blended water, an additional separate cold tap is rarely needed and may become a low use outlet.

Info box 2.3: Thermostatic mixing valves

Where a scalding risk is assessed as low (eg where healthy users immerse their whole body), type 2 TMVs that can be overridden by the users are required by building regulations. Where a scalding risk is considered significant (eg where users are very young, very elderly, infirm or significantly mentally or physically disabled or those with sensory loss) then type 3 TMVs that are pre-set and fail-safe should be provided (but are required at healthcare premises) and should be checked regularly to ensure they are fail-safe if the cold water supply pressure is interrupted.

Regular flushing of showers and taps

2.77 Consideration should be given to removing infrequently used showers and taps and where removed, the redundant supply pipework should be cut back, as close as possible, to a common supply, eg to the recirculating pipework or the pipework supplying a more frequently used upstream fitting.

2.78 The risk from legionella growing in peripheral parts of the domestic water system, such as dead legs 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 risk of legionella proliferation in the system. Once started, this procedure has to be sustained and logged, as lapses can result in a critical increase in legionella at the outlet. Where there are high-risk populations, eg healthcare and care homes, more frequent flushing may be required as indicated by the risk assessment.

Checklist for hot and cold water systems

2.79 The frequency of inspecting and monitoring the hot and cold water systems will depend on their complexity and the susceptibility of those likely to use the water. The risk assessment should define the frequency of inspection and monitoring depending on the type of use and user and particularly where there are adjustments made by the assessor to take account of local needs. Table 2.1 provides a checklist for hot and cold water systems with an indication of the frequency of inspection and monitoring.

Table 2.1: Checklist for hot and cold water systems

Service	Action to take	Frequency
Calorifiers	Inspect calorifier internally by removing the inspection hatch or using a boroscope and clean by draining the vessel. The frequency of inspection and cleaning should be subject to the findings and increased or decreased based on conditions recorded	Annually, or as indicated by the rate of fouling
	Where there is no inspection hatch, purge any debris in the base of the calorifier to a suitable drain Collect the initial flush from the base of hot water heaters to inspect clarity, quantity of debris, and temperature	Annually, but may be increased as indicated by the risk assessment or result of inspection findings
	Check calorifier flow temperatures (thermostat settings should modulate as close to 60 °C as practicable without going below 60 °C) Check calorifier return temperatures (not below 50 °C).	Monthly
Hot water services	For non-circulating systems: take temperatures at sentinel points (nearest outlet, furthest outlet and long branches to outlets) to confirm they are at a minimum of 50 °C within one minute (55 °C in healthcare premises)	Monthly
	For circulating systems: take temperatures at return legs of principal loops (sentinel points) to confirm they are at a minimum of 50 °C (55 °C in healthcare premises). Temperature measurements may be taken on the surface of metallic pipework	Monthly
	For circulating systems: take temperatures at return legs of subordinate loops, temperature measurements can be taken on the surface of pipes, but where this is not practicable, the temperature of water from the last outlet on each loop may be measured and this should be greater than 50 °C within one minute of running (55 °C in healthcare premises). If the temperature rise is slow, it should be confirmed that the outlet is on a long leg and not that the flow and return has failed in that local area	Quarterly (ideally on a rolling monthly rota)
	All HWS systems: take temperatures at a representative selection of other points (intermediate outlets of single pipe systems and tertiary loops in circulating systems) to confirm they are at a minimum of 50 °C (55 °C in healthcare premises) to create a temperature profile of the whole system over a defined time period	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for legionella control
POU water heaters (no greater than 15 litres)	Check water temperatures to confirm the heater operates at 50–60 °C (55 °C in healthcare premises) or check the installation has a high turnover	Monthly–six monthly, or as indicated by the risk assessment

Combination water heaters	Inspect the integral cold water header tanks as part of the cold water storage tank inspection regime, clean and disinfect as necessary. If evidence shows that the unit regularly overflows hot water into the integral cold water header tank, instigate a temperature monitoring regime to determine the frequency and take precautionary measures as determined by the findings of this monitoring regime	Annually
	Check water temperatures at an outlet to confirm the heater operates at 50–60 °C	Monthly
Cold water tanks	Inspect cold water storage tanks and carry out remedial work where necessary	Annually
	Check the tank water temperature remote from the ball valve and the incoming mains temperature. Record the maximum temperatures of the stored and supply water recorded by fixed maximum/minimum thermometers where fitted	Annually (Summer) or as indicated by the temperature profiling
Cold water services	Check temperatures at sentinel taps (typically those nearest to and furthest from the cold tank, but may also include other key locations on long branches to zones or floor levels). These outlets should be below 20 °C within two minutes of running the cold tap. To identify any local heat gain, which might not be apparent after one minute, observe the thermometer reading during flushing	Monthly
	Take temperatures at a representative selection of other points to confirm they are below 20 °C to create a temperature profile of the whole system over a defined time period. Peak temperatures or any temperatures that are slow to fall should be an indicator of a localised problem	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for legionella control
	Check thermal insulation to ensure it is intact and consider weatherproofing where components are exposed to the outdoor environment	Annually
Showers and spray taps	Dismantle, clean and descale removable parts, heads, inserts and hoses where fitted	Quarterly or as indicated by the rate of fouling or other risk factors, eg areas with high risk patients
POU filters	Record the service start date and lifespan or end date and replace filters as recommended by the manufacturer (0.2 μm membrane POU filters should be used primarily as a temporary control measure while a permanent safe engineering solution is developed, although long-term use of such filters may be needed in some healthcare situations)	According to manufacturer's guidelines
Base exchange softeners	Visually check the salt levels and top up salt, if required. Undertake a hardness check to confirm operation of the softener	Weekly, but depends on the size of the vessel and the rate of salt consumption
	Service and disinfect	Annually, or according to manufacturer's guidelines

Multiple use filters	Backwash and regenerate as specified by the manufacturer	According to manufacturer's guidelines
Infrequently used outlets	Consideration should be given to removing infrequently used showers, taps and any associated equipment that uses water. If removed, any redundant supply pipework should be cut back as far as possible to a common supply (eg to the recirculating pipework or the pipework supplying a more frequently used upstream fitting) but preferably by removing the feeding 'T' Infrequently used equipment within a water system (ie not used for a period equal to or greater than seven days) should be included on the flushing regime Flush the outlets until the temperature at the outlet stabilises and is comparable to supply water and purge to drain Regularly use the outlets to minimise the risk from microbial growth in the peripheral parts of the water system, sustain and log this procedure once started For high risk populations, eg healthcare and care homes, more frequent flushing may be required as indicated by the risk assessment	Weekly, or as indicated by the risk assessment
TMVs	Risk assess whether the TMV fitting is required, and if not, remove Where needed, inspect, clean, descale and disinfect any strainers or filters associated with TMVs To maintain protection against scald risk, TMVs require regular routine maintenance carried out by competent persons in accordance with the manufacturer's instructions. There is further information in paragraphs 2.152– 2.168	Annually or on a frequency defined by the risk assessment, taking account of any manufacturer's recommendations
Expansion vessels	Where practical, flush through and purge to drain. Bladders should be changed according to the manufacturer's guidelines or as indicated by the risk assessment	Monthly–six monthly, as indicated by the risk assessment

Water treatment and control programmes for hot and cold water systems

2.80 Dutyholders are required to prevent or control the risk from exposure to legionella. Precautions include physical methods such as regular movement of hot and cold water in distribution pipework, regular flushing of outlets to ensure water cannot stagnate in the hot and cold water systems and POU filters. For control measures to be effective, it is essential to keep the whole system clean, as biofilms or inorganic matter such as scale can reduce the efficacy of any type of control measure significantly.

2.81 Although temperature is the traditional and most common approach to control, sometimes there can be technical difficulties in maintaining the required temperatures, particularly in older buildings with complex water systems. Control methods including water treatment techniques, when used correctly and if properly managed, can be effective in the control of legionella in hot and cold water systems. However, the selection of a suitable system for the control of legionella is complex and depends on a number of parameters, including system design, age, size, and water chemistry, all of which can contribute to the complexity and difficulty of achieving adequate control. There is no single water treatment control regime that is effective in every case, and each control method has both benefits and limitations.

Temperature regime

2.82 Where temperature is used, hot water should be stored at a minimum of 60 °C and distributed so it reaches a minimum temperature of 50 °C (55 °C in healthcare premises) within one minute at outlets. Where circulation is not possible, trace heating is sometimes used to maintain the water temperature in the spur so that it delivers at 50 °C within one minute of running, but only provided it is shown to be effective.

2.83 Much higher temperatures should be avoided 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, the elderly or disabled and to those with sensory loss will be greater. Where a significant scalding risk is identified, using TMVs on baths and showers should be considered to reduce temperature and should be placed as close to the POU as possible. To ensure the correct function of 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 manufacturer’s operating instructions to ensure these devices are working safely and correctly.

2.84 When using temperature as a control regime, as well as routine monitoring and inspection, the checks in Table 2.1 should also be carried out and remedial action taken if necessary.

Biocide treatments

2.85 Where biocides are used to treat water systems, like the temperature regime they require meticulous control and monitoring programmes in place if they are to be equally effective. However, in healthcare premises, careful consideration should be given to any equipment that is connected to the water system that may be affected by the application of a biocide, eg renal and haemodialysis units. Due to the extremely sensitive nature of renal water plants, for healthcare premises reference should be made to *Water systems: Health Technical Memorandum 04-01* Part B (for England and Wales), or to *Scottish Health Technical Memorandum 04-01* (for Scotland).

2.86 If hot water is not needed for other reasons, eg for kitchens or laundries, and there is no requirement to store hot water at 60 °C (or distribute at 50 °C), then hot water temperatures can be reduced. As reducing hot water temperatures will leave the system vulnerable if there are any lapses in the biocide control regime, the control system should be checked at least weekly to ensure it is operating effectively and continuing to control legionella.

2.87 Any reduction of hot water temperatures should be carried out in stages and temperatures only reduced when efficacy against legionella is confirmed, with monitoring for legionella and biocide levels in the water system carried out at each stage.

2.88 However, reducing calorifier temperatures to below 60 °C, and using a biocide as the primary control measure, is currently not permitted in healthcare premises where there are patients who are at an increased risk of contracting legionnaires' disease. Healthcare premises should refer to *Water systems: Health Technical Memorandum 04-01* Part B (for England and Wales), or to *Scottish Health Technical Memorandum 04-01* (for Scotland).

2.89 It is essential that these water treatment programmes are monitored to demonstrate that the programmes are working within the established guidelines and are effective in controlling legionella bacteria in water systems. The frequency of monitoring and test procedures will vary according to the method selected.

2.90 Biocides used to treat water systems where water is used for domestic purposes may be contrary to water legislation and may make the water unwholesome. These systems should be selected with care and must comply with the requirements of The Water Supply (Water Quality) Regulations 2000, for Wales, the Water Supply (Water Quality) (Wales) Regulations 2010[29] and for Scotland, The Water Supply (Water Quality) (Scotland) Regulations 2001[30] and 2010.[31] Additionally, the installation of any biocidal system must comply with the requirements of The Water Supply (Water Fittings) Regulations 1999 and for Scotland, the Scottish Water Byelaws 2004.

Chlorine dioxide

2.91 Chlorine dioxide is an oxidising biocide/disinfectant that when used correctly, has been shown to be effective at controlling both legionella and biofilm growth in hot and cold water systems. In the appropriate application, it may be used to aid legionella control where maintaining a conventional temperature regime is difficult or where the removal of all dead legs and little used outlets is impractical. Chlorine dioxide is usually produced on site from a chlorite-based precursor using a chlorine dioxide generator or dosing system by reaction with one or more other chemical precursors or by a catalytic oxidation process.

2.92 Use of chlorine dioxide as a legionella control strategy is subject to BS EN 12671[32] and national conditions of use require that the combined concentration of chlorine dioxide, chlorite and chlorate in the drinking water does not exceed 0.5 mg/l as chlorine dioxide.

2.93 Establishing and maintaining a chlorine dioxide residual (as total oxidant) of 0.1– 0.5 mg/l at an outlet is usually sufficient to control legionella in the preceding pipework, although in a heavily colonised system higher residuals may be necessary. The dosage rate of chlorine dioxide required to achieve this residual will be dependent on the length and complexity of the water distribution system, the water turnover rate and the extent to which the water system is contaminated with an established biofilm. In a relatively clean water system with a high water turnover, a dosage rate of up to 0.5 mg/l is usually sufficient to achieve the desired residual at the outlets. While chlorine dioxide is not affected by the pH or hardness of the water, it is sometimes difficult to monitor chlorine dioxide samples in domestic HWS due to its increased volatility causing the chlorine dioxide reserve to be lost when taking a water sample. In a system containing infrequently used outlets, a programme of regularly flushing the outlets should be maintained until a chlorine dioxide residual is detected.

2.94 Chlorine dioxide is a water soluble gas and can penetrate and control established biofilms. If a system is heavily colonised then it will have a significant chlorine dioxide demand and it may be some considerable time before a stable chlorine dioxide residual is established at the extremities of the system. During the clean-up phase, it may be necessary to maintain a higher dosage rate than 0.5 mg/l and outlets normally used for drinking purposes will require additional controls. In such cases, an offline super-disinfection with an elevated level of chlorine dioxide (20– 50 mg/l) may be necessary, but this should only be undertaken following a detailed risk assessment and the system should be flushed through thoroughly after cleaning.

2.95 Where some of the water is used for drinking purposes, but the desired microbial control cannot be achieved without the combined total oxidant levels at the outlets exceeding 0.5 mg/l then the relevant outlets should be clearly labelled as unsuitable for drinking. Alternatively, the oxidants can be removed from the water at the POU by means of a suitable activated carbon-based drinking water filter. However, where such outlets are in neonatal or augmented care units, these should be clearly labelled as unsuitable for ingestion, including making up neonates' feeds.

2.96 When introducing chlorine dioxide, the dosing system should typically be installed, for a combined hot and cold water system, on the inlet to the tank supplying water to the remainder of the system. For a hot water system, this would be on the cold water inlet to the calorifier. The dosage of chlorine dioxide should be proportional to the water flow and the dosing system should incorporate safeguards to prevent inadvertent overdosing. In the case of hot water distribution systems with calorifiers/water heaters operating conventionally (ie at 60 °C), there will be a tendency for chlorine dioxide to be lost by 'gassing off', especially if the retention time in a vented calorifier/water heater is long. In most cases, however, some level of total oxidant should be found in the hot water, although at concentrations far less than the 0.5 mg/l injected.

2.97 It may be difficult to establish the desired chlorine dioxide residual throughout all areas of a large complex water distribution system from a single dosing point, particularly if it is colonised by an established biofilm. Installing satellite-dosing systems may be needed to boost the residual at key areas, such as interposing tanks or upstream of calorifiers.

2.98 Excessive levels of chlorine dioxide should be avoided since they can encourage the corrosion of copper and steel pipework and high levels of chlorine dioxide can degrade certain types of polyethylene pipework particularly at elevated temperatures. Users of chlorine dioxide systems will need to consider these issues and when choosing a system these points should be checked to ensure that the supplier addresses them satisfactorily.

2.99 The chlorine dioxide dosing system should be inspected at least weekly to confirm that it is operating correctly and that there is no evidence of chemical leakage. The treated water should be tested regularly at a suitable sample point downstream of the injection point to verify that there is at least 80% reaction efficiency, thus minimising the contribution of chlorite to the biocide dose; and at the sentinel outlets to verify the chlorine dioxide and total oxidant/chlorite residuals are as required. The dosing system should be serviced and maintained in accordance with the manufacturer's recommendations.

2.100 For most systems, the routine inspection and maintenance detailed in the bulleted list below is usually sufficient to ensure control, with any remedial action taken when necessary and recorded.

- weekly – check the system operation and chemical stocks in the reservoir;
- monthly – test the treated water for both chlorine dioxide and total oxidant/chlorite at an outlet close to the point of injection to verify the dosage rate and conversion yield;
- monthly – measure the concentration of chlorine dioxide at the sentinel taps – the concentration should be at least 0.1 mg/l; and adjust the chlorine dioxide dosage to establish the required residual at the sentinel sample points;
- annually – test the chlorine dioxide and total oxidant/chlorite concentration at a representative selection of outlets throughout the distribution system – the concentration should be at least 0.1 mg/l chlorine dioxide.

Copper and silver ionisation

2.101 Ionisation is the term given to the electrolytic generation of copper and silver ions providing a continuous release of ions in water. These are generated by passing a low electrical current between two copper and silver electrodes; copper and silver alloy electrodes may also be used. When used correctly, copper and silver ionisation is shown to be effective at controlling legionella and can penetrate and control established biofilms.

2.102 The Water Supply (Water Quality) Regulations 2001 set a standard for copper of 2 mg/l, which must not be exceeded. However, there is currently no standard for silver used for domestic purposes.

Info box 2.4: Guideline levels for silver

At the time of publication, the European Union and WHO do not dictate any established standards for silver, as there is currently insufficient data for recommending a concentration limit. Equipment manufacturers generally recommend copper (0.2–0.8 mg/l) and silver (0.02–0.08 mg/l) ion concentrations to control legionella effectively.

WHO states 'there is no adequate data with which to derive a health based guideline value for silver in drinking water'. WHO also states that 'special situations exist where silver may be used to maintain the bacteriological quality of drinking water and higher levels of up to 0.1 mg/litre could be tolerated in such cases without risk to health'.

2.103 Where some of the outlets on the treated water system are used for domestic purposes, rigorous controls and regular water testing needs to be maintained to ensure that the copper level does not exceed 2.0 mg/l as Cu^{2+} and the silver level does not exceed 0.1 mg/l as Ag^{+} at these outlets.

2.104 Ionisation systems are typically fitted on the incoming mains supply before water storage treating both hot and cold water systems. These systems may also be installed in independent hot or cold water circuits as well as on a recirculating pumped line treating a storage tank. If water softening systems are used, the ionisation system should be fitted after the softening system to avoid removal of some of the copper and silver ions by the water softening system resins. In hard water areas, a specific electrode evaluation and descaling procedure should be part of the programme as it is possible that the natural hardness will deposit on the electrodes and reduce ionisation efficiency.

2.105 Values of more than 0.2 mg/l copper and more than 0.02 mg/l silver are recommended at outlets to ensure effective control of legionella, and the ionisation system should be regularly checked to ensure it is capable of delivering enough copper and silver to maintain these concentration values at outlets while not exceeding the drinking water limits, if applicable.

2.106 Maintaining adequate silver ion concentrations in hard water systems can be difficult due to the build-up of scale on the silver electrodes potentially obstructing copper and silver ions release. Copper and silver ionisation systems that treat hard water systems should therefore be checked more regularly to ensure that the system is capable of delivering suitable ion levels throughout the system of more than 0.2 mg/l copper and more than 0.02 mg/l silver, measured at outlets. The ionisation process is pH sensitive and dosing levels may need increasing for pH levels greater than 7.6.

2.107 The copper and silver ionisation system should be regularly inspected and its electrodes cleaned as required to ensure that the system is delivering steady levels of more than 0.2 mg/l copper and more than 0.02 mg/l silver, measured at outlets, necessary to maintain control. Water samples should be taken regularly from the ionisation system and from the sentinel outlets and analysed by a UKAS-accredited laboratory to ensure enough copper and silver is produced by the system.

2.108 For most systems, routine inspection and maintenance is usually sufficient to ensure control and any remedial action should be taken when necessary and recorded:

- weekly – check rate and release of copper and silver ions in the water supply and install equipment capable of proportional dosing relative to flow;
- monthly – check copper and silver ion concentrations at sentinel outlets;
- annually – check the measurement of copper and silver ion concentrations at representative taps selected on a rotational basis once each year;
- check the condition and cleanliness of the electrodes and the pH of the water supply.

Chlorine

2.109 Chlorine is widely used to disinfect water supplies. Most mains water supplies will contain a low level chlorine residual in the range of 0.1–0.5 mg/l at the point where water enters a premises. This level of chlorine may not be sufficient to inhibit the growth of legionella within the water systems of a building and where necessary, supplementary dosing with the controlled addition of a further chlorine-based product may aid the control of legionella and biofilm.

2.110 Once diluted in the water supply the chlorine-based product dissociates to form hypochlorous acid and hypochlorite ions. The effectiveness of chlorine as a disinfectant is determined by the chlorine concentration, contact time, pH value, temperature, concentration of organic matter, and the number and types of microorganisms in the water.

2.111 WHO has set a health-based guideline maximum value of 5.0 mg/l for total chlorine as a residual disinfectant in drinking water. However, it is rarely used continuously in domestic water in buildings at levels higher than 1.0 mg/l as this would render the water unpalatable and may lead to an unacceptable level of corrosion.

2.112 While chlorine has an inhibitory effect on the formation of biofilm it is recognised as being less effective at penetrating and controlling established biofilms than some other oxidising disinfectants. Where a water system has an established legionella colonisation, the dosage of a chlorine product may suppress the growth of legionella.

2.113 Where a water system is relatively free from established biofilm, maintaining a free chlorine residual of 0.5–1.0 mg/l as Cl2 at an outlet will help reduce the development of biofilm in the preceding pipework and aid the control of legionella. A programme of regularly flushing the outlets until free chlorine residual is maintained can significantly improve the effectiveness of control in pipework leading to little used outlets.

2.114 Where used, the chlorine product dosing system should be inspected at least weekly to confirm that it is operating correctly and that there is no evidence of chemical leakage. Safeguards should be in place to prevent any overdosing in the system.

2.115 For most systems, routine inspection and maintenance, as in the bullet list below, is usually sufficient to ensure control. Remedial action should be taken when necessary and recorded.

- weekly – check the system operation and chemical stocks in the reservoir;
- monthly – measure the concentration of free chlorine at the sentinel taps – the concentration should be 0.5–1.0 mg/l; and adjust the chlorine product dosage to establish the required residual at the sentinel sample points;
- annually – test the chlorine product concentration at a representative selection of outlets throughout the distribution system – the target concentration should be at least 0.5 mg/l free chlorine.

Silver stabilised hydrogen peroxide

2.116 Silver stabilised hydrogen peroxide has a history of use in the control of legionella in water systems. A silver hydrogen peroxide solution is injected directly into the water system and if applied and maintained according to the manufacturers' instructions, can be an effective means of control. As with any water treatment programme it should be validated to ensure it is effective in controlling legionella. Silver hydrogen peroxide should not be used in water systems supplying dialysis units.

Supplementary measures

Point of Use (POU) filters

2.117 POU filters prevent the discharge of planktonic legionella and other potentially pathogenic microorganisms (bacteria and parasites) from the tap and shower outlets. They should be used primarily as a temporary measure until a permanent safe engineering solution is developed, although long-term use of such filters may be needed in some healthcare situations. They may also be considered where high level of disinfection of water systems may dislodge biofilm. Where POU filters are fitted, they should be renewed and replaced according to the manufacturer's recommendations.

Ozone and UV treatment

2.118 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, eg UV irradiation or ozone, and these systems are only effective at or very close to the point of application. This usually results in the residual effect 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.

Microbiological monitoring

2.119 Microbiological monitoring of domestic hot and cold water supplied from the mains is not usually required, unless the risk assessment or monitoring indicates there is a problem. The risk assessment should specifically consider systems supplied from sources other than the mains, such as private water supplies, and sampling and analysis may be appropriate.

Monitoring for legionella

2.120 Legionella monitoring should be carried out where there is doubt about the efficacy of the control regime or it is known that recommended temperatures, disinfectant concentrations or other precautions are not being consistently achieved throughout the system. The risk assessment should also consider where it might also be appropriate to monitor in some high risk situations, such as certain healthcare premises. The circumstances when monitoring for legionella would be appropriate include:

- water systems treated with biocides where water is stored or distribution temperatures are reduced. Initial testing should be carried out monthly to provide early warning of loss of control. The frequency of testing should be reviewed and continued until such a time as there is confidence in the effectiveness of the regime;
- water systems where the control levels of the treatment regime, eg temperature or disinfectant concentrations, are not being consistently achieved. In addition to a thorough review of the system and treatment regimes, frequent testing, eg weekly, should be carried out to provide early warning of loss of control. Once the system is brought back under control as demonstrated by monitoring, the frequency of testing should be reviewed;
- high-risk areas or where there is a population with increased susceptibility, eg in healthcare premises including care homes;
- water systems suspected or identified in a case or outbreak of legionellosis where it is probable the Incident Control Team will require samples to be taken for analysis (see Appendix 2.3).

2.121 Where monitoring for legionella is considered appropriate in hot and cold water systems, sampling should be carried out in accordance with BS 7592 *Sampling for Legionella organisms in water and related materials*.[33] The complexity of the system will need to be taken into account to determine the appropriate number of samples to take. To ensure the sample is representative of the water flowing around the system and not just of the area downstream of the fitting, samples should be taken from separate hot and cold outlets rather than through mixer taps or outlets downstream of TMVs or showers. Samples should be clearly labelled with their source location and if collected pre- or post-flushing.

2.122 In both hot and cold water systems, samples should be taken:

- if considered necessary by the risk assessment;
- from areas where the target control parameters are not met (ie where disinfectant levels are low or where temperatures are below 50 °C (55 °C in healthcare premises) for HWS or exceed 20 °C for cold water systems);
- from areas subject to low usage, stagnation, excess storage capacity, dead legs, excessive heat loss, crossflow from the water system or other anomaly.

2.123 In cold water systems, samples should also be taken as required:

- from the point of entry (or nearest outlet) if the water is supplied from a private water supply or where the temperature of the incoming mains supply is above 20 °C from the cold water storage tank or tanks;
- from the furthest and nearest outlet on each branch of the system (far and near sentinel outlets).

2.124 In hot water systems, samples should also be taken as required:

- from the calorifier hot water outlet and from the base of the calorifier, if it safe to do so, as some systems are under considerable pressure;
- from the furthest and nearest outlet on each branch of a single pipe system (far and near sentinel outlets);
- from the furthest and nearest outlet on each loop of a circulating system (far and near sentinel outlets).

Info box 2.5: Analysis of water samples

Analysis of water samples for legionella should be performed in UKAS-accredited laboratories with the current ISO standard methods for the detection and enumeration of legionella included within the scope of accreditation. These laboratories should also take part in a water microbiology proficiency testing scheme (such as that run by PHE or an equivalent scheme accredited to ISO 17043). Alternative quantitative testing methods may be used as long as they have been validated using ISO 17994 and meet the required sensitivity and specificity.

2.125 Table 2.2 gives guidance on action to take if legionella is found in the water system. However, for healthcare premises with vulnerable patients, the action levels and recommended actions in Table 2.3 should be considered.

Table 2.2 Action levels following legionella sampling in hot and cold water systems

Legionella bacteria (cfu/l)	Recommended actions
>100 cfu/l and up to 1000	Either: ■ if the minority of samples are positive, the system should be resampled. If similar results are found again, a review of the control measures and risk assessment should be carried out to identify any remedial actions necessary or ■ if the majority of samples are positive, the system may be colonised, albeit at a low level. An immediate review of the control measures and risk assessment should be carried out to identify any other remedial action required. Disinfection of the system should be considered
>1000 cfu/l	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. Retesting should take place a few days after disinfection and at frequent intervals afterwards until a satisfactory level of control is achieved.

Cleaning and disinfection

2.126 The risk from exposure to legionella should be controlled by keeping the water system and water in it clean and free from nutrients, including those arising from contamination and corrosion; and maintaining its cleanliness. Hardness scale may also trap nutrients, encouraging biofilm formation and so form a barrier to disinfectants.

2.127 Where necessary, hot and cold water services should be cleaned, flushed and disinfected in the following situations, as specified in BS 8558:

- on completion of a new water installation or refurbishment of a hot and cold water system;
- on installation of new components, especially those which have been pressure tested using water by the manufacturer (see the manufacturer's instructions);
- where the hot and cold water is not used for a prolonged period and has not been flushed as recommended or the control measures have not been effective for a prolonged period. For example, this could be as little as two or three weeks, but will depend on the ambient temperature, condition of the water system, potential for exposure to aerosols and the susceptibility of users considered in a specific risk assessment;
- on routine inspection of the water storage tanks, where there is evidence of significant contamination or stagnation;
- if the system or part of it has been substantially altered or entered for maintenance purposes that may introduce contamination;
- following water sampling results that indicate evidence of microbial contamination of the water system (see Table 2.2 or 2.3);
- during, or following an outbreak or suspected outbreak of legionellosis linked to the system;
- or where indicated by the risk assessment.

2.128 A suitable safe system of work, or for more complex systems, a site-specific method statement should be obtained before the start of any cleaning and/or thermal or chemical disinfection of a water system. The documentation should clearly define the process to be undertaken and should be derived from risk assessments of the typically encountered hazards, which might include:

- access/egress, storage and special site hazards, eg asbestos;
- machinery and equipment isolation;
- work in confined spaces;
- manual handling;
- work at height;
- slips, trips and falls;
- electrical equipment;
- chemical(s) to be used;
- personal protective equipment required;
- waste disposal and chemical neutralising process (a discharge permit maybe required from the water utility).

2.129 Evidence of the competence of individuals undertaking the tasks should be confirmed, indicating that the knowledge and experience of the operatives is satisfactory for undertaking the proposed work.

2.130 Disinfection of the water services when the system is offline may be by:

- **thermal disinfection**, ie by raising the HWS temperature to a level at which legionella will not survive, drawing it through to every outlet, and then flushing at a slow flow rate to maintain the high temperature for a suitable period (the contact time). This method is only applicable to HWS and is commonly used as a rapid response. It may be less effective than chemical disinfection and may not be practicable where the hot water supply is insufficient to maintain a high temperature throughout;

- **chemical disinfection**, ie by adding an effective agent such as chlorine or chlorine dioxide, drawing it through to every outlet, then closing the outlets and allowing it to remain in contact for a suitable period (known as the contact time). This method is commonly used when it is necessary to disinfect the cold water storage tanks and the whole system.

2.131 As part of the thermal or chemical disinfection process, a service record should be kept of all work undertaken. Any items that require attention or refurbishment should be noted on the disinfection record.

2.132 To confirm effective disinfection, any required microbiological samples should be taken between two and seven days after the system is refilled. Samples taken immediately after a disinfection process may give false negative results.

Info box 2.6: Thermal and chemical disinfection

Adding disinfectant or raising the temperature above 60 °C creates a hazard to users by chemical exposure or scalding. A risk assessment must be carried out and a safe system of work put in place throughout the disinfection process. Signage and outlet warning labels should be fitted to all areas to alert occupants of the building for whom the risk is greater (such as the very young, elderly or those with sensory loss) not to use these outlets.

Thermal disinfection

2.133 Thermal disinfection of hot water services is carried out by raising the temperature of the whole contents of the calorifier and circulating water for at least an hour. Every hot water outlet throughout the system must then be flushed and, to be effective, the temperature at the calorifier should be maintained high enough to ensure that the temperature at the outlets does not fall below 60 °C. Each tap and appliance should be run sequentially for at least five minutes at the full temperature (but not necessarily at full flow), and it should be measured and recorded.

2.134 Thermal disinfection may prove to be ineffective where parts of the calorifier or water system fail to reach the required temperature for a long enough period.

Chemical disinfection

2.135 The disinfection of a water system is normally based on chlorine being dosed at 50 ppm for a minimum contact period of one hour, at the end of which the concentration should not be less than 30 ppm free residual chlorine. However, lower concentrations and longer contact times are considered acceptable, as set out in BS 8558.

2.136 Other disinfectants may be used where they are shown to be effective. Their intended application should take into account the type of system and user profile at the specified concentration levels and contact period. If the disinfectant is for use in water systems supplying wholesome water then these must comply with the requirements of The Water Supply (Water Quality) Regulations 2000, for Scotland, The Water Supply (Water Quality) (Scotland) Regulations 2001 and 2010, and for Wales, the Water Supply (Water Quality) (Wales) Regulations 2010.

2.137 After disinfection, and before the system is brought back online, the disinfectant should be completely flushed from the system. Info box 2.7 is an example of a chemical-based disinfection procedure, in this case, chlorine.

Info box 2.7: Chlorine-based disinfection

Efficacy of chlorine as a disinfectant is pH dependent and pH values in excess of 7.6 should be avoided:

- Signage and outlet warning labels should be fitted to all areas.
- A pre-disinfection should take place if the conditions within the cold water storage tank are so poor that they could adversely affect the welfare of the operators undertaking the clean.

Cleaning:

- Drain the tank to the designated drain, neutralise any residual chlorine if a pre-disinfection has been completed.
- Under normal operation, the float-operated valve is a restriction within the supply pipework and so should be operated fully open, flushing any particulate matter from the supply main.
- Physically clean the tank and associated fittings using a method that does not damage the tank coatings. (It may not be possible to clean galvanised tanks where there is evidence of corrosion).
- Remove residual sludge and water by using a wet and dry vacuum cleaner, disposing to the designated location, and rinse the tank with fresh water.

Disinfection:

- Refill the tank with fresh make-up water, isolate from the mains supply and add the required quantity of disinfectant using the turbulence of filling to distribute it.
- Test the contents of the tank to confirm the required level of disinfectant has been achieved using a quantitative test kit.
- Draw the disinfecting solution through to the water heaters and subsequently to all outlets fed from the system.
- Test key far sentinel outlets to ensure the required concentration is reached.
- Test all other outlets with a fast and simple test showing the presence or absence of disinfectant.
- Top up the tank with fresh water and sufficient disinfectant to bring the concentration back up to target levels.
- Leave the system for the designated contact period.
- Retest key outlets at the end of the contact period to confirm that satisfactory disinfectant levels are achieved. Check concentrations at intervals during the contact period and restore the disinfectant levels if they decline. If the concentration should fall below the minimum, restart the process.
- Add a neutralising agent to the tank and ensure there is no disinfectant before flushing through to the water heaters.
- Draw neutralised water through to all outlets, measuring to ensure the absence of disinfectant.
- Remove signage and outlet warning labels.
- If the water is for non-potable use, the tank inlet can be reopened as long as the subsequent refilling dilutes any neutralising product to insignificant levels. If the tank supplies wholesome water to outlets, it should be fully drained, refilled with fresh water and flushed with water free from neutralising agent.

Shared premises and residential accommodation: Landlords

Residential accommodation: Landlords

2.138 Landlords who provide residential accommodation, as the person in control of the premises or responsible for the water systems in their premises, have a legal duty to ensure that the risk of exposure of tenants to legionella is properly assessed and controlled. This duty extends to residents, guests, tenants and customers. They can carry out a risk assessment themselves if they are competent, or employ somebody who is.

2.139 Where a managing (or letting) agent is used, the management contract should clearly specify who has responsibility for maintenance and safety checks, including managing the risk from legionella. Where there is no contract or agreement in place or it does not specify who has responsibility, the duty is placed on whoever has control of the premises and the water system in it, and in most cases, this will be the landlord themselves.

2.140 All water systems require a risk assessment but not all systems require elaborate control measures. A *simple* risk assessment may show that there are no real risks from legionella, but if there are, implementing appropriate measures will prevent or control these risks. The law requires simple, proportionate and practical actions to be taken, including identifying and assessing sources of risk, managing the risk, preventing or controlling the risk; and periodically checking that any control measures are effective.

2.141 For most residential settings, the risk assessment may show the risks are low, in which case no further action may be necessary, eg housing units with small domestic-type water systems where water turnover is high. If the assessment shows the risks are insignificant and are being properly managed to comply with the law, no further action may be required, but it is important to review the assessment periodically in case anything changes in the system. However, the frequency of inspection and maintenance will depend on the system and the risks it presents.

2.142 Simple control measures can help manage the risk of exposure to legionella and should be maintained, such as:

- flushing out the system before letting the property;
- avoiding debris getting into the system (eg ensure the cold water tanks, where fitted, have a tight-fitting lid);
- setting control parameters (eg setting the temperature of the calorifier to ensure water is stored at 60 °C);
- making sure any redundant pipework identified is removed;
- advising tenants to regularly clean and disinfect showerheads.

2.143 Landlords should inform tenants of the potential risk of exposure to legionella and its consequences and advise on any actions arising from the findings of the risk assessment, where appropriate. Tenants should be advised to inform the landlord if the hot water is not heating properly or if there are any other problems with the system, so that appropriate action can be taken.

2.144 The risk may increase where the property is unoccupied for a short period. It is important that water is not allowed to stagnate within the water system and so dwellings that are vacant for extended periods should be managed carefully. As a general principle, outlets on hot and cold water systems should be used at least once a week to maintain a degree of water flow and minimise the chances of stagnation. To manage the risks during non-occupancy, consider implementing a suitable flushing regime or other measures, such as draining the system if the dwelling is to remain vacant for long periods.

2.145 Where there are difficulties gaining access to occupied housing units, appropriate checks can be made by carrying out inspections of the water system, eg when undertaking mandatory visits such as gas safety checks or routine maintenance visits.

2.146 It may be impractical to risk assess every individual residential unit, eg where there are a significant number of units under the control of the landlord, such as Housing Associations or Councils. In such cases, a representative proportion of the premises for which they have responsibility should initially be assessed, on the basis of similar design, size, age and water supply, with the entire estate eventually assessed on a rolling programme of work.

Shared premises

2.147 Those who have, to any extent, control of premises for work-related activities or the water systems in the building, have a responsibility to those who are not their employees, but who use those premises. A suitable and sufficient assessment must be carried out to identify, assess and properly control the risk of exposure to legionella bacteria from work activities and the water systems on the premises.

2.148 In estate management, it is increasingly common for there to be several dutyholders in one building. In such cases, duties may arise where persons or organisations have clear responsibility through an explicit agreement, such as a contract or tenancy agreement.

2.149 The extent of the duty will depend on the nature of that agreement. For example, in a building occupied by one leaseholder, the agreement may be for the owner or leaseholder to take on the full duty for the whole building or to share the duty. In a multi-occupancy building, the agreement may be that the owner takes on the full duty for the whole building. Alternatively, it might be that the duty is shared where, eg the owner takes responsibility for the common parts while the leaseholders take responsibility for the parts they occupy. In other cases, there may be an agreement to pass the responsibilities to a managing agent. Where a managing agent is used, the management contract should clearly specify who has responsibility for maintenance and safety checks, including managing the risk from legionella.

2.150 Where there is no contract or tenancy agreement in place or it does not specify who has responsibility, the duty is placed on whoever has control of the premises, or part of the premises.

Info box 2.8: Example of shared premises and responsibilities

A managing agent looks after a commercial building and provides mains hot and cold water services to three tenanted areas. By contract, the managing agent has a responsibility to risk assess and ensure the safety of the water from the incoming mains up to where the water enters the part of the building the tenant occupies. The tenants have the responsibility to do the same from the point at which it enters their premises. All parties should take steps to ensure that each is fulfilling the legal responsibilities for the parts of the building over which they have control. The managing agent should take steps, eg by contractual arrangements, to ensure that tenants are complying with their duties because if the tenant's water system becomes contaminated with legionella bacteria it may act as a reservoir, seeding it back down into the systems for which the managing agent has responsibility.

2.151 Where employers share premises or workplaces, the Management of Health and Safety at Work Regulations 1999, regulation 11 (see www.hse.gov.uk/risk for more information) requires that they cooperate with each other to ensure their respective obligations are met. For example, with regard to the management of the water systems in the building, routine monitoring by any party may indicate possible problems within the building water system. This information should be communicated to enable cooperation and coordination, particularly where another party may be able to help or are contributing to the risk. In such cases, a joint plan can be formulated and appropriate remedial action taken.

Special considerations for healthcare and care homes

2.152 Legionnaires' disease is a potentially fatal form of pneumonia and everyone is susceptible to infection, but there are a number of factors that increase susceptibility, including increasing age (particularly those over 50 years); those with existing respiratory diseases or certain illnesses and conditions such as cancer, diabetes, kidney disease; alcoholics; smokers; and those with an impaired immune system.

2.153 Special consideration should be given to patients or occupants within healthcare premises, residential or care homes where they are exposed to water systems and a range of potential sources of waterborne infection, eg patient ventilation humidification systems that are not necessarily present in a non-healthcare setting.

2.154 This guidance gives information on special considerations where there are susceptible individuals but should be applied proportionately, eg in an acute hospital setting where there are likely to be a larger number of susceptible patients at risk of infection, the organisation may need to follow most or all aspects of the guidance. However, in other settings where there may be less susceptible residents, a local risk assessment will help determine which aspects of this guidance are relevant. Further guidance is also available for care settings in *Health and safety in care homes*.

2.155 Appendix 2.1 gives information on what the risk assessment should consider and should take into account the susceptibility of 'at risk' patients. Both the relative risks of legionella infection, scalding and any additional measures that may be required to effectively manage those risks should be considered.

Info box 2.9: Patients in augmented care units

Water systems: Health Technical Memorandum HTM 04–01 published by the Department of Health (England) advises that it may be preferable to provide separate small systems, with independent supply and local heating sources for patients in augmented care units (ie where medical/nursing procedures render the patients susceptible to invasive disease from environmental and opportunistic pathogens and include patients).

2.156 Hot and cold water systems should be maintained to keep cold water, where possible, at a temperature below 20 °C, and stored hot water at 60 °C and distributed so that it reaches the outlets at 55 °C within one minute. The minimum temperature at the most distant point should be 55 °C, ie the temperature of the hot water as it returns to the calorifier should not fall below 50 °C. Circulation of cold water and refrigeration should only be considered in specialist units where people are at particular risk as a result of immunological deficiency, eg transplant units. All other uses of water should also be considered and appropriate action taken, as these may not be appropriate in an augmented care setting (eg use of ice machines, drinking water fountains, bottled water dispensers etc). Where required, they should be considered as part of the risk assessment as there is an increased risk in compromised patients for legionella infection to occur following aspiration of ingested water contaminated with legionella.

2.157 For healthcare premises, the Department of Health (England) *Health Technical Memorandum 04–01: Addendum* advises the formation of Water Safety Groups (WSG) who develop the Water Safety Plan (WSP). Although the addendum focuses on specific additional measures to control or minimise the risk of *Pseudomonas aeruginosa* in augmented care units, it also has relevance to other waterborne pathogens including legionella. Info box 2.10 provides a brief summary of what constitutes a WSP and WSG. While not statutory under health and safety legislation, the formation of a WSG

Info box 2.10: Water Safety Groups and Water Safety Plans

Water Safety Group – The WSG is a multidisciplinary group formed to undertake the commissioning, development, implementation and review of the WSP. The aim of the WSG is to ensure the safety of all water used by patients/residents, staff and visitors, to minimise the risk of infection associated with water, including legionella. It provides a forum in which people with a range of competencies can be brought together to share responsibility and take collective ownership for ensuring it identifies microbiological hazards, assesses risks, identifies and monitors control measures and develops incident protocols.

As per the addendum, the roles, responsibility and accountability of the WSG should be defined. The chair of the WSG is a local decision but the Director of Infection Prevention and Control (DIPC) may normally lead the group. The WSG may typically comprise personnel who:

- are familiar with all water systems and associated equipment in the building(s) and the factors which may increase risk of legionella infection, ie the materials and components, the types of use and modes of exposure, together with the susceptibility to infection of those likely to be exposed;
- have knowledge of the particular vulnerabilities of the ‘at risk’ population within the facility and, as part of its wider remit, the WSG should include representatives from areas where water may be used in therapies, medical treatments or decontamination processes (eg hydrotherapy, renal, sterile services) where exposure to aerosols may take place.

Water Safety Plans – The WSP is a risk management approach to the microbiological safety of water that establishes good practices in local water usage, distribution, supply and controls. It will identify potential microbiological hazards, consider practical aspects and detail appropriate control measures. WSPs are working documents that need to be kept up to date and reviewed to ensure the adequate assessment and control of the risks from a wide range of waterborne pathogens, including legionellae in healthcare and care home settings.

WSPs include the need to:

- assess the risks which may be posed to patients (including those with particular susceptibility), employees and visitors;
- put into place appropriate management systems to ensure the risks are adequately controlled;
- ensure there are supporting programmes, including communication, training and competency checks.

The risks from legionellosis should form an integral part of any WSP, ensuring that there is adequate documentation and communication with the WSG both for normal operation of the systems and following incidents, eg when there have been failures in controls, equipment, cases of illness associated with the system etc.

and implementation of a WSP complements the requirements in the Approved Code of Practice *Legionnaires' disease. The control of legionella bacteria in water systems* for an adequate assessment of risk and the formulation and implementation of an effective written control scheme to minimise the risks from exposure to legionellosis. This should be applied proportionately depending on the setting.

Monitoring for legionella

2.158 The strategy for monitoring for legionella should identify patients at increased risk, eg in areas where immuno-compriomised patients are present, such as oncology, haematology and transplant units. The strategy should identify all components of the recirculating water system in those units and representative outlets where water samples can be taken and results interpreted to determine the level of colonisation.

2.159 Legionella monitoring should be carried out where there is doubt about the efficacy of the control regime or where recommended temperatures, disinfectant concentrations or other precautions are not being consistently achieved throughout the system. Where considered appropriate, monitoring for legionella should be carried out in line with BS 7592 *Sampling for legionella in water and related materials*. See paragraphs 2.119–2.125 for further information.

2.160 Monitoring results to determine appropriate action levels, depending on whether colonisation is local to an outlet or more widespread within the water system, should be interpreted by a competent person. To establish if the circulating hot water or the distributed cold water is under control, samples should be taken from separate hot and cold water outlets which are not blended. This will ensure the sample is representative of the water flowing around the system and not just of the area downstream of the mixing valve. Monitoring of hot and cold water systems where TMVs are fitted needs careful consideration to ensure the results are interpreted in the context of the conditions in place at the time of sampling.

2.161 Table 2.3 describes the action levels in healthcare premises with susceptible patients at an increased risk of exposure. Whereas, in a general healthcare setting where legionella monitoring is considered appropriate, Table 2.2 describes the actions to be taken.

2.162 Where considered necessary for ongoing patient management, POU filters should be used primarily as a temporary control measure while a permanent safe engineering solution is developed, although long-term use of such filters may be required in some cases.

Table 2.3 Actions to be taken following legionella sampling in hot and cold water systems in healthcare premises with susceptible patients

Legionella bacteria (cfu/l)	Recommended actions
Not detected or up to 100 cfu/l	In healthcare, the primary concern is protecting susceptible patients, so any detection of legionella should be investigated and, if necessary, the system resampled to aid interpretation of the results in line with the monitoring strategy and risk assessment
>100 cfu/l and up to 1000 cfu/l	Either: ■ if the minority of samples are positive, the system should be resampled. If similar results are found again, review the control measures and risk assessment to identify any remedial actions necessary or ■ if the majority of samples are positive, the system may be colonised, albeit at a low level. An immediate review of control measures and a risk assessment should be carried out to identify any other remedial action required. Disinfection of the system should be considered
>1000 cfu/l	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. Retesting should take place a few days after disinfection and at frequent intervals thereafter until a satisfactory level of control is achieved

Scalding

2.163 There is a risk of scalding where the water temperature at the outlet is above 44 °C. In certain facilities with 'at risk' patients this is especially so where there is whole body immersion in baths and showers of vulnerable patients, including the very young, elderly people, and people with disabilities or those with sensory loss who may not be able to recognise high temperatures and respond quickly. Where there are vulnerable individuals and whole body immersion, testing of outlet temperatures using a thermometer can provide additional reassurance.

2.164 The potential scalding risk should be assessed and controlled in the context of the vulnerability of those being cared for. The approach will depend on the needs and capabilities of patients or residents. For most people, the scalding risk is minimal where water is delivered up to 50 °C at hand washbasins and using hot water signs may be considered sufficient, where a TMV is not fitted. However, where vulnerable people are identified and have access to baths or showers and the scalding risk is considered significant, TMV Type 3 (TMV3) are required. Further advice on safe bathing can be found in the UK Homecare Association (UKHCA) guidance *Controlling scalding risks from bathing and showering*.[34]

2.165 Where the risk assessment considers fitting TMVs appropriate, the strainers or filters should be inspected, cleaned, descaled and disinfected annually or on a frequency defined by the risk assessment, taking account of any manufacturers' recommendations. To maintain protection against scald risk, TMVs require regular routine maintenance carried out by competent individuals in accordance with the manufacturer's instructions. HSE's website provides further information at www.hse.gov.uk/healthservices/scalding-burning.htm.

Info box 2.11: Use of TMV Type 3 (TMV3)

TMV3 meets the requirements of the NHS Estates Model Engineering Specification *Thermostatic mixing valves (healthcare premises)*[35] and cannot be overridden by the user. In reality, the chances of a severe scald from a washbasin tap are low and the need for a TMV3 on a hand washbasin should be assessed against the need for legionella control. It is important that a documented maintenance schedule is followed and the TMVs maintained to the standard recommended by the manufacturer.

Flushing

2.166 The risk from legionella is increased in peripheral parts of the hot and cold water system where there are remote outlets such as hand washbasins, and dead legs. Where reasonably practicable, dead legs should be removed or the risk minimised by regular use of these outlets. Where outlets in healthcare facilities with susceptible patients are not in regular use the risk assessment may indicate the need for more frequent flushing, ie twice weekly and water draw off should form part of the daily cleaning process to achieve temperature control for both hot and cold water and/or biocide flow through.

2.167 In circumstances where there has been a lapse in the flushing regime, the stagnant and potentially contaminated water from within the shower or tap and associated dead leg should be purged to drain without discharge of aerosols before the appliance is used.

2.168 For comprehensive advice about the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in healthcare premises, refer to *Water systems: Health Technical Memorandum 04–01* (for England and Wales), or to *Scottish Health Technical Memorandum 04–01* (for Scotland).

Appendix 2.1 Legionella risk assessment

1 It is a legal duty to carry out an assessment to identify and assess whether there is a risk posed by exposure to legionella from the hot and cold water system or any work associated with it.

2 The risk assessment should consider all aspects of operation of the hot and cold water systems and while there will be common factors, the individual characteristics of each system should be taken into account. Site personnel who manage the systems to determine current operational practice should be consulted. The commissioning, decommissioning, periods of operation, maintenance, treatment and subsequent management of each individual aspect of operation will require review and validation to ensure site procedures are effective.

3 The checklist below gives the most common key requirements when assessing risk associated with a hot and cold water system based on mechanical, operational, chemical and management aspects:

- details of management personnel who play an active role in the risk management process, to include names, job titles and contact information for:
  - the dutyholder;
  - the appointed responsible person (s), including deputies;
  - service providers, eg water treatment suppliers, cleaning and disinfection service providers;
- an assessment of the competence of those associated with risk management, including their training records;
- identification of roles and responsibilities, to include employees, contractors and consultants;
- a check to confim that consideration was given to preventing the risk by elimination or substitution before implementing appropriate control measures;
- the scope of the assessment, ie the details and entirety of the plant being assessed;
- assessment of the validity of the schematic diagram which should include all parts of the system where water may be used or stored;
- details of the design of the system, including an asset register of all associated plant, pumps, strainers, outlets and other relevant items;
- assessment of the potential for the water system to become contaminated with legionella and other material;
- details of any water pre-treatment process;
- assessment of the potential for legionella to grow within the system and effectiveness of control measures:
  - chemical and physical water treatment measures;
  - disinfection and cleaning regimes;
  - remedial work and maintenance;
- evidence of corrective actions being implemented;
- evidence of proactive management and follow-up of previous assessment recommendations or identified remedial actions;
- evidence of the competence of those involved in control and monitoring activities;
- a review of the legionella control scheme, including management procedures and site records or logbooks, which include:
  - system maintenance records;
  - routine monitoring data;

  - water treatment and service reports;
  - cleaning and disinfection records;
  - legionella and other microbial analysis results.

The following specific considerations should also be assessed for hot and cold water systems:

- quality of the supply water – where this is not wholesome, additional risks and measures to mitigate the risk must be included in the risk assessment process;
- examination of tanks for configuration, flow pattern, protection against contamination, materials of construction, condition, temperature, size in comparison to water consumption and cleanliness or contamination;
- any points in the system where there is a possibility of low or no flow, such as blind ends, dead legs and little used outlets;
- any parts of the CWDS susceptible to heat gain to an extent that could support the growth of legionella;
- any parts of the system with low water throughput including, eg low-use fittings in unoccupied areas or oversized tanks that may lead to stagnation;
- any parts of the system which are configured in parallel with others and where the water flow could be unbalanced;
- hot water system return pipes – stagnation often occurs, particularly at points furthest away from the water heater, where circulation has failed and the hot water has cooled;
- timely, appropriate remedial action to poor temperature or monitoring results and using this as an indicator of the effectiveness and adequacy of the management controls in place.

The assessment should include recommendations for remedial actions for controlling legionella where necessary and identify who will undertake the actions. Actions should be prioritised and a review date set for determining completion of these tasks.

See BS 8580[36] for more information.

Appendix 2.2 Legionella written control scheme

1 The risk from exposure will normally be controlled by measures which do not allow the proliferation of legionella bacteria in the system. Once the risk is identified and assessed, a written control scheme should be prepared, implemented and properly managed for preventing or controlling legionella.

2 The scheme should specify the various control measures, how to use and carry out those measures, describe the water treatment regimes and the correct operation of the water system. The scheme should be specific and tailored to the system covered by the risk assessment. Along with the guidance in this document, this appendix summarises the information to include in a legionella written control scheme, ie:

- purpose;
- scope;
- risk assessment;
- management structure:
  - dutyholder;
  - responsible person(s) and communication pathways;
  - training;
  - allocation of responsibilities, ie to the dutyholder, responsible person(s) and water treatment service provider;
- up-to-date schematic plan showing the layout of the system(s) and its location within and around the premises – 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;
- the correct and safe operation of the system;
- precautions in place to prevent or minimise risk associated with the system;
- analytical tests, including microbiological testing, other operational checks, inspections and calibrations to be carried out, their frequency and any resulting corrective actions;
- remedial action to be taken in the event that the scheme is shown not to be effective, including control scheme reviews and any modifications made;
- health and safety information, including details on storage, handling, use and disposal of any chemical used in both the treatment of the system and testing of the system water;
- incident plan, which covers the following situations:
  - major plant failure, eg chemical system failure;
  - very high levels or repeat positive water analyses for legionella;
  - an outbreak of legionellosis, suspected or confirmed as being centred at the site;
  - an outbreak of legionellosis, the exact source of which has yet to be confirmed, but which is believed to be centred in an area which includes the site.

Appendix 2.3 Action to take if there is an outbreak of legionellosis

1 In England and Wales, legionnaires' disease is notifiable under the Health Protection (Notification) Regulations 2010[37] and in Scotland under the Public Health (Notification of Infectious Diseases) (Scotland) Regulations 1988.[38] Under these Regulations, human diagnostic laboratories must notify Public Health England (PHE), Public Health Wales (PHW) or Health Protection Scotland (HPS) (see 'Further sources of advice') of microbiologically confirmed cases of legionnaires' disease.

2 An outbreak is defined as two or more cases where the onset of illness is closely linked in time (weeks rather than months) and where there is epidemiological evidence of a common source of infection, with or without microbiological evidence. An incident/outbreak control team should always be convened to investigate outbreaks. It is the responsibility of the Proper Officer to declare an outbreak. The Proper Officer, appointed by the Local Authority, is usually a Consultant in Communicable Diseases Control (CCDC) in England and Wales, or the Consultant in Public Health Medicine (CPHM) in Scotland. If there are suspected cases of the disease, medical practitioners must notify the Proper Officer in the relevant local authority.

3 Local Authorities will have jointly established incident plans to investigate major outbreaks of infectious diseases, including legionellosis, and it is the Proper Officer who activates these and invokes an Outbreak Committee, whose primary purpose is to protect public health and prevent further infection.

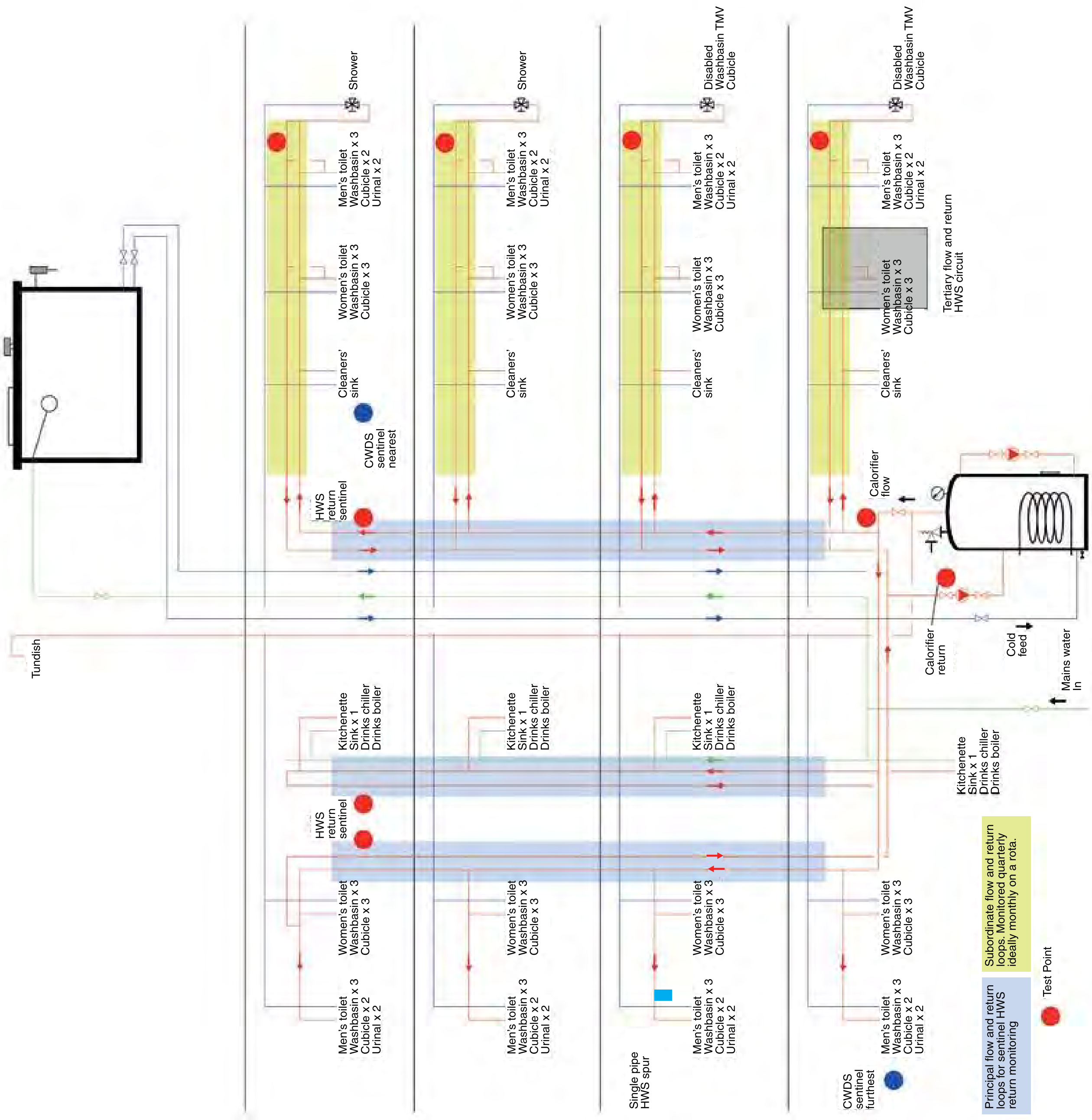
4 HSE or local Environmental Health Officers may be involved in the investigation of outbreaks, their aim being to pursue compliance with health and safety legislation. The local authority, Proper Officer or EHO acting on their behalf will make a visit for public health reasons, often with the relevant officer from the enforcing authorities (ie HSE or the local authority) for health and safety reasons. Any infringements of relevant legislation may be subject to a formal investigation by the appropriate enforcing authority.

5 There are published guidelines (by PHE, PHW and HPS) for the investigation and management of incidents, clusters, and outbreaks of legionnaires' disease in the community.

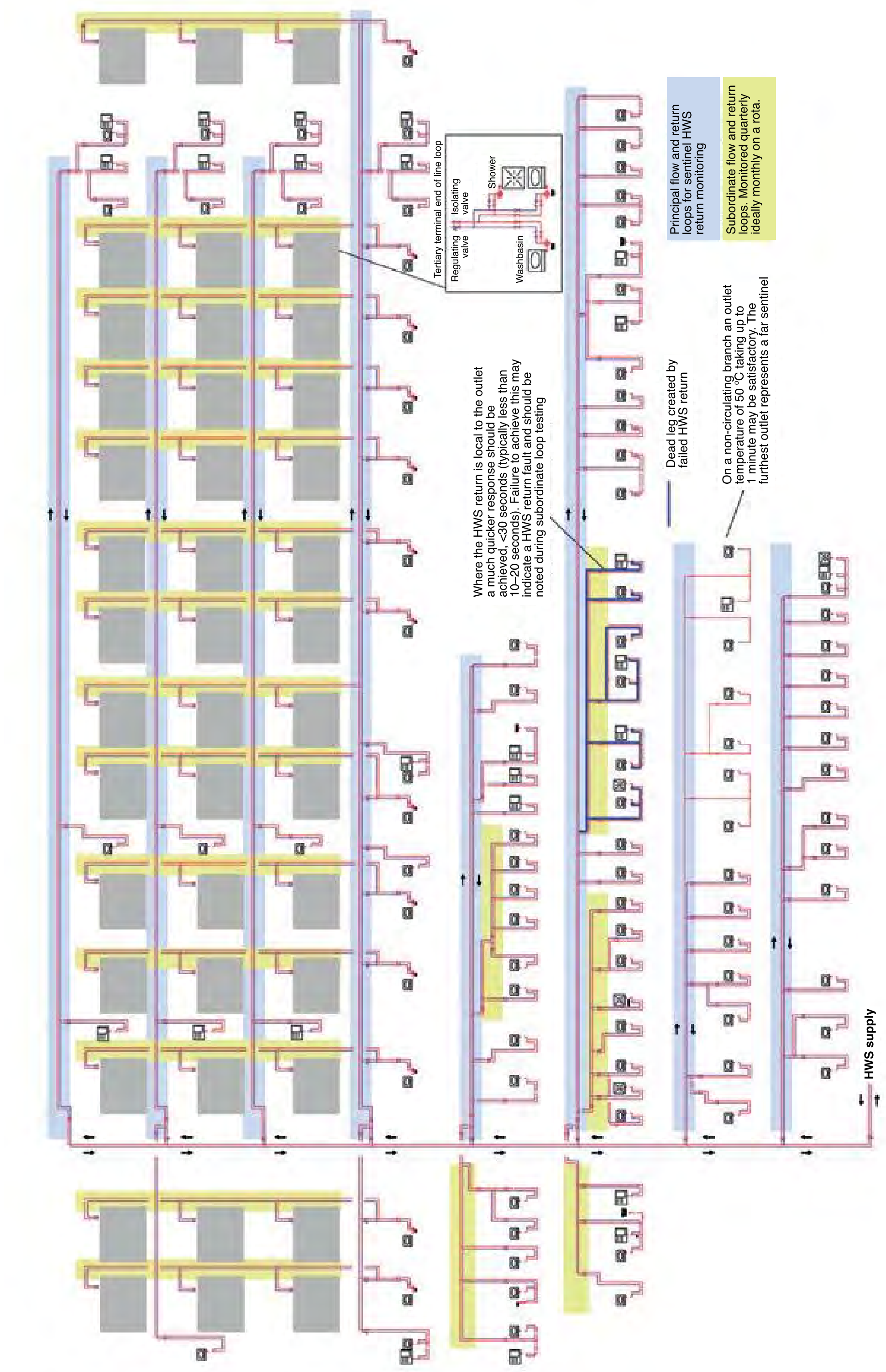
6 These are, for England and Wales, *Guidance on the Control and Prevention of Legionnaires' Disease in England*[39] and for Scotland, *Guidelines on Management of Legionella Incidents, Outbreaks and Clusters in the Community*.[40]

7 If a water system is implicated in an outbreak of legionnaires' disease, emergency treatment of that system should be carried out as soon as possible. This will usually involve the processes detailed in paragraphs 2.124–2.135.

Appendix 2.4 Example of sentinel points in a simple hot water system (HWS)



Appendix 2.5 Example of sentinel points in a complex hot water system (HWS)



Glossary

aerosol a suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having a negligible falling velocity. In the context of this document, it is a suspension of particles which may contain legionella with a typical droplet size of <5 µm that can be inhaled deep into the lungs.

algae a small, usually aquatic, plant that requires light to grow.

bacteria (singular bacterium) a microscopic, unicellular (or more rarely multicellular) organism.

biocide a substance which kills microorganisms.

biofilm a community of bacteria and other microorganisms embedded in a protective layer with entrained debris, attached to a surface.

calorifier an apparatus used for the transfer of heat to water in a vessel, the source of heat being contained within a pipe or coil immersed in the water.

chlorine an element used as a biocide and for disinfection.

chlorine dioxide a compound used as a biocide.

cold water service installation of plant, pipes and fitting in which cold water is stored, distributed and subsequently discharged.

contact time the time a chemical is retained in the system.

corrosion inhibitors chemicals which protect metals by: passivating the metal by the promotion of a thin metal oxide film (anodic inhibitors); or 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.

dead leg a length of water system pipework leading to a fitting through which water only passes infrequently when there is draw off from the fitting, providing the potential for stagnation.

disinfection the reduction of the number of microorganisms to safe levels by either chemical or non-chemical means (eg biocides, heat or radiation).

distribution circuit pipework which distributes water from hot or cold water plant to one or more fittings/appliances.

domestic water hot and cold water intended for drinking, washing, cooking, food preparation or other domestic purposes.

fouling organic growth or other deposits on heat transfer surfaces causing loss in efficiency.

hot water service 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 bacteria of the genus legionella.

legionella (plural legionellae) a bacterium (or bacteria) of the genus legionella.

legionellosis any illness caused by exposure to legionella.

mg/l (milligrams per litre) a measure of dissolved substances given as the number of parts there are in a million parts of solvent. It is numerically equivalent to ppm (parts per million) with respect to water.

microorganism an organism of microscopic size, including bacteria, fungi and viruses.

neonates newborn children.

nutrient a food source for microorganisms.

pasteurisation heat treatment to destroy microorganisms, usually at high temperature.

pH the logarithm of the reciprocal of the hydrogen ion concentration in water, expressed as a number between 0 and 14 to indicate how acidic or alkaline the water is. Values below 7 are increasingly acidic, 7 is neutral, and values higher than 7 are progressively alkaline. However, acidity and alkalinity are not proportional to pH.

planktonic free-floating microorganisms in an aquatic system.

point of use (POU) filters a filter with a maximal pore size of 0.2 µm applied at the outlet, which removes bacteria from the water flow.

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.

risk assessment identifying and assessing the risk from legionellosis from work activities and water sources on premises and determining any necessary precautionary measures.

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.

sentinel taps for hot water services – the first and last taps on a recirculating system. For cold water systems (or non-recirculating HWS), the nearest and furthest taps from the storage tank. The choice of sentinel taps may also include other taps which represent parts of the recirculating system where monitoring can aid control.

sero-group a sub-group of the main species.

sessile aquatic microorganisms adhering to a surface, normally as part of a biofilm.

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 that covers a surface produced by some microorganisms.

sludge a general term for soft mud-like deposits found on heat transfer surfaces or other important sections of a cooling system. Also found at the base of calorifiers and cold water storage tanks.

stagnation the condition where water ceases to flow and is therefore liable to microbiological growth.

strainers coarse filters 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 a mixing valve in which the temperature at the outlet is pre-selected and controlled automatically by the valve.

total viable counts (TVC) the total number of culturable bacteria (per volume or area) in a given sample (does not include legionella).

wholesome water water supplied for such domestic purposes as cooking, drinking, food preparation or washing; or supplied to premises in which food is produced

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3 *Hazardous substances at work: A brief guide to COSHH* Leaflet INDG136(rev5) HSE Books 2012 www.hse.gov.uk/pubns/indg136.htm

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10 *Water Fittings and Materials Directory* Water Regulations Advisory Scheme www.wras.co.uk/Directory

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16 *Water Byelaws 2004* Scottish Water www.scottishwater.co.uk

17 BS 3198 *Specification for copper hot water storage combination units for domestic purposes* British Standards Institution

18 *Managing health and safety in construction. Construction (Design and Management) Regulations 2007. Approved Code of Practice* L144 HSE Books 2007 ISBN 978 0 7176 6223 4 www.hse.gov.uk/pubns/books/l144.htm

19 Approved Documents for Building Regulations in England and Wales:
www.planningportal.gov.uk/buildingregulations/
Approved Documents for Building Regulations in Scotland:
www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards

20 *The Private Water Supplies Regulations 2009* SI 3101/2009
The Stationery Office

21 *The Private Water Supplies (Wales) Regulations 2010* Welsh SI 66/2010
The Stationery Office

22 *The Private Water Supplies (Scotland) Regulations 2006* SSI 209/2006
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The Stationery Office

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The Stationery Office

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The Stationery Office

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39 *Guidance on the Control and Prevention of Legionnaires' Disease in England* Health Protection Agency 2010 www.hpa.org.uk

40 *Guidelines on Management of Legionella Incidents, Outbreaks and Clusters in the Community* Health Protection Agency Scotland 2009 www.hpa.scot.nhs.uk

Further sources of advice

United Kingdom Accreditation Service (UKAS), 21–47 High Street, Feltham, Middlesex TW13 4UN www.UKAS.com

Public Health England (PHE)
www.gov.uk/government/organisations/public-health-england

Public Health Wales (PHW) www.publichealthwales.wales.nhs.uk

Health Protection Scotland (HPS) www.hps.scot.nhs.uk

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Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

British Standards can be obtained in PDF or hard copy formats from BSI: http://shop.bsigroup.com or by contacting BSI Customer Services for hard copies only Tel: 0845 086 9001 email: cservices@bsigroup.com.

The Stationery Office publications are available from The Stationery Office, PO Box 29, Norwich NR3 1GN Tel: 0870 600 5522 Fax: 0870 600 5533 email: customer.services@tso.co.uk Website: www.tsoshop.co.uk/ (They are also available from bookshops.) Statutory Instruments can be viewed free of charge at www.legislation.gov.uk/, where you can also search for changes to legislation.

This document is available at www.hse.gov.uk/pubns/priced/hsg274part2.pdf.

NHS National Services Scotland

Scottish Health Technical Memorandum 04-01:

Water safety for healthcare premises
Part A: Design, installation and testing

Health Facilities Scotland
Engineering and Environment

July 2014

Contents

Disclaimer

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Acknowledgements

Health Facilities Scotland would like to thank the Steering Group led by the Department of Health for their efforts in producing the HTM 04-01 Part A. document.

HTM 04-01 Part A has been updated and amended by Health Facilities Scotland for use in NHSScotland as SHTM 04-01 Part A. Some updating has been done to take account of experience in using the guidance and recent developments affecting design and installation of domestic water services arising from the impact of the discovery of *Pseudomonas aeruginosa* bacteria in water supplies, including re-titling “Water safety for healthcare premises”. The significant participation of the National Water Services Advisory Group is gratefully acknowledged.

Note: This version (2.0) of SHTM 04-01 Part A has been updated to take account of latest guidance forthcoming regarding measures to prevent build-up of waterborne bacteria and biofilm such as *Pseudomonas* as it affects design and specification of domestic hot and cold water systems and components. (Notes 6, 15 and 17 and paragraphs 7.46, 9.54 and 10.1 particularly refer.

Preface

About Scottish Health Technical Memoranda

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

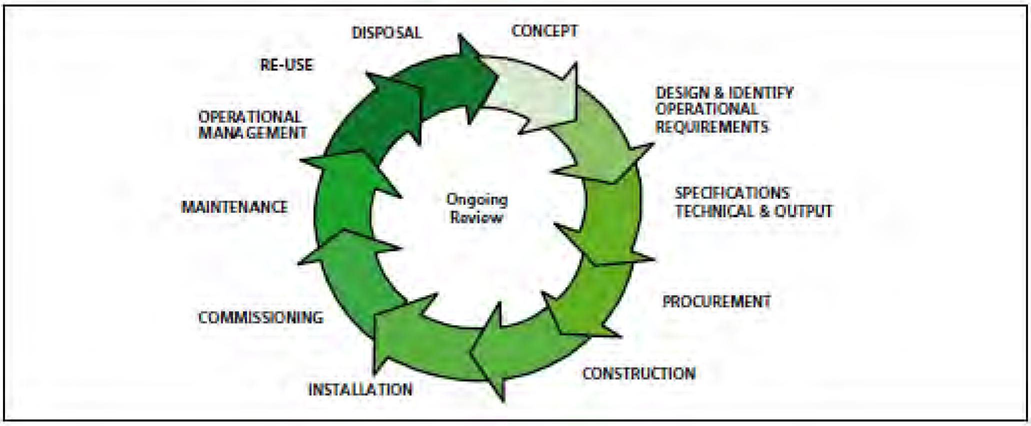
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle: Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

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

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

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

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



Healthcare building life-cycle

Structure of the Scottish Health Technical Memorandum suite

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

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

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

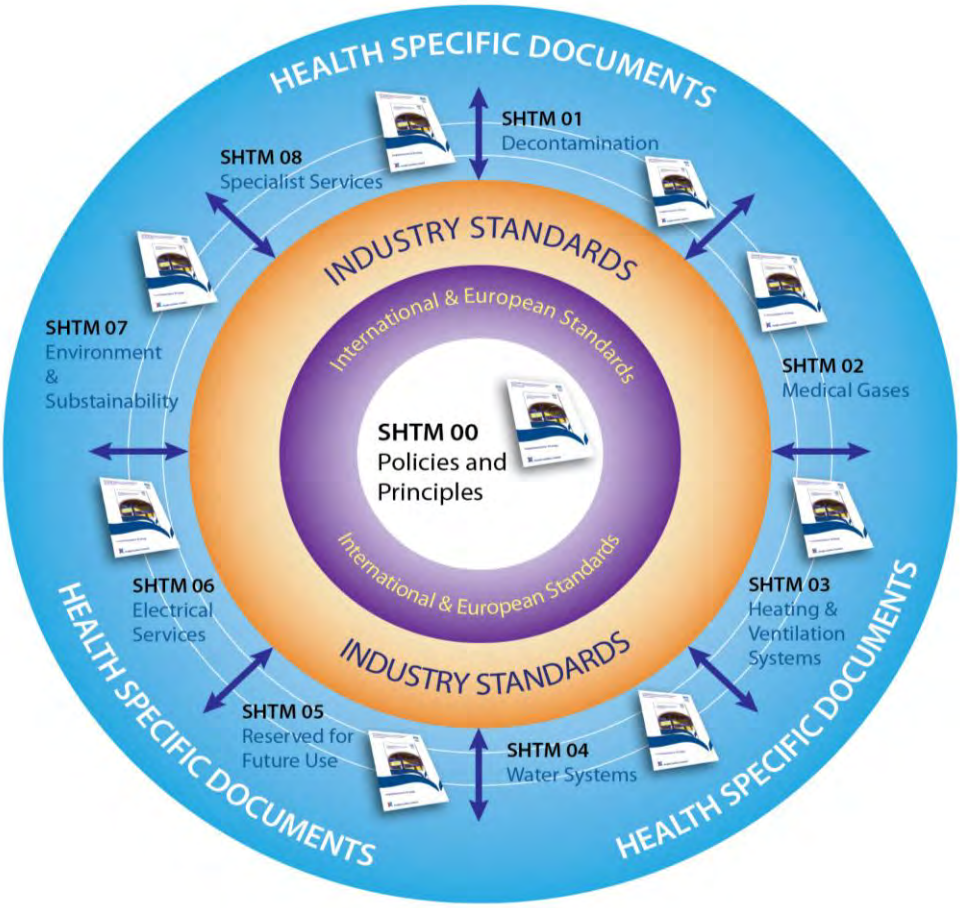
Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical safety guidance for low voltage systems

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent: Environment and Sustainability – EnCO$_2$de.

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

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

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



Engineering guidance structure

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Executive summary

Preamble

Scottish Health Technical Memorandum (SHTM) 2027: ‘Hot and cold water supply, storage and mains services’ and SHTM 2040: ‘The control of *Legionella* in healthcare premises: a code of practice’ have both been revised, and have, at the same time, been combined into this single document: SHTM 04-01: ‘Water safety for healthcare premises”.

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

SHTM 04 now supersedes SHTM 2027 and SHTM 2040 and absorbs information from Scottish Hospital Technical Note 6: ‘The safe operation and maintenance of thermostatic mixing valves’ and Scottish Health Guidance Note: ‘Safe’ hot water and surface temperatures.

Introduction

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

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

This Scottish Health Technical Memorandum gives comprehensive advice and guidance to healthcare management, design engineers, estate managers and operations managers on the legal requirements, design applications, maintenance and operation of hot and cold water supply, storage and distribution systems in all types of healthcare premises. It is equally applicable to both existing and new sites whether procured conventionally (i.e. owned by the NHS) or via PFI/PPP funding. It is equally applicable to modifications and changes to existing premises and a risk assessment should be carried out to determine, highlight and record where it may not be reasonable or technically possible to implement the SHTM 04-01 guidance.

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Aims of this guidance

This guidance has been written to:

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

Recommendations

In healthcare facilities, there is a risk of scalding for vulnerable patients, the very young, older people and mental health patients. Therefore, this guidance strongly recommends that thermostatic mixing devices should be considered for many hot water outlets. It is stressed that hot water outlets throughout for staff use should also be fitted with thermostatic mixing devices unless otherwise recorded in a risk register. Safe water and delivery devices are summarised as follows:

Area/Activity	Recommended temperature (°C)	Type of device (see MES D08 for explanation of valve types)
Staff bases, ward and consulting rooms etc basins In-patient, out-patient hand-wash basins	41	Type 3 Thermostatic
General areas to which patients and visitors may have access	41	Type 2 Thermostatic

Area/Activity	Recommended temperature (°C)	Type of device (see MES D08 for explanation of valve types)
Paediatric baths	40 - to allow for the cold paediatric bath/sink NB: paediatric nurses should always use a thermometer	Type 3 Thermostatic
General baths	43	Type 3 Thermostatic
Showers	41	Type 3 Thermostatic
Assisted baths	46 - to allow for the cold mass of bath NB: Nurses should always use a thermometer before immersing patients	Type 3 Thermostatic
Hair-wash facilities	41	Type 3 Thermostatic
Bidets	38	Type 3 Thermostatic
All sinks, kitchens, pantries, slop sinks etc	55 - minimum required for food hygiene and decontamination purposes	Separate hot and cold taps or combination tap assembly Type 1; no preceding thermostatic device
Office, staff-only access areas hand-wash basins	43	Type 1

Hot water outlets provided for food hygiene and decontamination purposes should be provided with a notice '**Caution – Very Hot Water**'

It is preferable that thermostatic mixing devices are fitted directly to the mixed temperature outlet, or be integral with it, and be the method of temperature and flow control.

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

Note 1: As well as complying with the recommendations outlined in this document, the design and installation of the hot and cold water services, new or extended, in any NHS premises must also comply with the Scottish Water Byelaws 2004.

a. 1999, recommendations of the water suppliers in the Water Regulations Advisory Scheme's (WRAS) 'Water Regulations Guide', and any other requirements of the local water authority;

b. the Health and Safety Executive's Approved Code of Practice and guidance document 'Legionnaires' disease: the control of *Legionella* bacteria in water systems' (commonly known as L8), which requires that there must be a Written Scheme in place in respect of controlling *Legionella* in water systems.

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1. Introduction

Preamble

1.1 Scottish Health Technical Memorandum (SHTM) 2027: 'Hot and cold water supply, storage and mains services' and SHTM 2040: 'The control of *Legionella* in healthcare premises: a code of practice' (NHSScotland Property and Environment Forum, 1999) have both been revised, and have, at the same time, been combined into this single document: Scottish Health Technical Memorandum 04-01: 'Water safety for healthcare premises'. The guidance has been revised in line with changes to relevant regulations, standards, other guidance and also technical developments. It absorbs information from Scottish Hospital Technical Note 6: 'the safe operation and maintenance of thermostatic mixing valves and Scottish Health Guidance Note: 'Safe' hot water and surface temperatures'.

1.2 Scottish Health Technical Memorandum 04 now supersedes Scottish Health Technical Memorandum 2027 and Scottish Health Technical Memorandum 2040, and absorbs information from Scottish Hospital Technical Note 6 and Scottish Guidance Note regarding 'Safe' hot water and surface temperature.

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

1.4 In its new form, the document is divided in seven parts. This part (Part A) outlines the principles involved in the design, installation and testing of the hot and cold water supply, storage and distribution systems for healthcare premises. Some variation may be necessary to meet the differing requirements for the water authority (see Note 3); Part B covers operational management while Parts C and D respectively cover TVC testing and Water Disinfection. Part E refers to alternative materials and filtration comprising an updated version of the former Scottish Hospital Technical Note (SHTN) 2. Part F covers issues related to chloramination of water supplies and Part G provides advice on the preparation of Written Schemes.

General

1.5 Current statutory legislation requires both 'management' and 'staff' to be aware of their individual and collective responsibility for the provision of wholesome, safe hot and cold water supplies, and storage and distribution systems in healthcare premises. This applies whether premises are NHS owned or procured via PFI/PPP and operated by Consortia Facilities Management staff or subcontractors.

1.6 Premises used for the delivery of healthcare are dependent upon water to maintain hygiene through a safe and comfortable risk assessed environment for all who may interface and support functional care delivery.

1.7 The development, construction, installation and maintenance of hot and cold water supply systems are vital for public health.

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

1.9 Measures to control the spread of microorganisms in healthcare premises include the regular use of alcohol-based hand-rubs, and this can result in a significant reduction in the use of hand-wash basins. There has also been a trend to providing an enhanced provision of hand-wash basins and this results in reduced throughput of water to each. Under-use of taps encourages colonisation with *Legionella* and other microorganisms such as *Pseudomonas spp*. Designers should be aware of these issues and, accordingly, consider how they might impact on the frequency of use of hand-wash basins (see also paragraphs 5.4–5.6 in Part B on the extent of utilisation).

Legislation, standards and guidance

1.10 As well as complying with the recommendations outlined in this document, the design and installation of the hot and cold water services, new or extended, in any NHS premises should also comply with:

- the Scottish Water Byelaws 2004, recommendations of the water suppliers in the Water Regulations Advisory Scheme's (WRAS) 'Water Regulations Guide', and any other requirements of the local water supply authority (see Note 3);
- the Health and Safety Commission's Approved Code of Practice and guidance document L8, which requires that there must be a Written Scheme in place in respect of controlling *Legionella* in water systems.
- The Scottish Water Byelaws 2004 are set out, along with the Department for Environment, Food and Rural Affairs (DEFRA's) (1999) guidance (see References) and with the water industry's interpretation of these provisions, in the WRAS 'Water Regulations Guide'. The WRAS is funded by the water suppliers to provide advice on the Scottish Water Byelaws 2004 on a national basis. WRAS also administers the WRAS "approval scheme" that assesses and lists water fittings and materials for compliance with the Regulations. The 'Water Fittings and Materials Directory' contains information on suitable fittings and materials and is updated every six months.

Note 2: Where SHTM 04-01 exceeds the requirements of the above, it shall take precedence.

1.11 Designers and installers of hot and cold water distribution systems are required by the Scottish Water Byelaws 2004 to notify the water supply authority of any proposed installation of water fittings and to have the water supply authority consent before installation commences. It is a criminal offence to install or use water fittings without their prior consent. Liaison with the local water supply authority is strongly recommended at an early stage to avoid problems of compliance in the design.

1.12 All materials used in the construction of systems referred to in this SHTM must comply with the requirements of the Scottish Water Byelaws 2004 (Regulations 3-7: “Requirements for water fittings”) and be in accordance with relevant British Standards and codes of practice. All materials in contact with wholesome water supplies must be listed in the ‘Water Fittings and Materials Directory’.

1.13 Water quality is governed by the Water Supply (Water Fittings) Regulations 1999, building regulations, approved codes of practice and technical standards intended to safeguard quality.

Model Engineering Specification

1.14 Model Engineering Specification C07, which is a procurement specification, supports this SHTM and provides details of the extent of the work required.

Exclusions

1.15 Although many of this SHTM’s recommendations will be applicable, it does not set out to cover water supply for fire-fighting services nor water supply for industrial or other specialist purposes, other than to indicate precautions that should be taken when these are used in association with domestic water services. The point at which a “domestic” activity becomes an industrial process, for example in food preparation, has not been defined, and the applicability will need to be considered in each case.

1.16 This SHTM does not cover wet cooling systems such as cooling towers. Guidance on these systems is given in the Health & Safety Commission’s Approved Code of Practice and guidance document L8. Although none remain within NHS Scotland estate there are some within close proximity to healthcare premises where wind-borne aerosols could be drawn in via air intakes or openable windows.

1.17 While some guidance on other water-service applications is included, it is not intended to cover them fully. i.e:

- for sterile services departments, see SHPN 13: ‘Decontamination’;
- for hydrotherapy pools, see the Public Health Laboratory Service’s ‘Hygiene for hydrotherapy pools’;
- for spa pools, see the Public Health Laboratory Service’s ‘Hygiene for spa pools: guidelines for their safe operation. The report of a PHLS spa pools working party’.

Definitions

1.18 Definition of terms is as those contained in the Scottish Water Byelaws 2004.

Note 3: The water industry

Water supply

In Scotland, the various water supply authorities were not 'privatised' as in England. The various regional authorities were combined into a single entity 'Scottish Water', remaining in the public sector and hereinafter referred to as 'the water supply authority'. In April 2008 the retail function was deregulated, with competition for business customers.

Regulatory authorities

The Water Services etc (Scotland) Act 2005 established the Water Industry Commission for Scotland and the following of regulatory bodies which are also relevant are summarised below:

a. the Water Industry Commission for Scotland, which regulates the state-owned Scottish Water by the water companies, oversees the standards of service provision and protects the interests of water consumers, ensuring value for money; www.watercommission.co.uk

b. the Scottish Environment Protection Agency (SEPA) regulates the quality and controls pollution of "controlled" waters (that is, most inland and coastal waters) and protects the water resources in Scotland; www.sepa.org.uk

c. the Drinking Water Quality Regulator (DWQR) regulates the quality of supply of drinking water. www.dwqr.org.uk

2. Source of supply

General

2.1 Normally, the source of water supply to healthcare premises is by one or more service pipe connections from the mains of the water supply authority. If the quantity and rate of flow is inadequate, or if the cost of providing the service connection appears to be uneconomical, alternative sources of supply such as boreholes or wells may be investigated.

2.2 Where the constraint is only that of inadequacy of the water authority's supply, the healthcare building needs could be met by using a private supply as an additional source to the water authority's supply. In such cases, the water authority's supply should be the priority supply for drinking, culinary and special hygienic services. By limiting the use of the private supply to services not requiring the highest level of hygiene, the extent of treatment of the private supply may be reduced. Private supplies used in this way must convey water through a separate pipework system that is clearly labelled. Outlets served by the private supply system should also be appropriately labelled.

2.3 Provision should be included for alternative water supply arrangements to meet an emergency, regardless of the source or sources of supply finally adopted. Alternative arrangements would include a second service connection from the water authority or a private supply. In either case the alternative supply should not be vulnerable to the cause of loss of the original supply. Direct physical interconnection of pipework and valves of a water authority's supply with any private supply without adequate backflow protection is prohibited by the Water Supply (Water Fittings) Regulations 1999. The water quality requirements applicable to the main supply apply also to any alternative supplies.

2.4 The water authority must be advised if it is proposed to use any private supply as well as the water authority's supply, and advice should be sought on the limitations imposed in respect of break cisterns and interconnection thereafter as required by the Water Supply (Water Fittings) Regulations 1999.

2.5 In Scotland all water intended for human consumption is required by legislation to comply with the quality standards laid down by the Drinking Water Quality Regulator (DWQR) with powers as laid down in Section 7 of the Water Industry (Scotland) Act 2002. DWQR can force the statutory water authority to comply with the standards set out in the Water Supply (Water Quality) (Scotland) Regulations 2001. These regulations apply to water sampled at the point where the water is available for use and also embrace water used in the preparation of food and beverages.

2.6 The responsibility for enforcing this legislation for public water supplies rests primarily with the Drinking Water Quality Regulator and the water supply authority and the legislation also covers private water supplies. In respect of public water supplies, the water supply authority has a duty to provide a wholesome supply and to demonstrate – by monitoring – that the supplies meet the standards required.

Supplies from a water supply authority

2.7 The following factors should be taken into consideration in the initial stages of the design:

- the water supply authority's requirements;
- the estimated daily consumption, and the maximum and average flows required, together with the estimated time of peak flow;
- the location of the available supply;
- the quality, quantity and pressure required;
- the cold water storage capacity required;
- the likelihood of ground subsidence due to mining activities or any other reason;
- the likelihood of there being any contaminated land on site;
- the proposed method of storage and probable number and purpose of direct connections to pressure mains;
- the minimum and maximum pressures available at the service connection;
- details of the physical, chemical and microbiological characteristics of the water supply and scope of any possible variations in such characteristics;
- the possibility of an alternative service connection from some other part of the water authority's network, including pressure details;
- the water authority's (see Note 3) contingency plan in the event of no water supply for whatever reason.

> **Note 4:** Regulations require notification to the water supply authority of any proposed changes and additions to the water supply system in the premises. Prior to making any changes, a risk assessment should be carried out and audited by an independent assessor.

2.8 These initial design investigations should normally reveal the need for any further treatment, pressurisation and storage of the water authority's (Note 3 refers) supply to meet healthcare building requirements and enable an estimate of costs to be made.

2.9 BS6700: 2006, successor BS EN 806-1-5: 2000-2012 and BS8558: 2011 give further guidance on the procedures that should be followed when carrying out preliminary investigations in relation to new water supplies. (Paragraph 3.11 in Part B also refers)

2.10 During the design stage, close collaboration with the water supply authority should be maintained, and consent must be sought on the final arrangements before proceeding with the installation. These arrangements should include:

- siting of service connection, access chamber, metering, bypassing, flushing out, physical security of service connection, installation and provisions for the fire-fighting service;
- compliance with the Water Supply (Water Fittings) Regulations 1999.

Private supplies

2.11 Private supplies independent of the statutory water authority (see Note 3); are also governed by the Water Supply (Water Quality) (Scotland) Regulations 2001 and 2010. A license is required from the Scottish Environment Protection Agency (SEPA) before embarking on any private water supply scheme. If, for any reasons of back-up or security of supply, there is a connection to the public supply (regardless of whether, or how often, it is used), the installations must comply with the Water Supply (Water Fittings) Regulations 1999. Private supplies should be registered with the statutory water authority that has the responsibility to monitor the wholesomeness of the supplies where these are used for domestic or food production purposes.

2.12 The standards for private water supply quality are very similar to those for public supplies. Reference should also be made to the Standing Committee of Analysts' (2002) 'The microbiology of drinking water'.

2.13 SEPA keeps records and maps of all known sources of private water supply together with details of the geological strata and water-bearing characteristics of the area under its control.

2.14 The feasibility of such a private supply should be decided by comparing the capital costs (of the construction of works, including mains, pumping plant, treatment plant etc) and revenue costs (of electricity for pumping, water treatment chemicals, direct and indirect maintenance and associated management costs, regular water analysis tests etc) with the long-term cost of water supply from the water authority over the predicted life-cycle of the installation. Due consideration should be given to the long-term costs of a private supply, and account should be taken of potential deterioration in water quality and/or capacity of the private supply source.

2.15 Where consideration is being given to the use of a private supply, specialist assistance should be sought to:

- confirm the long-term availability of water in sufficient quantity, which is either of proper quality or suitable for treatment;
- confirm the long-term quality of water and define requirements for water treatment;
- design and specify the works needed;

- carry out a full evaluation of the costs and practicability of a private supply compared to a connection from the water supply authority.

3. Water treatment regimes

3.1 Provided water is supplied from the public mains and its quality is preserved by correct design, installation and maintenance, it can be regarded as microbiologically acceptable for use. It is exceptional, however, for a water supply, either public or private, that is wholly ‘potable’ to be entirely free from aquatic organisms, and consequently it is important that appropriate measures are taken to guard against conditions that may encourage microbial multiplication.

3.2 Reasons for treatment of water from the supply authority in healthcare premises would be for processing for laundries, domestic hot water systems and steam boiler feed water, where either the degree of hardness proves excessive or exceptional softness causes corrosion. Most private supplies, however, are likely to require some measure of treatment, and in many cases, the installation of pumping and treatment plant needs to be extensive to ensure a constant acceptable quality.

3.3 Treatment systems that are used in conjunction with potable water systems should be selected with care. Addition of any substance must not cause a breach of any requirements in the Water Supply (Water Quality) Regulations 2001 and 2010. Any substance should be approved in accordance with those Regulations, for example, by being in the Drinking Water Quality Regulator’s list of approved substances for contact with drinking water, which is included as an appendix in the ‘Water Fittings and Materials Directory’.

3.4 Automatic water treatment systems should be fail-safe and have sufficient instrumentation to monitor their operation. The water supply connections to the equipment must be adequately protected against backflow. Monitoring by means of building management systems should be considered.

3.5 In healthcare premises, both hot and cold water are considered to be potable and therefore water treatment supplied to healthcare premises must comply with current legislation on water quality.

3.6 Further details can be found in BSRIA’s Application Guide AG 2/93: ‘Water treatment for building services systems’ (with amendments) and Parts D and E of this SHTM.

3.7 The continuous chlorination of hot and cold water service systems, after initial disinfection (see Section 17), to control the growth of *Legionella* is not recommended because chlorine has a limited ability to penetrate biofilm and inactivate sessile micro organisms.

3.8 Treatment using chlorine dioxide or copper/silver ionisation can be used however, (but see Section 15, Appendix 5 and Part D of this SHTM).

4. Water softening

4.1 Hard waters are unsuitable for many industrial and domestic purposes. Treatment may therefore be necessary to remove or alter the constituents to render the water suitable for particular purposes.

4.2 Hardness is due to calcium and magnesium salts in the water and is expressed in terms of milligrams per litre as calcium carbonate ($CaCO_3$). Temporary (carbonate) hardness is related to the bicarbonate salts of calcium and magnesium. Permanent (non-carbonate) hardness is related to the other salts of calcium and magnesium, that is chlorides, sulphates, nitrates etc. The generally accepted classification of waters is shown in Table 1, below.

Description	Milligrams per litre (mg/litre as $CaCO_3$)
Soft	0 to 50
Moderately soft	50 to 100
Slightly hard	100 to 150
Moderately hard	150 to 200
Hard	200 to 300
Very Hard	Over 300

Table 1: Classification of water hardness

4.3 When the temperature of water is raised, the hardness will be reduced by some of the dissolved salts (temporary hardness) coming out of solution and forming solids in suspension, some of which will be deposited on heating surfaces to form an adherent lime scale, thus reducing the heat transfer rate.

4.4 The extent of treatment required to prevent scale formation will depend upon the process for which the water is being heated; it may therefore be necessary to achieve one of the following conditions:

- replacement of calcium and magnesium salts by their more soluble sodium equivalents;
- removal of all salts, that is, demineralisation;
- where water of greater purity is required for specialised uses, it can be produced from softened water by reverse osmosis or by demineralisation.

4.5 Softening is not considered necessary for palatability. In some instances the softening process makes the water less pleasant to taste without affecting the potability.

4.6 Epidemiological studies have shown that the incidence of cardiovascular disease tends to be higher in areas with soft water supplies than in areas with hard water supplies. The association is clearest where the soft water supplies contain hardness below about 150 mg/litre (as $CaCO_3$).

The explanation is not known, but it is considered prudent, where possible, not to drink water that has been artificially softened to concentrations lower than this. Softened water may also tend to dissolve metals from pipes. Water softeners containing ion-exchange resins may be subject to bacterial contamination if not adequately maintained. Softeners using salt-regenerated ion-exchange resins increase the sodium content of the water during softening, and this may be undesirable for children and anyone on strict salt-restricted diets. These concerns can be avoided if water intended for drinking and cooking is not softened.

4.7 Waters having a hardness of up to 400 mg/litre have been used for public supplies without preliminary softening. While it is accepted that supplies for domestic purposes need not be softened, partial softening may be carried out by the water supply authority (see Note 3).

4.8 The need for softened water in hospitals for domestic purposes other than drinking and cooking should be considered on the merits of each case. If treatment is considered essential, the extent of softening should be the minimum to achieve an acceptable level. A generally acceptable level is between 80 and 150 mg/litre, and not less than 60 mg/litre, but this should not be taken as a requirement for hospitals as it may be impracticable to achieve. The cost and difficulties of treatment may be prohibitive for certain waters if the hardness value is particularly high and the content of magnesium is appreciable.

4.9 Generally, within healthcare premises, softening of a hard water supply will be required on feeds to the following:

- boilers and hot water supply systems – to prevent sludge and lime scale building up in pipework and plant (see BS2486:1997);
- mixing devices and blending valves – to avoid clogging of control ports and showerheads by lime scale;
- laundries – high maintenance costs and the uneconomic uses of soap or detergents are caused by the presence of hardness.

Note 5: Problems often occur in thermostatic mixing valves whereby scale is deposited as a result of hard cold water being heated in the blending process.

4.10 The most common water-softening process used for the protection of hot water calorifiers is base-exchange softening. This process removes permanent and temporary hardness from water. The technique uses an ion-exchange process in which the calcium and magnesium ions in solution are removed and replaced by an equivalent number of sodium ions. This method of water softening is not recommended for drinking water or water for culinary use, since a raised level of sodium is associated with heart disease.

4.11 Other water softening methods include physical water conditioning and magnetic water conditioning. Physical water conditioners function by triggering the growth of nuclei or seed crystals in the water. When the water is heated or subjected to pressure change, dissolved salts precipitate onto these seeds to form crystals, which do not adhere to the sides of the pipes and are washed out with the flow. Some hard scale will still form, but it will be dissolved provided sufficient seeds are created. The main problem is to ensure an adequate supply of the seed crystals, which have a relatively short life before they are absorbed back into the water. The efficacy of these water-conditioning measures needs to be considered.

4.12 For further details on processes which control scale formation in hot water services systems, refer to BSRIA's Application Guide AG 2/93: 'Water treatment for building services'.

5. Filtration

General

5.1 Scottish Hospital Technical Note (SHTN) 2 (second edition) was published in December 1999. Its guidance reflected examinations at the time of domestic water systems in Scottish Hospitals where water had been supplied by the water supply authorities who used chlorine as a disinfecting agent. It also dealt with the adverse impact on copper tube installations in many parts of the country and listed suitable alternatives.

These examinations revealed significant deposits of sediment and debris in pipework that could provide an environment conducive to the development of bacteria through, for instance, the generation of biofilms. Filtration was recommended to:

- ensure that the domestic water supply and associated pipework was maintained at a high standard of cleanliness throughout the system;
- reduce the accumulation of sediments that may promote the growth of water-borne organisms.

SHTN2 has been updated and expanded to become Part E of this SHTM.

5.2 Filtration need not be provided for cold water for non-domestic use, for example, fire-fighting, boiler-feed or other chemically treated or dosed systems unless there is a significant and regular suspended solid carry over from the public water supply.

5.3 Anecdotal evidence suggests that there has been some improvement in water quality following recent examinations of domestic water systems in a number of Scottish healthcare premises with reduced deposits of sediment and debris in pipework and storage tanks. It should be stated, however, that organic matter is a significant source of solids and, as this is a seasonal issue, the evidence currently available should be treated with caution as it may have been derived during periods of low organic contamination.

5.4 On-site filtration has been regarded by some as an optional provision despite its inclusion being mandatory since 1999. It is stressed that opting out of installing such plant should *not* be the default situation. Any decision to exclude filtration would be dependent on careful consideration of the following issues. This list is not exhaustive:

- whether a project comprises an additional building (or buildings) on an existing site without filtration plant;
- a risk assessment taking into account the type of accommodation served;
- a risk assessment based on the type and vulnerability of patients served;

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- an assessment of the practicality of introducing filtration for the likes of a ward refurbishment project that involved extending or upgrading part of an existing (unfiltered) system;
- analysis of samples of incoming water supplies.

The last issue is particularly important. In existing premises, an examination of maintenance records would determine whether strainers were routinely becoming clogged as an indicator of a history of suspended solids being present in the water authority's incoming supplies.

Before the installation and maintenance of on-site filtration plant is dismissed as an unaffordable burden, the following **benefits and associated savings** must be balanced against capital and revenue costs of filtration plant.

- the requirement for periodic removal of sediment from storage tanks is eliminated along with the precautions associated with working in confined spaces;
- the need for a separate or divided storage tank to allow supplies to be maintained during sediment removal is eliminated;
- cold water storage tank lids would not require to be completely and readily removable for access to clean and de-sludge, leaving only the need to provide inspection covers;
- the amount of suspended solids carried into the piping network would be virtually eliminated as they would be retained within the filtration plant so that strainers could be omitted from shower thermostatic mixing valve assemblies. In filtration retrofit situations, existing strainer cartridges could be removed. In these situations removal of strainers would also remove a catchment for biofilm and bacteria build-up.

Description

5.5 Where it has been determined to install on-site filtration plant, the following guidance will apply.

5.6 Where filtration is provided it is normally used to prevent ingress of suspended solids into plant and pipework, and as such may be defined as the process of separating solids from liquids using a porous medium. The medium can consist of granular materials (sand, clay, carbon etc) assisted by chemical and/or bacterial activity, woven meshes and screens made of metals, fabrics, ceramics and polymeric membranes.

5.7 Filtration plant is usually specified by various criteria including minimum particle size retained, expressed in microns (μm). 'Absolute filtration' of a given size indicates that the plant can remove 99.9% of all particles above a given size. 'Nominal filtration' is normally taken to mean that 95% of all particles above a specified size will be removed.

5.8 As a guide, suspended materials are normally classified according to Table 2, overleaf.

Material	Particle diameter	
	mm	µm
Pebbles	>10	-
Gravel	10 - 2	-
Very coarse sand	2 - 1	-
Coarse sand	1 - 0.5	1000 - 500
Medium sand	0.50 - 0.25	500 - 250
Fine sand	0.25 - 0.10	250 - 100
Silt	0.10 - 0.01	100 - 10
Clay	<0.01	<10
Colloid	10-4 - 10-6	0.1 - 0.001

Table 2: Particle size

5.9 In practice, water will contain a range of sizes of suspended particulates. The rate of blockage by suspended solids for any given filter will depend on a number of factors such as:

- throughput;
- concentration of suspended solids and other fouling debris;
- size distribution;
- shape of particles.

5.10 Particles less than 0.1µm are invisible microscopically. The smallest visible macroparticle is approximately 40µm. Particles less than 0.001µm are considered dissolved and in solution.

Capacity

5.11 To accommodate the variation in flow, and to allow for filter changes etc, the equipment should be installed with redundancy built in.

Design features

5.12 The level of filtration where thermoplastic pipework systems are installed should be 5 micron absolute.

5.13 The level of filtration where stainless steel pipework systems are installed should be 0.5 micron absolute. If the stainless steel pipework manufacturer is prepared to give a written guarantee offering a lifespan of the installation that is not less that in CIBSE “Guide to ownership, operation and maintenance of building services”, the level of filtration can be relaxed to 5.0 microns.

5.14 For small establishments (such as health centres and clinics), it will normally be appropriate to use filters with cartridge or membrane elements (see also paragraph 5.19). This form of filtration may also be appropriate for larger premises but would be a function of water quality, user demand and patient category.

5.15 In larger establishments and those with high water usage, the filtration equipment plant should be fully automatic in operation and include self - cleaning and back-washing modes so that the filter medium does not become a reservoir for organisms capable of contaminating the service pipework. To allow for servicing of the plant, a bypass line with strainer filter should be provided, complete with isolation valves and non-return valves. The bypass should be provided with drains and vents to facilitate disinfection prior to bringing it into service.

5.16 As an alternative to the installation of a bypass strainer, the provision of two units to operate sequentially with automatic changeover on a regular basis will minimise potential failures and maintenance. Precautions should be taken to minimise stagnation of water in the dead-legs that may occur with this arrangement – weekly flushing of dead-legs should take place.

5.17 All items in contact with water must be of materials that comply with the Scottish Water Byelaws 2004 (for example, materials approved by the Water Regulations Advisory Scheme and listed in the WRAS ‘Water Fittings and Materials Directory’, having been assessed and shown not to have adverse effects on water quality).

5.18 Parameters essential for the continued performance of the plant should be automatically monitored, for example downstream pressures and automatic cycling of back-washing facilities. These should be relayed to a building management system.

Point-of-use filtration

5.19 Point-of-use filters have been found to provide protection from exposure to bacteria such as *Legionella and Pseudomonas* by preventing the dispersal of bacteria from showers and other water outlets. To be effective, the filter membrane needs to have a nominal pore size of no greater than 0.1µm. Before their use is contemplated, two factors should be considered:-

- the filters do not eradicate the organism, but prevent discharge to the environment from the filtered outlet only;
- by retaining the organism within the pipework, it may be possible for the organisms to multiply and regressively ‘seed’ other parts of the distribution system.

Filters will also need to be changed routinely, depending on usage of the outlets. Their use, therefore, should be considered only as part of an overall regime of bacterial control to be used where the most vulnerable patients are to be treated. Installation of point-of-use filters should be subject to risk assessment and designers should be aware of the reduced flow that will arise from increased resistance. This could be an issue on upper floors of premises with a gravity-fed installation. Once a point-of-use filter has been installed it will require to be retained in use thereafter unless a risk assessment deems otherwise. In new or refurbished installations taps should be provided that can accommodate the later installation of point-of-use filters if the need arose.

6. Metal contamination

6.1 Copper piping has not been routinely specified for Scottish hospitals since 1999 (Scottish Hospital Technical Note 2 refers) and the following section applies to existing installations where extensions are being provided retaining the existing specification or to very small, stand-alone facilities, or to temporary accommodation with a short life-span.

6.2 Analytical results have shown that there can be a serious problem from lead contamination of water supplies. The Water Supply (Water Quality) Regulations 2001 and 2010 set an upper concentration for lead in drinking water of 0.01 mg/litre to be achieved by 2013. This value is likely to be exceeded if lead pipes are present or if copper pipes have been joined with solder containing lead. In general, if hospital drinking water contains more than 0.01 mg/litre of lead, remedial action should be taken. The use of lead solder is prohibited on all plumbing installations where water is required to be wholesome.

6.3 Copper concentrations above 1 mg/litre may cause staining of laundry and sanitaryware and increase the corrosion of galvanised iron and steel fittings. Although the maximum allowable copper concentration in drinking water is 2 mg/litre, most supplies will give a level at the tap of less than 1 mg/litre.

6.4 Water supplies to certain specialist units such as maternity, neo-natal paediatric, general paediatric and renal dialysis units (see the Renal Association, 2002) should be monitored to ensure that water quality is within acceptable limits. The designer should seek epidemiological advice to ascertain the exact water quality requirements for specialist units.

6.5 Where the water supply is known to dissolve metals (that is, soft water), regular sampling should be carried out at strategic sampling points to ascertain that the level of metal contamination in the water supply to the premises, plus any added during its passage through the distribution system, does not result in limits above the stated safe levels. This will especially apply if the distribution pipework includes a multiplicity of leaded solder capillary joints. In soft water areas, metal contamination can occur by simple dissolution. Pitting corrosion arising in hard water areas, as a result of deleterious carbonaceous films laid down during the manufacturing process, does not normally give rise to elevated copper levels in the water and is not nowadays a problem if independently certified tubes to BS EN 1057: 1996 are used. Excessive use of acidic flux in the making of capillary joints can lead to corrosion of copper plumbing, especially if the system is allowed to stagnate after commissioning. WRAS Information and Guidance Note 9-04-02: ‘Solder and fluxes’ (available on its website http://www.wras.co.uk) gives further information on solders and fluxes.

6.6 If the proposed water supply is likely to take up metals in excess of acceptable limits, it will be necessary to consider treatment of the water such as raising hardness.

7. Water storage

General

7.1 Where there is an interval of time between final testing and commissioning of domestic hot and cold water systems, the systems should be drained dry until put into use. This may be impractical and moisture could be retained on pipe internal surfaces leading to the proliferation of harmful microorganisms. Alternative procedures would comprise either pressure testing with air or inert gas or leaving systems filled with over-chlorinated water – all subject to risk assessments. This will include storage, where provided. The design and installation of the system must be such as to facilitate effective draining. Further guidance can be found in Part E of this SHTM.

Water is stored in healthcare premises for the following reasons:

- to provide a reserve supply during failure of the main cold water supply;
- to reduce the maximum demand on the cold water main;
- to provide accommodation for the expansion of any water subjected to heat, that is, hot water and heating services;
- to reduce the pressure from that of the distribution system.

7.2 The purpose for which the storage is used can vary, but has only a minor effect on its design. The following generally covers the range of uses:

- cold water services, domestic, laundry etc;
- cold water feed to hot water services;
- drinking water supplies;
- treated cold water for laundries, heating etc when local supplies are unsuitable;
- break tanks on cold water supplies serving points of use where backflow is, or is likely to be, harmful to health due to a substance representing a serious hazard, for example, supplies to pathology laboratories;
- feed and expansion for heating service;
- fire-fighting.

Extent of storage

7.3 There is a conflict between the water supply authority's desire to have 24 hours water storage and the requirements of HSE L8 which recommends 12 hours, the latter being intended to maximise turnover and avoid stagnation of stored water. The requirements of each individual project require risk assessment and discussed with the water supply authority at the earliest possible design stage. Storage should be designed to minimise residence time in the cistern and maximise turnover of water to avoid stagnation and deterioration of water quality. Storage volume should be calculated on the basis of peak demand and the rate of make-up from source of supply. There may be more than one peak period in each 24 hours. The interval between peak periods is important as it affects the storage capacity based on the make-up flow. It also determines the available time for maintenance if twin cisterns are not installed. Where multiple storage tanks are to be incorporated the total storage should be split among the two or more tanks that may be provided.

7.4 Appendix 1 is based on the results of studies into water consumption in various types and sizes of hospitals. CIBSE Guide G: 'Public health engineering' gives further guidance on sizing cold water storage. While it is accepted that the desirable minimum for total storage will vary with the classification of the particular health building, the upper limit of storage for a district general hospital is 900 litres per bed per day and for a teaching hospital 1,350 litres per bed per day, excluding provision for the staff residences, laundries and any special storage for fire-fighting purposes.

7.5 It must be borne in mind that the overall pattern of healthcare is changing and the data available now is a best estimate of what is required. The guidance in Appendix 1 is known to overestimate water usage in healthcare premises and, moreover, yields data in litres per second. Reference should be made to SHTM 04-01 Part E. (As an example, a hospital of between 400 and 600 beds might consume 100,000m^3 of water annually, that is, about 11 m^3/h over a 24-hour period. Peak hourly demand, however, may reach 50 m^3/h.)

7.6 A summation of the average daily consumption for each ward unit contained in a building should be made. From the requirements of each building, the policy of water storage for the whole complex should be decided. It does not always follow that peak demands for each building will coincide, and therefore there may be scope for applying a diversity factor to the whole site.

7.7 Where the water requirement is to be met from a private supply, the summation for each building may require assessment on the basis of storing and using water according to the minimum treatment of the water for each particular use. Likewise, where the water is hard enough to require softening for certain domestic and/or laundry purposes, separate storage will be required, and this should be taken into account when assessing the total stored water.

7.8 Appendix 1 does not cater for water requirements for staff quarters or such support services as laundries, bulk stores and workshops etc. The staff quarters and industrial areas may be remote from the main hospital and supporting departments. The laundry may serve a number of healthcare buildings as well as the premises at which it is located. The storage requirement for such accommodation should therefore be calculated separately and integrated with the accommodation whenever this is practical. Appendix 1 provides data on typical demands expected from staff residences.

7.9 Where new healthcare premises are to be built in separate phases, the water storage, supply and distribution service for the whole premises should, as far as possible, be planned and evaluated at the design stage. This will enable the total water supply requirement to be assessed in the planning stages, and appropriate areas of accommodation (but not tank storage) to be allocated.

Location and form of storage

7.10 It is more convenient and more secure to house water storage cisterns at sufficient height to provide adequate flow to all parts of the development by gravity, thus avoiding reliance on pumps etc. This is achieved by siting cistern rooms at roof level. Where buildings are widely dispersed, it is preferable to install a number of smaller cisterns rather than building a water cistern tower.

7.11 The location of storage will depend on the total volume required, the topography and layout of the site proposed for development, and the sources and adequacy of the water supply. A limited site footprint may call for much higher buildings to achieve the required accommodation. Depending on the supply water pressure, it may be necessary to install pressurisation equipment to boost the incoming supply. The cost of the supporting structure will have an important bearing on the solution adopted.

7.12 A hospital built on a restricted site might need both central and local storage to be provided in each building or in one of the buildings to serve other buildings in the development. Local storage at high level should give an average supply of about four hours if gravity-fed, but if the building structure will economically accept greater tankage this should be adopted. The total supply should be based on the average usage over 24 hours. There are some advantages in locating central storage at low level, for example easier access for maintenance, and reduced structural costs.

7.13 Where such storage is located in individual buildings and an adequate supply is available from the water authority (see Note 3), a connection in accordance with the Scottish Water Byelaws 2004 to each point of storage may be the most economical arrangement. In such cases, interconnections between selected points of storage should be provided to deal with emergency and maintenance requirements, always providing that such interconnections do not contravene the Scottish Water Byelaws 2004 and do not result in water stagnating within the storage or distribution system. Where the development is widespread and a water authority's multiple connections are not the best solution, the general arrangement might consist of a total storage reservoir, strategically sited, serving cisterns located as conveniently as possible to the major centres of usage.

7.14 To maintain good water quality, however, common practice favours the use of smaller decentralised storage capacity as opposed to large central storage and distribution. The use of smaller local cisterns helps to avoid the problem of water stagnation in cisterns and also avoids long runs of distribution pipework between cisterns and points of use. Shorter pipework runs reduce the amount of heat gain in the cold water service *en route* to points of use.

7.15 Although the final assessment of the capacities of storage cisterns will emerge from the design requirements of Appendix 1, the building's structural design will influence the number of cisterns required and the cistern layout. Standard sizes of tank should be used where possible.

7.16 Cisterns must not be located in any position where there is any likelihood of flooding, excessive heat gain or any other factor that could affect the contents of the cisterns. They should not be installed in any location where access for general inspection or maintenance is restricted.

7.17 Separate systems should be provided for pathology and mortuary departments.

External storage

7.18 The ideal location for external cold water storage cisterns is the roof of the highest building, provided the structural design can support the load. If concrete water cisterns are to be considered, they should be designed to form an integral part of the building structure. The materials of construction, however, must comply with the Water Supply (Water Fittings) Regulations 1999.

7.19 Where storage is below ground, as distinct from being housed within a building, it is essential to ensure that there is no risk of contamination. Investigations of such risk require careful consideration of site conditions and should include such aspects as flooding; subsidence; the location of sewers and drains and other buried services; the maximum and minimum height of the water table in the area; the natural drainage of surface water; ingress of contaminants such as dust, debris etc; and, in the event of storage below a car parking area or roads, the danger of oil/fuel seepage. The future development of the healthcare building and probable extensions should also be taken into account in this respect.

7.20 Storage below ground should be adopted only as a last resort, and cisterns should be installed within a watertight bund allowing sufficient space all around and beneath the storage vessel to permit inspection and maintenance. Any underground construction arrangement, concrete or otherwise, not directly against earth will reduce the risk of contamination. The tank chamber must include provision for a sump to collect drainage water and any piping necessary to pump out tanks to the site drainage. The Scottish Water Byelaws 2004 require any buried concrete reservoir to be designed, constructed and tested in accordance with BS8007: 1987.

7.21 The economic depth for reservoirs constructed in concrete is a function of the quantities to be stored. It should be considered at the outset of the planning stage, and will be influenced by load-bearing characteristics of the locality and take account of the outlet main's position and particulars. If it is found necessary to exceed a depth of 3.3m, a specialist should be consulted. A rectangular or square concrete reservoir will generally provide a more economic proposition than one or more circular reservoirs.

Internal storage

7.22 As in the case of external storage, cisterns should be installed in positions where they can be readily inspected and maintained and where they will not be affected by frost or high temperatures.

7.23 It is essential in all cistern installations that a clear working space of not less than 0.5m – but ideally 1m – is maintained around the cistern. Minimum clearances of 0.5 m below and 0.75m above the cisterns are necessary to facilitate erection, inspection and maintenance. A minimum of 0.5m should be provided between the floor of the catchment basin and the underside of the cistern.

7.24 Roof spaces in which cisterns are to be installed must have adequate trap doors or other means of access and adequate lighting to facilitate inspection and maintenance.

Note 6: Reference should be made to SHTM 08-07 “Confined Spaces: policies, procedures and guidance” originally published by Health Facilities Scotland, 2012. Traditionally, access for internal inspection, cleaning, etc has been by means of access panels in lids. This gives rise to difficulties in extracting maintenance personnel in the event of illness where there is restricted space between the top of a tank and the soffit. It is therefore recommended that a preferred solution would be to specify side access panels in new build, replacement and refurbishment situations

Construction of cisterns

7.25 All storage cisterns should be constructed in accordance with manufacturers' recommendations and should comply with the Water Supply (Water Fittings) Regulations 1999, be WRAS-approved, and comply with BS6700: 2006, BS EN 806-1-5 2000-2012 and BS8558: 2011. Glass-reinforced plastic (GRP) tanks should comply with BS EN 13280: 2001. The WRAS Information and Guidance Note 9-04-04: ‘Cold water storage systems – design recommendation for mains supply inlets' provides useful advice regarding the design of the inlet arrangements to ensure compliance with the Regulations.

7.26 Depending on size and/or capacity, tankage should be divided into convenient compartments suitably interconnected and valved to facilitate cleaning, disinfection, repair, modification and inspection without seriously disturbing the cold water service. Tank strengthening shall be by means of stainless steel tie-bars and not baffle plates. Where multiple tanks are provided they should be connected in series. Where tanks are connected in parallel and served via ball valves it is impossible to divide the flow equally due to inequality of levels and pipework configurations. A solution to this would be to use a pumped supply with level sensors that would allow the tanks to be drawn down and refilled together.

7.27 Separate cisterns should also be provided for storage of different water supplies, for example cold water storage, recovered or recycled water, softened water and fire-fighting water. Precautions must be taken to ensure that mixing does not take place between such supplies, and it should be noted that isolation by means of shut-off valves between them is not acceptable.

7.28 Normally the materials used for storage cisterns serving healthcare premises are predominantly GRP, but concrete or steel may also be considered. The material selected should comply fully with the Water Supply (Water Fittings) Regulations 1999. Pre-insulated sections are recommended where practical.

7.29 Sectional cisterns fabricated from GRP or pressed steel provide a convenient means of bulk storage of water at atmospheric pressure. The components can be readily transported to site and, subject to unit multiples, they can be erected to give varying proportions of length to breadth and depth. It is also possible to make provision for future extension in capacity by an increase in available base area or, within limits, depth.

7.30 If sectional cisterns are selected, designs with external assembly flanges and self-draining profiles should be used, since this arrangement facilitates easy cleaning of internal surfaces of the cisterns.

7.31 The Scottish Water Byelaws 2004 lay down the minimum requirements for potable water storage cisterns. Recommendations to comply with these are given in the WRAS 'Water Regulations Guide'. The requirements are indicated in Figure 1.

Note 7: Cisterns should be sited away from heat sources and be protected from heat gains by insulation. Adequate access should be provided for inspection and maintenance (both internally and externally).

7.32 Each storage cistern or its compartment should also be provided with the following:

- internal and external access ladders as necessary to comply with current health and safety requirements;
- a full-way servicing valve at each inlet and outlet connection, except for cisterns providing water to primary circuits or heating circuits, vent pipes, overflow pipes, and warning pipes. Where practicable, all outlets should be taken from the base of the cistern and be sited opposite to the inlet as recommended in the Scottish Water Byelaws;
- a suitably-sized drain connection complete with isolating valve. The invert of the drain connection should be positioned so as to provide maximum drainage of the cistern.

7.33 Cisterns should be adequately supported on bearers placed under the longitudinal or lateral cistern section joints. To avoid distortion, a flat section of marine ply or equivalent should be sited between the support structure and the cistern. Final siting should be in accordance with the manufacturers' recommendations.

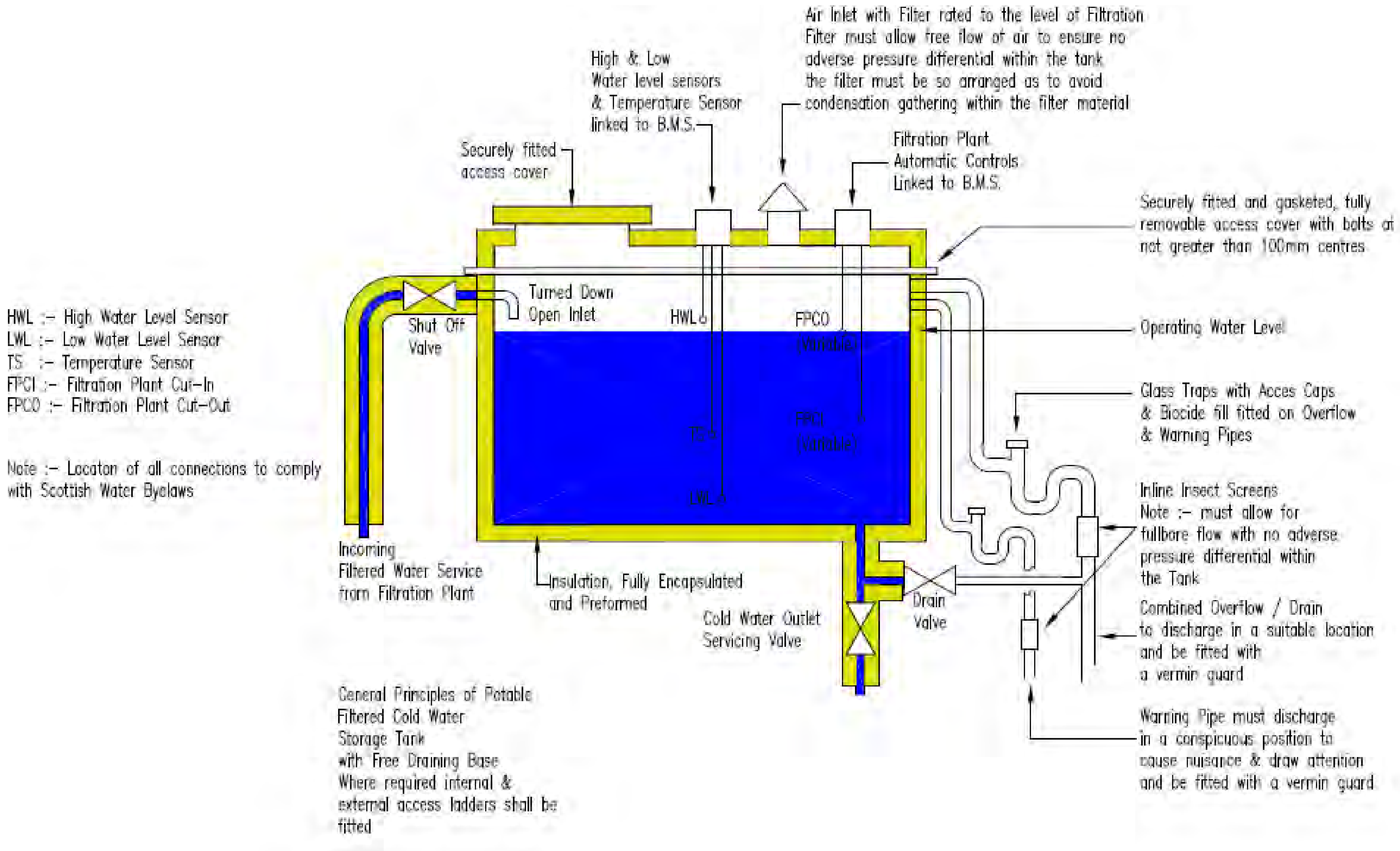

Figure 1(i): General filtered potable water storage cistern arrangements

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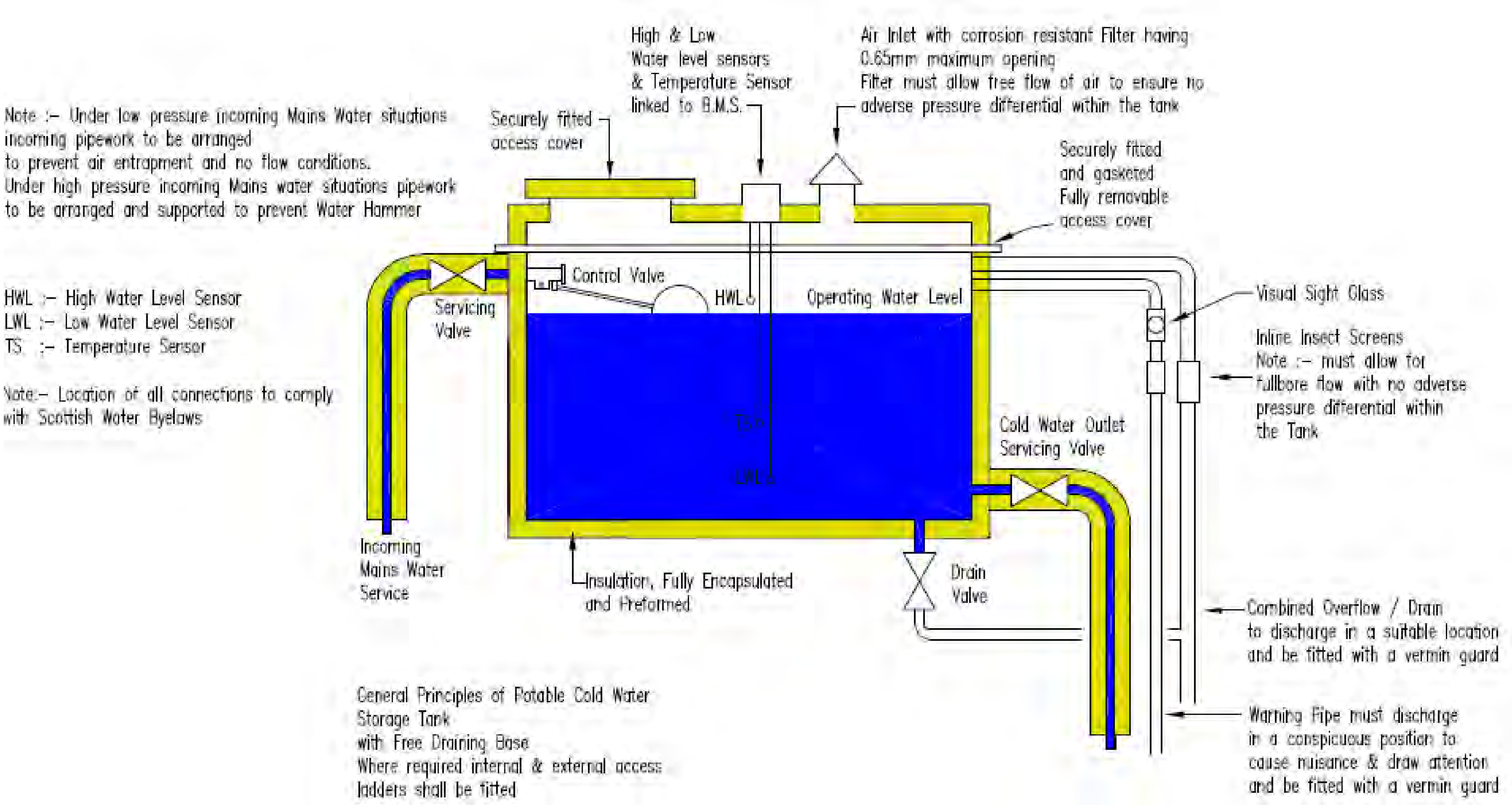

Figure 1(ii): General unfiltered potable water storage cistern arrangements

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Note 8: Where an unfiltered tank is used with a side outlet, the tank should be sized to take account of the contents from the top of the outlet.

7.34 The design may incorporate a watertight drip tray under the cistern to contain condensed water or leakage so as to avoid damage to accommodation below. The necessity for a drip tray or watertight bund with drainage will depend on individual case requirements. The floor of the drip tray or bund should be graded to a drainage sump complete with drain pipe. A single pipe should drain off any overflow water from the sump and lead to a discharge point at ground level where any water flow would be readily noticed. If it is not possible to terminate the discharge pipe from the sump so that any discharge of water can be seen, an audible alarm should be installed to warn of overflow conditions. Cistern support levels should be constructed to keep the valves clear of the water level in the drip tray or bund in the event of cistern leakage. Special requirements apply to the supporting of GRP sectional cisterns on bearers, and manufacturers' recommendations should be observed. The cistern should be provided with a warning pipe or a no less effective device to indicate leakage through the inlet control valve if this should occur.

7.35 On no account should a cistern be installed on a concrete plinth (directly or on steel beams) that is protected by an asphalt membrane. Subsequent irregular settlement into the asphalt may lead to cistern distortion and leakage.

7.36 A consideration in deciding cistern shape and layout is the location of the services duct. Whereas the cistern room may be positioned aesthetically in relation to the building elevation, the duct serving it will be located to suit the internal layout. The pipe route from the system to the service duct will require access for inspection and protection from frost and heat gain.

Cistern rooms

7.37 GRP or steel cisterns should be installed in well-ventilated but draught-proof housings constructed so as to prevent the ingress of birds, rodents and insects. The housing accommodating the cistern and the positioning of the cistern within the room must be designed to permit easy access for inspection and maintenance.

7.38 Prefabricated GRP housings, protected from extremes of temperature by thermal insulation, can provide an economical and aesthetic solution.

7.39 The load-bearing capacity of the main structure will limit the distributed load that the cistern room and its contents can impose, and will ultimately limit capacity. If, however, cisterns can be located above main service ducts or stairwells, this will minimise the effects.

7.40 General space lighting should be provided in cistern rooms, together with suitable power points for low voltage small tools and inspection lamps.

7.41 The contents and capacity of all cisterns should be clearly labelled in letters not less than 100mm high on a white background.

Ancillary pipework, valves and fittings

7.42 The arrangement of the cisterns in the room should be such that the pipework runs are as short as possible, but accessibility and walkway clearance are ensured. Flanges on parallel runs should be staggered.

7.43 Adequate allowance should be made in the pipework layout for possible future cistern extension.

7.44 All cistern-room pipework and valves should be insulated and clearly labelled to identify their purpose.

7.45 The use of delayed-action ball valves on large water storage cisterns should be considered, since these help avoid stagnation of water in the cistern.

7.46 Strainers should be fitted within the water pipework system to protect thermostatic valves etc against ingress of particulate matter. The installation of these fittings should allow adequate access for maintenance/replacement, and they should be provided with means of upstream and downstream isolation. (see also paragraph 5.4, however) Strainers can be a source of *Legionella* and other waterborne bacteria and should be included in routine cleaning, maintenance and disinfection procedures (see Section 7, Part B).

7.47 Service isolation valves should be fitted to all pipework preceding sanitary tapware and WCs etc for servicing, repair or replacement. Drain-valve provision may also be appropriate for certain installations, for example, service pipework to en-suite facilities etc.

Shower heads:

7.48 L8 requires shower heads to be disinfected (quarterly or) as necessary. This imposes significant maintenance and cost burdens to be accommodated from limited staff and financial resources.

The following options are available to NHS Boards:

- disinfect individual shower heads, progressively, one at a time;
- carry a float of shower heads, pre-disinfected, and replace those in use as part of a campaign change whereby the displaced shower heads would be disinfected in batches and become the next float. This could involve all shower heads or involve economical or convenient batches, depending on the number involved;
- remove shower heads due for disinfection, discarding them for replacement by new shower heads.

The policy adopted will be influenced by the practicalities involved, the number of shower heads to be dealt with and the overall alternative costs. Whichever solution is decided upon will require to be auditable. This will involve the provision of a unique identification for each shower.

Flexible hose within shower assembly

7.49 The various options for disinfection or replacement of shower heads also apply to the associated flexible hoses and reference should be made to paragraph 11.35 regarding the specification for linings. In the event that a disinfection policy is followed the flexible hoses are regarded as an integral part of the shower mixing valve assembly. The shower heads *and* hoses should be dried following disinfection and stored in dry conditions until required for use, otherwise the whole process will have been nullified. If a replacement policy is adopted, the attached hose assemblies should be replaced along with the shower heads.

Buffer vessels for cold water boosting sets

7.50 Buffer vessels are typically vertical in orientation and normally have a diaphragm to separate the water from the gas space above. They introduce a potential problem of colonisation by *Legionella*, as the plantroom space temperature will exceed that of the incoming water. They should preferably be of a design such that water flows through the vessel, entering at low level, and discharging at a higher level below the water line. Interconnecting pipework should be kept to a minimum, and the vessel should be insulated to minimise heat gain. All materials in contact with water should be WRAS-approved (see also paragraph 9.41).

Water meters

7.51 BS6700:2006, BS EN 806-1-5: 2000-2012 and BS8558: 2011 give guidance on the design and installation of water meters.

7.52 Revenue meters are normally supplied and installed by the water authority, whereas the consumer may install sub-meters.

7.53 Adequate sub-metering of water supplies should be provided so that supplies can be monitored for individual heavy-use departments. Such monitoring will assist in the detection of leaks or abnormal water demands. Water meters can be connected to a Building Energy Management System (BEMS), which can identify anomalous consumption and lead to the early detection of leaks.

7.54 Appropriate bypass arrangements with valves immediately upstream and downstream should be provided; the bypass loop should be as short as practicable and be arranged to be in the horizontal plane.

8. Cold water distribution system

General

8.1 The design and installation of the cold water distribution system should comply with the Scottish Water Byelaws 2004 and relevant parts of BS6700: 2006, BS EN 806-2: 2005 and BS8558: 2011. A simple cold (and hot) water system is shown in Figures 2(i), 2(ii) and 2(iii).

Note 9: All pipework to be insulated; isolating and control valves not shown; all drains should discharge to waste via a type A "air" gap.

NB: In order to prevent back flow of dirty dishwater into mains water supplies causing contamination, a WRAS fluid protection category 5 type "A" break tank now requires to be fitted to all **commercial dishwashers**. Although it is the responsibility of the purchaser of the equipment to comply, checks will be carried out by Scottish Water to verify compliance.

8.2 The installation should be designed to avoid waste, undue consumption, misuse and contamination. Every water fitting through which water is supplied for domestic purposes should be installed in such a manner that no backflow of fluid from any appliance, fitting or process can take place. An assessment of the level of backflow contamination risk (the fluid category) should be made for each fitting, appliance etc. The system should be designed and installed so that each risk is adequately protected against backflow, either by means of the design or by use of backflow prevention devices. Devices are listed in the WRAS 'Water Regulations Guide' together with the degree of backflow protection they provide.

8.3 The design of the pipework should ensure that there is no possibility of a cross-connection between installations conveying potable water and an installation containing non-potable water, recovered water or water supplied from a private source. There should be no possibility of backflow towards the source of supply from any tank, cistern, fitting or appliance, whether by back-siphonage or otherwise.

8.4 From an early stage in the design process of the water installation, liaison and consultation should take place with the designer of the building, the building owner or his agent, the water supply authority and all other public and private utilities, highway and local authorities, landowners and others involved. There is a legal duty to notify the water authority of proposed installation work and have its consent for the work before installation commences.

8.5 All cold water distribution pipework, mains and cistern down-feeds should be located, as far as is practicable, to minimise heat gains from their environment. Pipework should not be routed through hot ducts or run adjacent to heat sources, such as radiators. Where hot and cold water pipes are run horizontally together, the cold water pipe should be located beneath the hot water pipe to minimise local warming by means of convection. Cold water pipe-runs should not be installed above ceiling-mounted radiant heating panels or similar excessive heat sources. Where practical, installing cold water mains within a different floor from other heat-conveying pipework will achieve complete segregation and avoid unwanted increase of cold water temperatures.

8.6 All pipework should be insulated, except for any exposed final connections to sanitary appliances, and should be arranged to eliminate or minimise dead-legs.

8.7 The superseded Water Supply (Water Quality) (Scotland) Regulations 1990 permitted cold water to be delivered at temperatures up to 25°C. Currently, there is no standard for drinking water temperature in European or domestic legislation. In normal circumstances it should be below 20°C, but there have been recent reports in several NHS Board areas of temperatures at or well above 25°C. This appears to be a function of reservoirs containing shallow water and being more susceptible to the effects of solar heat. Anything above 20°C creates the potential for *Legionella* bacteria to breed. As far as possible, the objective should be to design the cold water systems to ensure that the inlet, outlet and surface water temperatures of cisterns and cold water feed/header tanks for the hot water calorifiers are not greater than 2°C above that measured at the main water meter. Also, at cold water draw-off points, a temperature of no greater than 2°C above the temperature measured in cistern and cold water header tanks should be reached within two minutes. However, in view of the trend to higher incoming temperatures, it is recommended that incoming temperatures are at least recorded and monitored via a BEMS installation. This will warn as to any need to dump water or invest in the provision of recirculation and/or cooling facilities, all measures of last resort.

Note 10: For the control of *Legionella* and other water-borne organisms, 20°C is the quoted lower value above which multiplication of *Legionella* in particular begins to take place (see Part B, Section 4).

8.8 The control of water temperature in the cold water service, however, will essentially rely on good insulation and water turnover. Cold water services should be sized to provide sufficient flow at draw-off points. Stagnation should be avoided. Modern buildings have a high degree of energy efficiency that can result in a build up of heat that is not readily dissipated. It is therefore necessary to achieve separation of cold water service pipework from other heat sources as void and vertical shafts temperatures can build up to the detriment of keeping cold water distribution temperatures at required levels.

8.9 Pumped circulation of cold water and refrigerated cold water should normally only be considered in specialist units where people are at particular risk as a result of immunological deficiency; for example bone marrow transplant units and certain oncology departments. Such systems require careful design. For other accommodation the aim should be to promote turnover of cold water by means of the design of the distribution circuitry.

8.10 In ward areas provided with en-suite facilities, the aim should be to supply sanitary assemblies in series, with the WC connected to the final element. Elsewhere, pipeline routeings should be run so that other outlets are connected with a WC or flushing device, for example sluice hopper or pantry sink, providing the final element at the distal end of the branch – this may require pipe routeing reversal. See Figures 3 and 4.

8.11 In other clinical areas, a similar arrangement for the distribution of cold water should be adopted.

8.12 The cold water distribution system should be designed so that the pressure is the same as that for the hot water service at draw-off points. This may require the inclusion of pressure-reducing valves in the distribution pipework. If unequal pressures exist in the hot and cold water supplies to combination taps where water mixes in the body of the tap, a single check valve is required on each feed pipe to the tap to prevent backflow of water from one to the other.

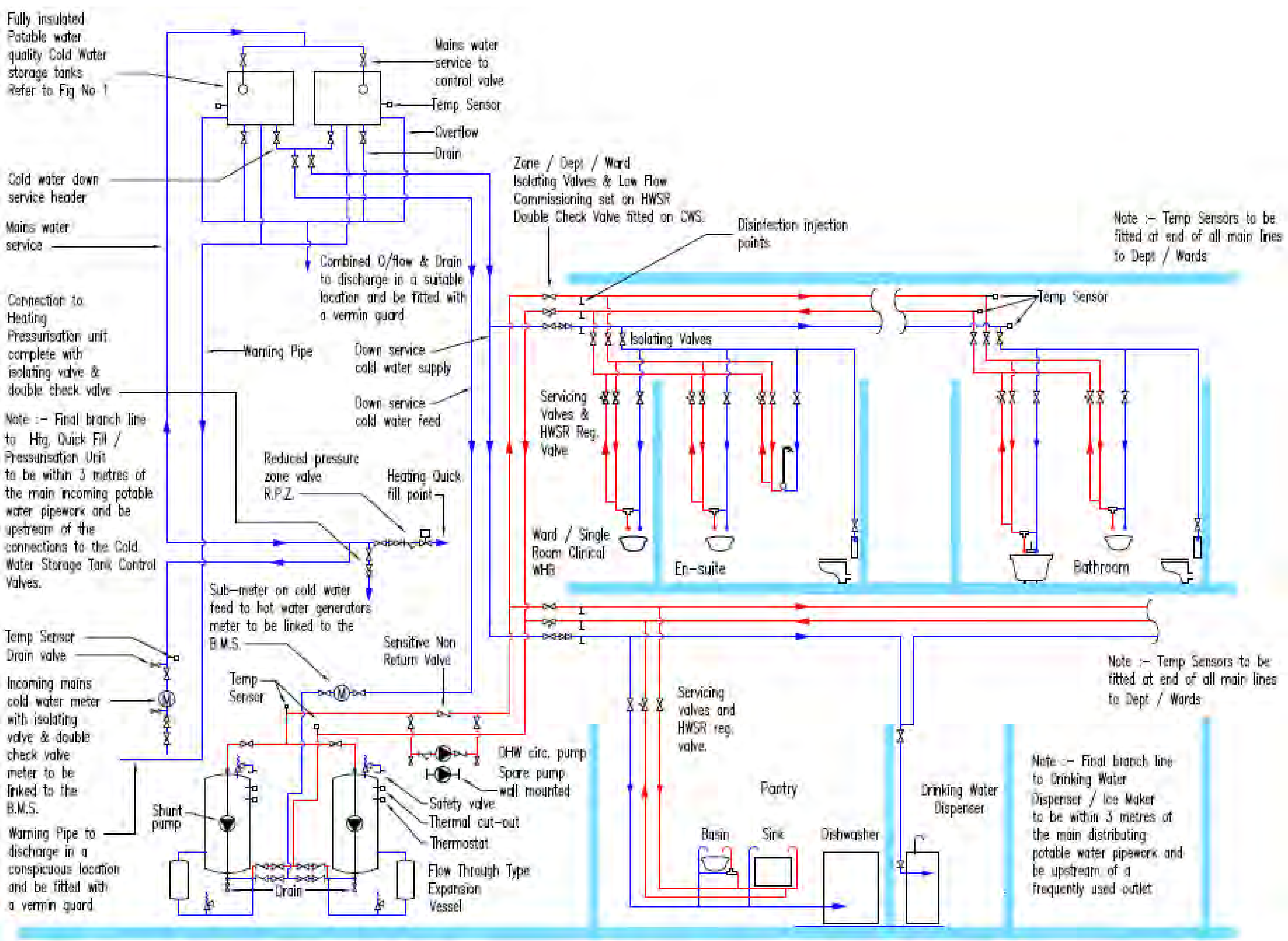

Figure 2(i): Schematic layout of a domestic hot & cold water service system with high level storage

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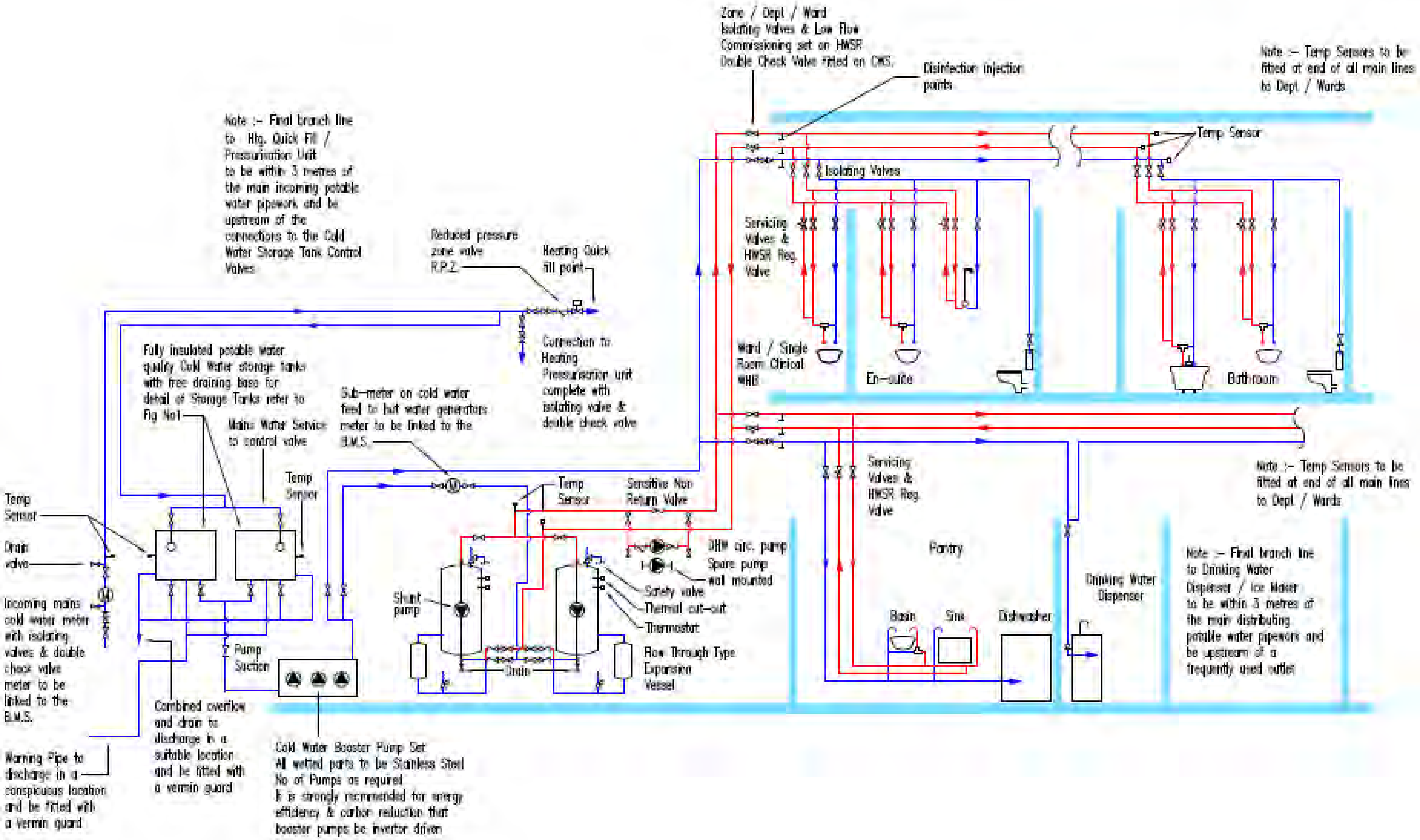

Figure 2(ii): Schematic layout of a domestic hot & cold water service system with low level storage and booster pumps

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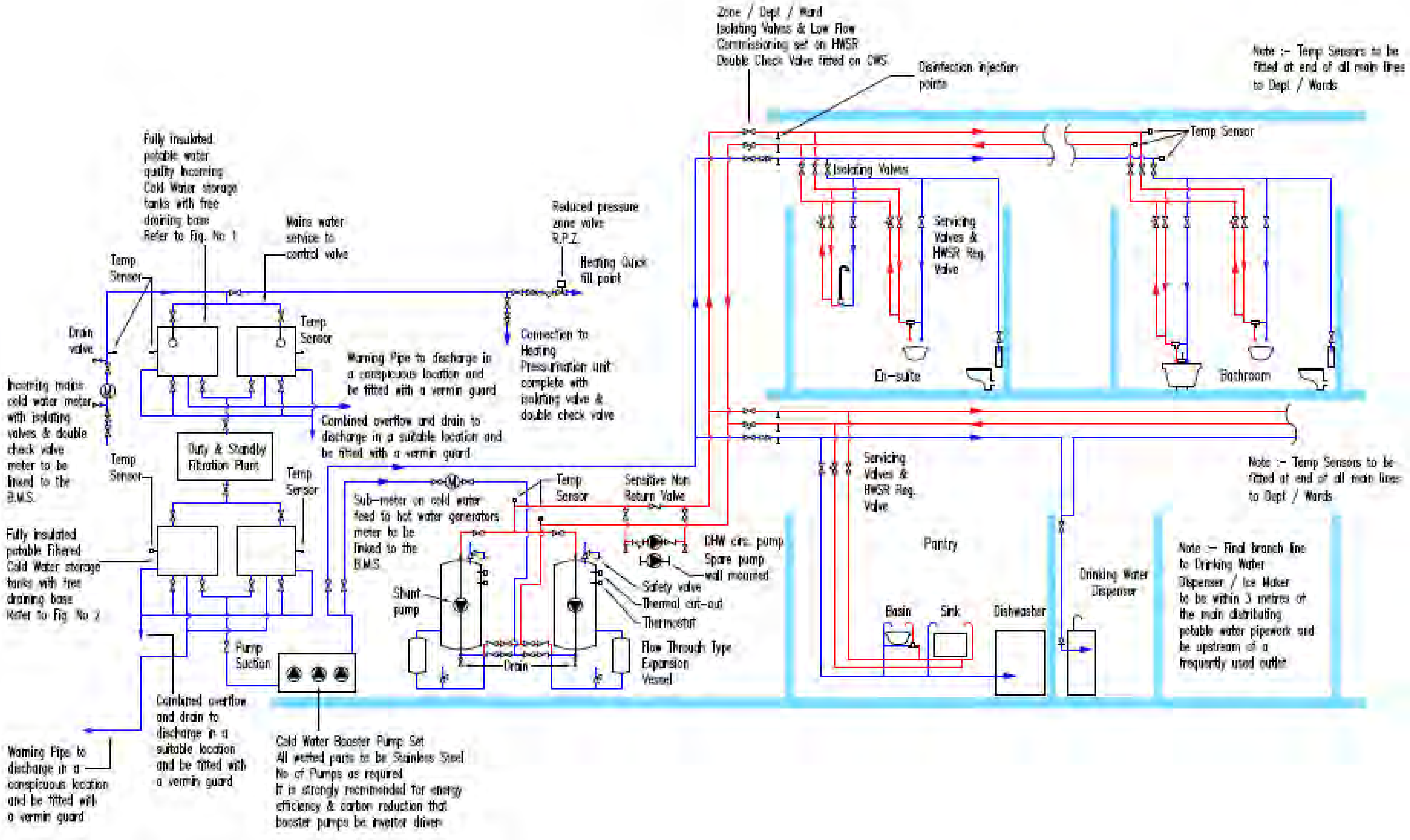

Figure 2(iii): Schematic layout of a domestic hot & cold water service system with low level storage, booster pumps and filtration plant

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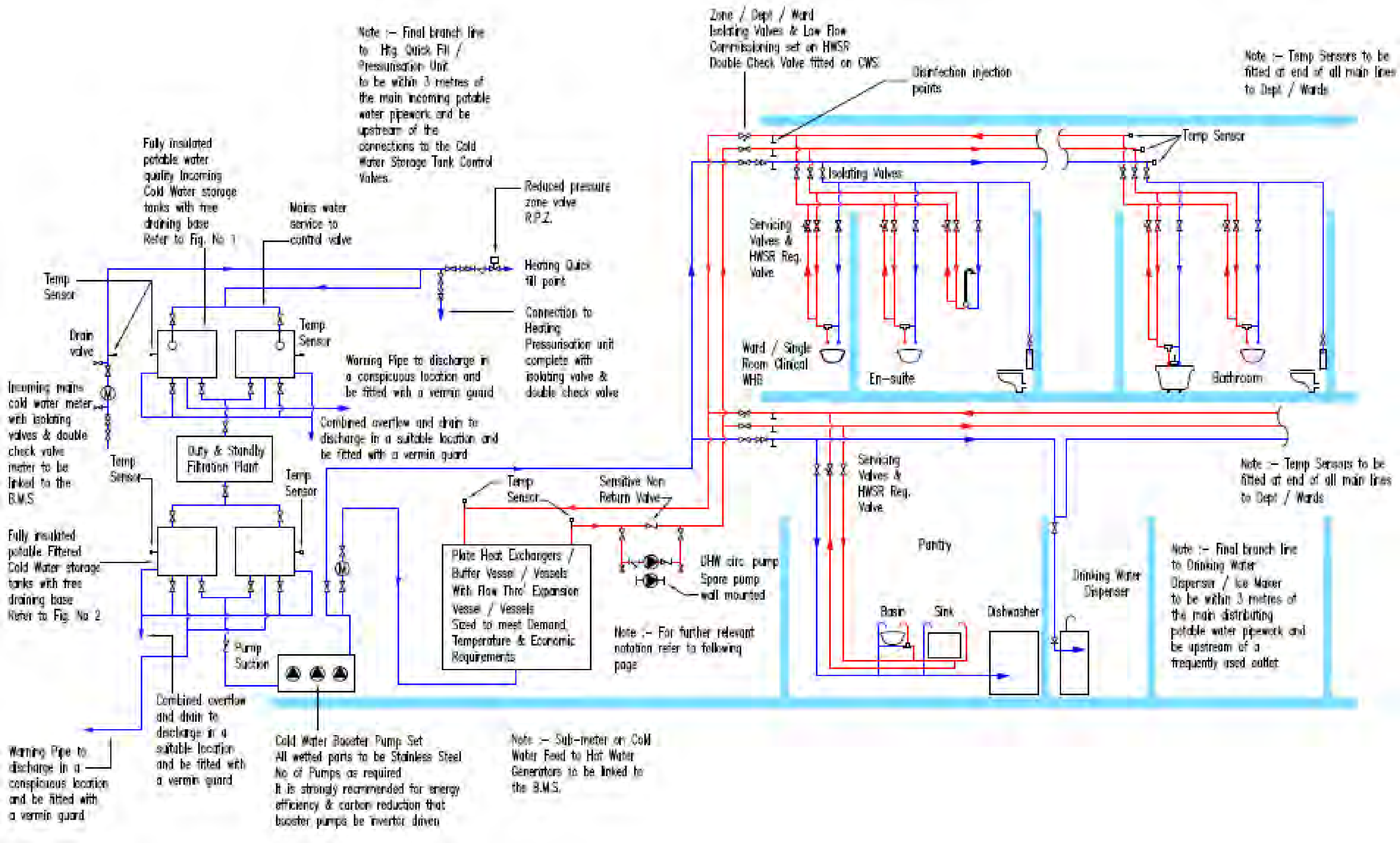

Figure 2(iv): Schematic layout of a domestic hot & cold water service system with low level storage, booster pumps, filtration plant and plate heat exchangers/buffer vessel(s)

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Notes for Figures 2(i) – 2(iv): The foregoing schematic diagrams are intended to be generic but the following issues will require to be addressed whichever design solution is adopted and should be subjected to risk assessment. Solutions adopted in new build situations may not be appropriate in retro-fit installations.

- plate heat exchangers may have a significant impact on boiler loading whereas high efficiency semi-storage calorifiers may have a lesser impact. The potential for switching off heating to accommodate peak domestic hot water demands should be investigated. (For example, an underfloor heating system could be temporarily switched off for a short period without being noticed, taking advantage of the thermal inertia);

- in selecting plant, the most cost-effective use of boiler power should be pursued along with the most appropriate use of available plant space. There is thus a potential trade-off between the output of plate heat exchangers and the size or capacity of related buffer vessels;

- the design of the domestic hot water system whether using high efficiency semi-storage calorifiers or plate heat exchangers & buffer vessels with associated controls will require to be matched to the domestic hot water demand and output of the primary heat source;

- sizing of and pipework to the buffer vessel will require to be such as to maintain the correct amount of “useable” hot water (in terms of avoiding the *Legionella* bacteria colonising temperature range) for as long as possible, coincidentally with the duration of the heat demand;

- it is necessary to ensure adequate recovery time is provided between recurring peaks taking account of the impact on the sizing of the buffer vessel and output available from plate heat exchangers;

- a balance has to be achieved between the size of plate heat exchange equipment and available boiler power;

- the output from the plate heat/buffer vessel assembly (however sized) must achieve and maintain output temperatures in accordance with the requirements of this Scottish Health Technical Memorandum;

Notes for Figures 2(i) – 2(iv) continued:

- depending on the relationship between the primary exchanger and buffer vessel, subsidiary consideration should be given to the potential for abnormal peak demands and the adverse impact these would have on return hot water temperatures. Although not mandatory at the time of preparing this document, consideration should be given to the fitting of flow restrictors to ensure that return hot water temperatures are not compromised. Consideration should be given to installing service valves with inherent flow limiters at outlets. These will assist in balancing activities, ironing out peaks and may assist in reducing wastage of water;

- careful consideration is required as to the method of introducing pipework into the buffer vessels in order to minimise the possibility of entering cold water diluting (reducing) the outgoing hot water temperature. A constant-running destratification pump would provide a rapid recovery of hot water increasing the output as the inflow of cold water diminishes.

Where bidets are required they shall comply with the requirements of SHTM 64. They shall be Hospital pattern with flush grated waste, therefore no plug, and shall have over-rim supply. Ascending spray type bidets shall not be installed. Bidets shall be installed to meet the requirements of the relevant Water Byelaws.

In smaller premises there is a risk of stagnation arising where two tanks are installed. One alternative would be to substitute a pressure regulating bypass for the second tank between the incoming main and the down service(s) to eliminate unequal flow while still allowing facilities for maintenance. Another alternative would be to have a single tank where filtered incoming supplies are provided. This would require to be subject to risk assessment.

Where equal control of pressure within hot & cold water systems is critical, pressure reducing valves should be fitted on the boosted cold water service and also on the boosted cold water feed to the hot water generating plant. The valves should be installed immediately after the pipework leaves the booster pump manifold.

Ice-making machines should be of the automatic type, *without a reservoir*, that make ice on demand. They should not be located at the end of a line to avoid a build-up of microorganisms. They should be connected to a potable mains supply upstream of a regularly used pipe run.

Drinking water

8.13 When separate drinking water systems have been provided the policy has normally been to distribute directly from the mains without storage, with stored cold water (down service) being used solely for supplies to WCs, hand-wash basins etc. Providing drinking water without storage may not be appropriate in healthcare premises because of the need to have some security of supply. The advantage of separate drinking and cold water services chiefly lie in the possibility of treating the latter (softening or other forms of treatment) without adulterating the drinking supplies. However, low water flows in dedicated drinking water piping lead to stagnation, temperature build-up and the possibility of exceeding the 20°C limits.

Softening will avoid the scale problems associated with thermostatic mixing devices. (Problems often occur when scale is deposited as a result of hard cold water being heated in the blending process.) However, this will be wasteful if the cold water supply is to be used for WC flushing.

8.14 A possible strategy, therefore, is to have a drinking water system that also provides WC flushing and, to some extent, this will assist water turnover and the maintenance of water quality. The disadvantage of the concept, apart from installation cost, is that the use of WCs, particularly in en-suite facilities, as the mechanism for achieving good utilisation in the cold water service no longer becomes possible (see paragraph 8.10). The concept for water turnover in en-suite facilities could still be achieved, however, if the cold water service were run in series to en-suite facilities with minimum dead-legs to draw-offs, with the final connection on the system being a highly utilised outlet, for example a sink.

Many hospitals, however, now store all water in tanks arranged to contain water of drinking quality, having sealed lids and screened vents. This offers complete flexibility, avoids problems with stagnation and is recommended practice.

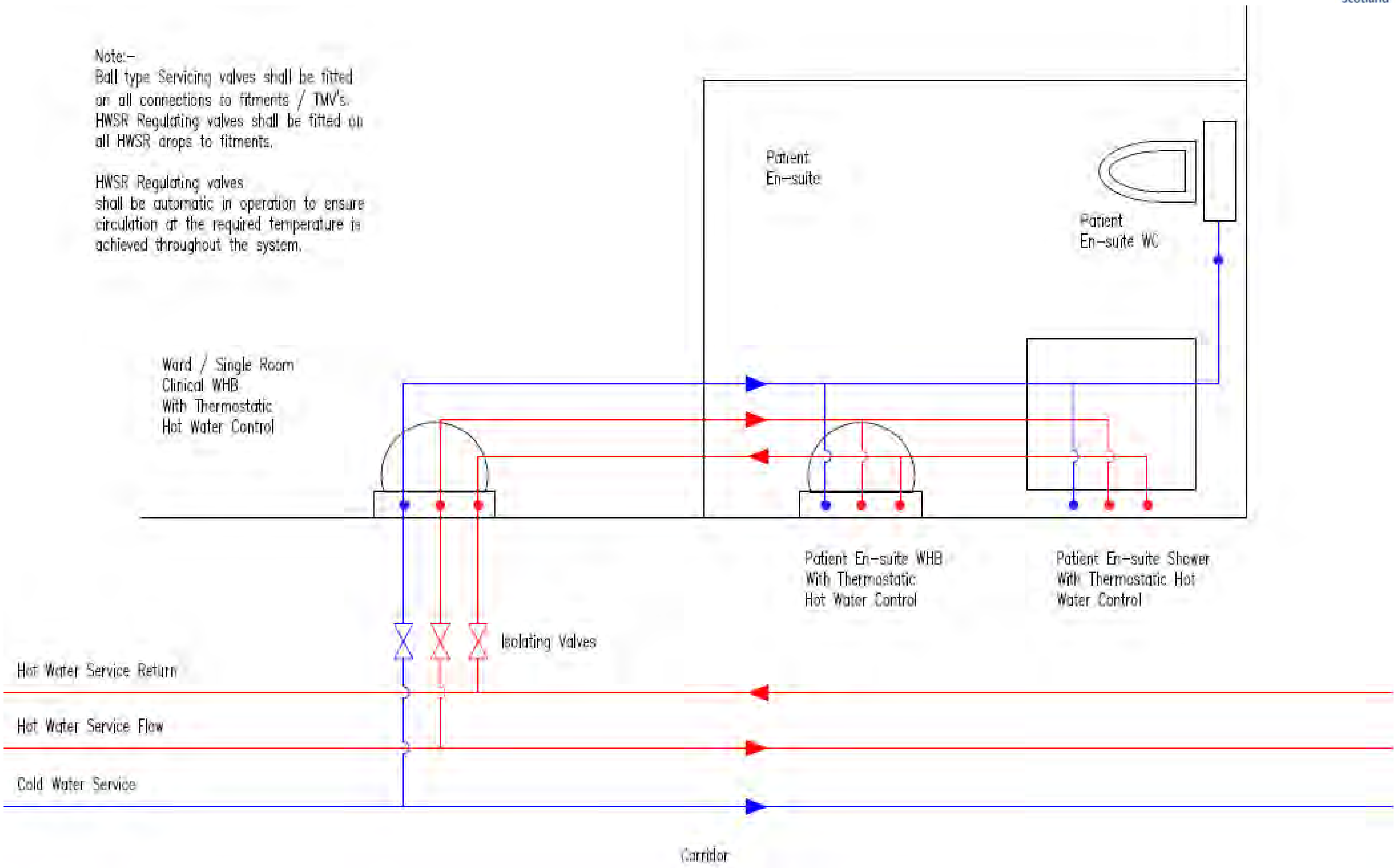

Figure 3: Piping arrangements for an en-suite facility

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Pumped systems

8.15 Some water supply authorities are reducing pressure to reduce mains leakages. Where the pressure of the water supply is inadequate, it will be necessary to utilise pressurisation plant. Similarly, pumping or pressurisation may be required for fire-fighting purposes.

8.16 Various arrangements of pumping system are indicated in BS6700: 2006, BS EN 806-1-5: 2000-2012 and BS8558: 2011. Where booster pumps are to be installed, a break cistern will be required between the mains supply pipe and the pumps. This is required in order to comply with the Scottish Water Byelaws 2004 with regard to prevention of backflow. Any pump delivering more than 12 litres/min connected directly to the incoming main must be notified to the water authority whose consent is required.

8.17 Control of the pump(s) should be fully automatic in operation and controlled by pressure sensors for the following reasons:

- to reduce energy consumption;
- to prevent heat gain from the pump to the water, which could become significant if large pumps are used;
- to reduce wear on the pumps and hence reduce maintenance.

8.18 Factors to be considered when selecting pumps are:

- quantity and pressure of water to be pumped;
- the number of units required to obtain the necessary output and to provide adequate standby capacity;
- the desirability of speed variation;
- the degree of automatic sequence control required;
- the characteristics of the system on both the delivery and suction sides, and in pumping efficiency and priming requirements;
- the type of materials used in manufacturing the pumps relative to the chemical analysis of the water to be pumped;
- ferrous metal materials should not be incorporated in wetted areas.

8.19 The operation and shutdown of pumps may be controlled by various methods depending on the circumstances, such as water-level float switches, pressure switches, flow switches, electrode probes or pneumatic systems. Certain services may also require the pumping equipment to be energised from the emergency electrical service as recommended in SHTM 06-01: Electrical services supply and distribution'.

8.20 Where two or more pumps are installed, the design flow should be achieved with one pump stationary (or out of service). Automatic control should be provided to control all pumps cyclically and sequentially to ensure that each is regularly brought into service.

8.21 The pumping sets for lifting to higher-level storage should be controlled from the level in the high-level tanks by transmitting sensors, level switches or other suitable devices. A low level alarm should be arranged to give a warning when the storage volume of water falls to a predetermined low level.

8.22 The expansion vessels forming part of the pumping sets are typically pressurisation vessels, are typically vertical in orientation and have either a diaphragm or nitrogen fill in the upper space. They introduce a potential problem of colonisation by *Legionella*, as the plantroom space temperature will exceed that of the incoming water. They should be preferably of a design such that water flows through the vessel, entering at low level, and discharging at a higher level below the water line. Interconnecting pipework should be kept to a minimum, and the vessel should be insulated to minimise heat gain. All materials in contact with water should be WRAS-approved. It is important that the expansion vessel is located on the cold feed rather than on the hot water side of the system.

8.23 The plantroom should be constructed with a waterproof and non-dusting type of walls, floors and ceilings. Floor should incorporate a slight fall to a drainage trench that should terminate in a trapped gully. The trapped gully should incorporate provisions either to avoid or replenish any trap-water-seal loss. The plantroom will require adequate lighting, ventilation and heating (to prevent freezing or condensation), with electric power points and/or provision for low-voltage supplies for portable lighting and tools.

8.24 If heavy plant is to be installed which may, on occasion, need to be removed for testing, maintenance or replacement, fixed lifting beams of suitable capacity should be provided.

Specialised systems

8.25 Where water supplies are required for specialised systems such as endoscope cleaning installations, dialysis units etc, the designer should consult the hospital infection prevention and control team (IPCT) to establish any specific water treatment requirements for the process, and also the local water supply authority to clarify any special precautions that may be necessary, such as backflow prevention devices. The advice of the water supply authority should also be sought as to any possible variation in the quality of supply or possible change in the source of supply (see also Health Building Note 07-01 (2008): 'Facilities for renal services: Satellite dialysis unit').

Vending, chilled water and ice-making machines

8.26 The water supply to this equipment should be taken from a potable supply via a double check valve to prevent backflow and be upstream of a regularly used outlet with the minimum of intervening pipe-run, that is, less than 3m. The supply should not be softened. Additionally, it should be established that the usage is sufficient to avoid deterioration in water quality, for example that the inlet water temperature does not exceed 20°C.

8.27 The equipment should be positioned so that the warm air exhaust does not impinge directly on taps or hoses supplying cold water.

8.28 Reference should also be made to the Food Safety (Temperature Control) Regulations 1995 and Food Safety (General Food Hygiene) Regulations 1995. The Automatic Vending Association of Britain (AVAB) codes of practice should be followed regarding hygiene and water quality and hygienic operation of vending machines (http://www.ava-vending.org). Vending machines dispensing carbonated drinks require special materials of construction which should be WRAS-approved.

9. Hot water services

General

9.1 Hot water services should be designed and installed in accordance with the Scottish Water Byelaws 2004 and relevant parts of BS6700: 2006, BS EN 806-2: 2005 and BS8558: 2011. The hot water system may be of either the vented or the unvented type.

9.2 The basic components of a hot and cold service system as used within hospitals are shown in Figures 2 (i)-(iv); most installations will have additional features and components.

9.3 A vented system usually consists of a cold water storage cistern situated above the highest outlets, which feeds a hot water storage vessel (for example a calorifier or direct-fired boiler).

9.4 An unvented system usually has the hot water storage vessel connected to the mains water supply via a backflow prevention device and a pressure-reducing valve or supplied via a break-tank or booster pump set. The components of a directly heated unvented hot water system are shown in Figure 4.

9.5 Hot water is taken from the top of the storage vessel, or water heater, and will normally be circulated around the building in a piped distribution system. The flow temperature should be set to 60°C and the minimum temperature of all return legs to the vessel or water heater should be 50°C. Correct grading of pipework is essential to maintain correct circulation. In all but very small domestic installations, circulation is essential and trace heating should only be used in existing installations to overcome local problems with circulation where rectification would otherwise be disruptive to the operation of the accommodation served. In all but domestic systems, if recirculation is not used, some form of trace heating will be required. Such systems, however, should be restricted to areas where backflow contamination is a potential problem, for example pathology laboratories: these should be supplied from separate systems. The individual outlets, taps, mixing valves or other outlet devices will be served from the distribution system; this should be designed such that the minimum temperature at the most distant taps or outlets is 55°C.

> **Note 11:** The control of *Legionella* requires there to be a minimum temperature of 50°C in hot water service systems (see Part B of this SHTM). A minimum of 55°C may be required for the operation of suitable fail-safe mixing devices required to provide ‘safe’ hot water at the upper limit of the recommended range. Hot water at 55°C is required for many applications such as washing in kitchens and laundries.

9.6 A small number of localised hot water distribution systems can have advantages over one large centralised system. With smaller systems, hot water heaters are located closer to points of use and it is therefore easier to maintain hot water distribution temperatures within recommended values. Balancing water flow rates in the hot water secondary distribution system becomes less of a problem, and distribution losses are reduced. A small, localised hot water distribution system may comprise a gas-fired water heater, a storage calorifier, a semi-storage calorifier or plate heat exchanger. The adoption of localised hot water distribution systems will require the provision of local plantrooms.

9.7 With large centralised hot water systems, it is more difficult to maintain secondary distribution temperatures within recommended values; also, water flow rates in large secondary distribution systems can prove difficult to balance. At periods of low draw-off, detritus can lodge within the large horizontal distribution pipes forming part of centralised systems.

9.8 There are also maintenance factors to be considered. With a central hot water system, plant maintenance can be focused in one location, whereas with localised systems there will be a number of plantrooms at remote locations.

Hot water heater types

9.9 In most healthcare premises, hot water storage vessels include the heating source, which can be steam, high- or medium-pressure hot water, or electric immersion heating elements. The flow to the pipeline distribution system is normally taken from the top of the vessel, as too is the open vent, which may or may not be combined. The cold feed and return pipe should be taken in at the lowest point of a calorifier. Instantaneous water heaters for distribution systems have similar pipeline connections. All water heaters must be WRAS-approved and listed in the 'Water Fittings and Materials Directory'.

9.10 Traditional design practice has been to provide a non-check-valved cold feed and expansion pipe to the calorifier/water heater and an open vent discharging over the cold feed cistern.

Achieving hydraulic balance is essential. The cold feed will be the neutral point and the calorifier must always be under negative pressure to avoid pumping over. With the circulating pump located on the flow pipework after the open vent, the vent should be taken through the lid of the cold water storage tank and sealed in place to maintain integrity. This will ensure that the system is free from contamination, notably particulate matter. Systems require to be monitored to provide early warning of rises in cold water temperatures due to malfunctions in performance. Incorrect design or installation should be manifest during commissioning before systems are put into use.

9.11 Most vessels have some means of access for inspection, either via a special panel or by removing the heating coils/elements. When new calorifiers are required, it should be specified that they have separate and adequately sized access panels.

9.12 Where water quality indicates the need, cathodic protection from galvanic action by means of sacrificial anodes should be provided.

9.13 The combined storage capacity and heater output must be sufficient to ensure that the outflow temperature, at continuous design flow (at least 20 minutes) from calorifiers or other heaters, should not be less than 60°C. This applies to both circulating and non-circulating hot water systems. The positioning of the control and high limit thermostats, cold feed and return water connections must ensure that these temperatures are achieved.

9.14 There are basically three types of water heater:

- instantaneous heater;
- storage calorifier;
- limited storage calorifier.

Instantaneous water heaters

9.15 This type of heater can be further subdivided into:

- **instantaneous water heaters for single or multi-point outlets**: these devices are usually either electrically or gas heated. The general principles and limitations of instantaneous water heaters are given in BS6700: 2006, BS EN 806-1-5: 2000-2012 and BS8558: 2011. In essence:
  - the hot water flow rate is limited and is dependent upon the heater's power rating;
  - the water in instantaneous water heaters is usually heated to about 55°C at its lowest rate, and its temperature will rise and fall inversely to its flow rate. Where constant flow temperature is important, the heater should be fitted with a water governor at its inflow. Close control of temperature is of particular importance for showers. To attain constant temperatures on delivery, water flow and pressure must also be controlled. Variations in pressure can cause flow and temperature problems when the heater is in use, and when setting up or adjusting flow controls;
  - they are susceptible to scale formation in hard water areas, where they will require frequent maintenance;
  - this form of hot water heating should be considered only for smaller premises or where it is not economically viable to run a hot water circulation to a remote outlet;
- **instantaneous-type water heaters for distribution systems**: these devices, which normally use steam or high/medium pressure hot water as the primary heating medium, are designed to heat their rated throughput of water rapidly from cold to the design outlet temperature. They can be used either to feed directly into a hot water distribution system, or in conjunction with a storage vessel which reduces the load on the heater during periods of peak demand. This type of heater includes:
  - **hot water generators**: these are vertical instantaneous water heaters that contain modular helical primary coils normally served by steam, medium temperature hot water (MTHW) or high temperature hot water (HTHW). The unit incorporates a temperature control device, which varies the rate of primary energy input so as to maintain a constant hot

water flow temperature over a range of secondary flow rates through the heater;

– **plate heat exchangers:** plate heat exchangers consist of a number of rectangular plates sandwiched between two flat end plates and held together by tie bolts. The plates have ports in all four corners that allow entry and discharge of the primary and secondary liquids. Primary liquid is directed through alternate pairs of plates while the domestic hot water is normally fed in a counter flow direction through the remaining pairs of plates. Each plate is sealed round the edges by a gasketing system, the design of which should ensure that fluids cannot, under normal operating conditions, either leak to atmosphere or mix. This type of heat exchanger can be extended easily, or shortened, to suit changes in hot water demand.

Storage calorifiers

9.16 Storage calorifiers are usually cylindrical vessels mounted either vertically or horizontally; the base of a vertical calorifier should be convex, with the vessel being supported on feet. The latter design is preferred, as it avoids the annular space where the base joins the cylinder wall. Heater batteries are usually located near the bottom of the cylinder, which can give rise to an area of water beneath the battery significantly below the storage temperature. This “dead” area can provide an ideal breeding ground for bacteria. Galvanised cylinders are particularly susceptible to scale formation, which can also provide a source of nutrition and shelter for bacteria.

9.17 As a result of this, galvanised cylinders are not permitted in new hospital installations or for replacement.

9.18 The following points should be considered during the design process (see also paragraphs 9.28–9.29):

- the entire storage volume should be capable of being heated to 60°C without permanent pockets of lukewarm water;
- the shell lining should be resistant to bacterial growth;
- sufficient access to ensure adequate cleaning of the shell must be provided;
- a suitably-sized drain should be connected to the base of the calorifier.

Limited storage calorifiers

9.19 These calorifiers can either have an independent heating facility such as oil or gas burners or electric elements, or use primary water/steam from a boiler to heat the water via a heat exchanger. The equipment is available in a range of storage capacities and recovery flow rates. This type of equipment is particularly suitable where systems are being decentralised and water heaters are required close to the point of use.

Sizing of hot water storage vessels

9.20 Storage should be calculated on the requirements of peak demand and the rate of heat input. There may be more than one peak period in each 24 hours. The interval between peak periods is important, as it affects the recovery time.

9.21 The CIBSE Guide G: 'Public health engineering', gives guidance on sizing hot water storage.

9.22 Since the original study set out in Appendix 1 a review of systems indicates that the overall capacity and consumption predicted is excessive (see paragraphs 7.4–7.5).

9.23 Where storage calorifiers are used, the hot water storage capacity should be sufficient to meet the consumption for up to two hours; this must include the period of maximum draw-off. The installed hot water capacity should be sized for current needs and should not be designed with built-in capacity for future extensions.

9.24 Some devices are optimistically rated so that, at a continuous demand equal to their design rating, the flow temperature can fall below 60°C. Semi-storage or high-efficiency minimum storage calorifiers and instantaneous heaters are especially prone to this if under-sized.

Connection arrangements for calorifiers and water heaters

9.25 Where more than one calorifier or heating device is used, they should be connected in parallel, taking care to ensure that the flow can be balanced so that the water temperature from all the calorifiers is not less than 60°C at all times (see also paragraph 9.42).

9.26 Installations must not include for series operation of calorifiers.

Stratification in storage vessels

9.27 Stratification will occur in any storage calorifier or heater; the temperature gradient will depend on the rate of draw-off and heat input. In some calorifier designs, stratification is significantly more pronounced and is a feature of their design. There will always be a volume of water in the temperature range that encourages maximum growth of *Legionella*.

Note 12: Water temperatures in the range 20°C–45°C favour growth of *Legionella*. It is uncommon to find proliferation below 20°C, and *Legionella* does not survive long above 60°C. The optimum laboratory temperature for the growth of *Legionella* is 37°C, that is, body temperature. *Legionella* may, however, remain dormant in cool water, multiplying only when the temperature reaches a suitable level.

Note 13: Stratification: in a storage calorifier the upper level, above the heating element, will be at operating temperature (60°C) during normal periods of demand. Below this level will be a volume of water between the feed water temperature and operating temperature. This level will vary as draw-off takes place according to the thermal input and rate of demand.

9.28 Storage and semi-storage calorifiers should be provided with independently pumped circulation from the top to the base of the calorifier; this is referred to as a 'shunt pump'. The pump should be run continuously for about an hour during periods of minimum demand to raise the entire contents of the calorifier to 60°C. During periods of low draw-off, the temperature will readily achieve 60°C to effect disinfection. Control should be by a timing device that can be adjusted when the profile of demand has been established.

9.29 Some semi-storage/high-efficiency calorifiers are supplied with an integral pump that circulates water in the calorifier; in this case a second shunt pump is not required.

Provisions for maintenance

9.30 There should be adequate access to calorifiers for inspection and cleaning, removal and replacement of tube bundles and removal and replacement of the entire calorifier.

9.31 All calorifiers and water heaters must be fitted with a drain valve located in an accessible position at the lowest point on the vessel so that accumulated sludge may be removed effectively from the lowest point. The drain should be of sufficient size to empty the vessel in a reasonable time. A schedule of approximate calorifier emptying times is given in Table 3.

9.32 Drain valves should be of the ball type to avoid clogging, and a drainage gully should be provided of sufficient size to accommodate the flow from the calorifier drain.

Unvented hot water systems

9.33 Hot water storage systems have traditionally been provided with an open vent pipe that relieves any steam generated in the event of failure of temperature controls. The open vent pipe also protects against rupture of the cylinder by expansion of water.

9.34 The use of unvented hot water systems is now permitted in the UK and is covered in Section 4: Safety section of Section 6 Energy in the Non-Domestic

Scottish Technical Handbooks, 2007, which covers installation, specification and discharge.

9.35 Where an unvented hot water system is connected directly to the water mains, no back-up will exist in the event of a water supply failure. Such an arrangement may also be unacceptable to the local water supply authority, since they will be required to meet the maximum demand at any time over a 24-hour period.

Calorifier type	Diameter/ length ratio	Capacity: Litres (Gallons)	Drain valve sizes mm (inch) 25 (1.0)	38 (1.5)	50 (2.0)
Horizontal	1:2.5	13,500 (3,000)	3 hr 00 min	1hr 20 min	45 min
		9,000 (2,000)	2 hr 10 min	1hr 00 min	30 min
		4,500 (1,000)	1hr 10 min	30 min	20 min
		2,250 (500)	39 min	17 min	10 min
		1,800 (400)	32 min	14 min	8 min
		1,400 (300)	25 min	11 min	6 min
Horizontal	1:1.5	13,500 (3,000)	3 hr 00 min	1 hr 20 min	45 min
		9,000 (2,000)	2 hr 10 min	1 hr 00 min	30 min
		4,500 (1,000)	1 hr 10 min	30 min	20 min
		2,250 (500)	39 min	17 min	10 min
		1,800 (400)	32 min	14 min	8 min
		1,400 (300)	25 min	11 min	6 min
Vertical	1:1.5	13,500 (3,000)	2 hr 45 min	1 hr 15 min	40 min
		9,000 (2,000)	2 hr 00 min	55 min	30 min
		4,500 (1,000)	1 hr 10 min	30 min	20 min
		2,250 (500)	38 min	17 min	9 min
		1,800 (400)	31 min	14 min	8 min
		1,400 (300)	25 min	11 min	6 min
Times assume no hose and simple ball-type valve					

Table 3: Approximate emptying times for calorifiers

9.36 The design and installation of unvented hot water systems should comply fully with the Non-Domestic Scottish Technical Notebooks, 2007 and the Scottish Water Byelaws 2004.

9.37 The key requirements are that the temperature of stored water should be prevented at any time from exceeding 100°C and that discharges from safety devices should be conveyed to a safe and visible place and protected to prevent blockages by the ingress of birds, rodents or insects etc.

9.38 A schematic layout of a typical directly heated unvented hot water system is illustrated in Figure 4 along with a brief description of the main components.

9.39 The discharge pipes from the temperature relief valve and expansion valve should be carefully located so that they are readily visible but do not present a risk to people and protected to prevent blockage by the ingress of birds, rodents or insects etc.

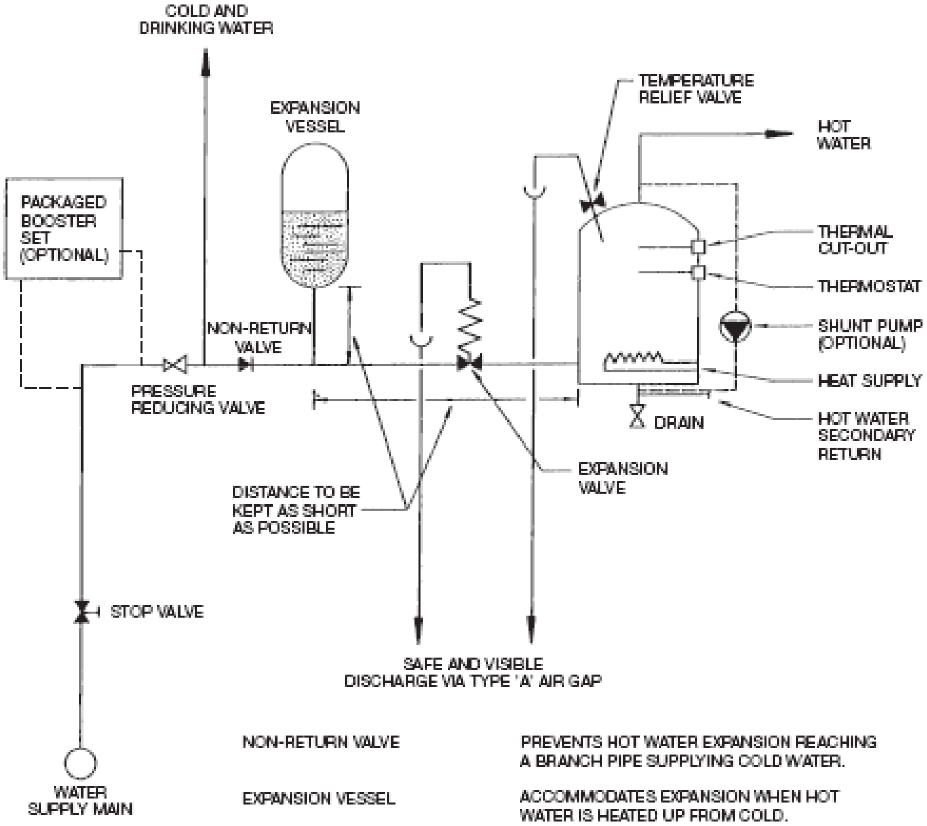
9.40 Where the hot water is heated directly, for example by a steam or LTHW primary coil, a non-self-resetting thermal cut-out wired to a motorised valve on the primary coil must be provided for control of excessive temperature. This should be further protected by a direct-acting protection device, particularly with a plastic pipework installation.

Sealed expansion tanks for unvented hot water systems

9.41 These vessels are typically vertical in orientation and normally have a diaphragm to separate the water from the gas space above. They introduce a potential problem of colonisation by *Legionella*, as the plantroom space temperature will exceed that of the incoming water. It is important that the expansion vessel is located on the cold feed rather than on the hot water side of the system and is fully insulated. All materials in contact with water should be WRAS approved.

Hot water distribution system

9.42 To control the possible colonisation by *Legionella*, it is essential to maintain the temperature within the hot water circulating system. To some extent, if properly maintained, the calorifier/water heater will provide a form of barrier to *Legionella* and other water-borne organisms. For premises with intermittent use, the generation of domestic hot water must be continuous unless there is an anticipated prolonged shut down, in which case systems should be drained dry, as occurs between final commissioning and putting systems into use in a new build situation.



NON-RETURN VALVE	PREVENTS HOT WATER EXPANSION REACHING A BRANCH PIPE SUPPLYING COLD WATER.
EXPANSION VESSEL	ACCOMMODATES EXPANSION WHEN HOT WATER IS HEATED UP FROM COLD.
EXPANSION VALVE	DISCHARGES EXPANDED WATER UPON FAILURE OF THE EXPANSION VESSEL.
TEMPERATURE RELIEF VALVE	USED AS A BACK-UP IN THE EVENT OF FAILURE OF BOTH THE THERMOSTAT AND THE THERMAL CUT-OUT.
THERMAL CUT-OUT	CUTS OFF HEAT SOURCE AT A PREDETERMINED MAXIMUM TEMPERATURE.
THERMOSTAT	CONTROLS THE TEMPERATURE OF STORED WATER AT 60°C ± 2°C.

Figure 4: Directly heated unvented systems

9.43 The minimum flow temperature of water leaving the calorifier/water heater should be 60°C at all times, and 55°C at the supply to the furthermost draw-off point in the circulating system. The minimum water temperature of all return legs to the calorifier/water heater should be 50°C.

Note 14: A minimum of 55°C may be required for the operation of suitable mixing devices required to provide ‘safe’ hot water at the upper limit of the recommended range.

9.44 To achieve the required circulating temperatures, it will be necessary to provide some form of regulation to balance the flow to individual pipe branches serving groups of draw-off points, for example each washroom/toilet and en-suite facility etc.

9.45 The means of balancing the hot water circulation can be achieved by either manual or thermostatic regulating valves installed in the return. There should be means of isolation, both upstream and downstream. Adequate access for servicing is also essential.

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9.46 In ward accommodation where en-suite facilities are provided, it is recommended that the hot water circulation be extended to draw-off points in series, for example the supply to a basin, bath and/or shower should be run as one circuit (see Figure 3).

9.47 The operating pressures for both hot and cold water at draw-off points should be the same.

9.48 The domestic hot water system must not be used for heating purposes. This includes all radiators, towel rails, heated bedpan racks etc, whatever the pipework configuration.

9.49 Particular attention should be given to ensuring that pipework containing blended water is kept to the minimum. The same restriction applies to "communal" blending, that is, where more than one outlet is served by one device. Central blending systems should not be used, since the length of distribution pipework containing water in the temperature range that supports *Legionella* growth would be excessive. Generally, the complete length of spurs without circulation should be as kept to a minimum with circulation pipework taken right up to the point of use. Redundant branches and dead-legs within existing installations should be removed, including replacing tee-pieces on the circulating and main distribution pipework with straight couplings to avoid spurs containing stagnant, non-circulating water. A typical configuration of pipework to sanitary fittings is shown in Figure 3.

Water temperatures and delivery devices

9.50 The risk of scalding for patients (children and young people, older people, and people with disabilities) and staff is a particular problem in healthcare premises caring for such individuals, and therefore thermostatic mixing devices will be needed for many hot water outlets, with different temperatures required for differing toiletry needs. A risk assessment will be necessary to establish the need and type of device to be installed.

9.51 Hand-washing is best performed under running water in basins/sinks without plugs, as they easily become soiled especially where usage is high – this necessitates the installation of a mixing device.

Note 15: The Scottish Water Byelaws 2004 place limits on the flow of water to draw-offs where plugs are not provided. Spray-type mixer taps are not recommended in healthcare premises; therefore, the type of tap should be carefully selected to minimise the formation of aerosols. The water flow profile must be compatible with the shape of the wash hand basin. Rosettes, flow straighteners and aerators have been found to be heavily colonised with biofilm but their removal can create turbulent flow at increased pressure resulting in splashing of surrounding surfaces and flooring. Current advice is that they should be removed but this should be subject to risk assessment. (With regard to the requirement for plugs, see also the section on baths, sinks, showers and taps in DEFRA's (1999) guidance document to the Regulations.)

9.52 Thermostatic mixing valves should comply with the standards of the MES D08: 'Thermostatic mixing valves (healthcare premises)'. Thermostatic valves should be tested and accepted by the BuildCert TMV Scheme (http://www.buildcert.com/TMV).

9.53 The types of mixing device are specified in Table 4.

Showers

9.54 Showers with fixed heads are preferred for prevention of backflow. Where flexible hoses and moveable shower outlets are provided, the outlet must not be capable of being accidentally immersed into a drain, WC or other potential source of contamination. Some shower heads are provided with a means for adjusting the flow, for example fine spray, pulsating flow etc, selected by utilising different sets of nozzles. As this will exacerbate possible stagnation problems, they should *not* be installed in healthcare premises. Taps and showers should be flushed every three days for 1 minute for hot and cold supplies or the retained water flushed to waste immediately before use without the generation of aerosols.

9.55 To facilitate the required regular removal of shower thermostatic mixing valves for inspection, careful consideration will be required to ensure that these are not recessed in such a way that access can damage thermal insulation on connecting pipework or to the removable panels themselves in wet areas. Surface mounted thermostatic mixing valves with smooth protective panels concealing isolating valves, strainers and check valves will eliminate this problem and avoid repetitive damage to waterproof membranes. Alternatively, access for inspection and removal could be provided from the rear, off an adjacent corridor (hotel-style).

Strainers

9.56 Strainers should be fitted within the water pipework system to protect expansion vessels, mechanical backflow protection devices, thermostatic valves etc (see also paragraph 5.4) against ingress of particulate matter, swarf, etc, that can be in circulation during initial commissioning procedures. They should be provided with means of upstream (and downstream where appropriate) isolation. Strainers can be a source of *Legionella* and *Pseudomonas* bacteria and should be removed after commissioning has been satisfactorily completed.

Cold feed cisterns and tanks

9.57 When separate cold feed cisterns are provided for hot water service installations, they should comply with the requirements for cold water systems.

> **Note 16:** Hot water cylinders with an integral feed and expansion tank are not recommended.

Service isolation valves

9.58 Service isolation valves should be fitted to all pipework preceding sanitary tapware and WCs etc for servicing, repair and replacement. Drain-valve provision may also be appropriate for certain installations, for example service pipework to en-suite facilities etc.

Area/activity	Recommended temperature (°C)	Type of device (see MES D08 for example explanation of valve types)
Staff bases, ward and consulting rooms etc basins In-patient, out-patient hand-wash basins	41	Type 3 Thermostatic
General areas to which staff and visitors may have access See note c below	41	Type 2 Thermostatic
Paediatric baths	40 - to allow for the cold paediatric bath/sink NB: Paediatric nurses should always use a thermometer	Type 3 Thermostatic
General baths	43	Type 3 Thermostatic
Showers	41	Type 3 Thermostatic
Assisted baths	46 - to allow for the cold mass of the bath NB: Nurses should always use a thermometer before immersing patients	Type 3 Thermostatic
Hair-wash facilities	41	Type 3 Thermostatic
Bidets	38	Type 3 Thermostatic
All sinks, kitchens, pantries, slop sinks etc	55 - minimum required for food hygiene and decontamination purposes	Separate hot and cold taps or combination tap assembly Type 1; no preceding thermostatic device
Office, staff-only access areas hand-wash basins	43	Type 1

Table 4: Safe water temperatures and delivery devices

Note 17:

a. in all new installations thermostatic mixing devices shall be fitted directly to the mixed temperature outlet or be integral with it, and be the method of temperature and flow control, i.e. the mixing device should not be separate and supply water via second tap or manual mixer since there will be many cases where draw-off of cold water will not occur;

b. thermostatic mixing devices have complex internal structures that can entrap waterborne bacteria and biofilm. Risk assessments should be carried out to determine the potential to replace thermostatic mixing devices with ordinary in augmented care accommodation where it is unlikely that patients will use wash hand basins;

c. in the case of bidets with ascending sprays, or a handled douche, which may be accidentally immersed in an adjacent WC, water taps must be supplied via a suitable air gap, normally from a storage cistern;

d. automatic taps should be considered for general public access washroom/toilets, surgical scrub sinks and hand-wash basins in main kitchen/food preparation areas. Because the temperature is non-user adjustable they should be supplied from a Type 2 TMV set to 41°C and they are not recommended where the frequency of use of sanitary assemblies is low. Part of the operational management will necessitate “flushing” of outlets. Such flushing can be time-consuming and is not facilitated by automatic taps that require a continual presence. These procedures must be recorded in ICU accommodation and for seldom used taps, although they are not recommended in low-use situations. Proximity detectors should include a timer than can be adjusted to take account of the optimum washing time: this is particularly important for scrub sinks;

e. non-touch / infrared / sensor taps also have a greater risk of their complex internal surfaces becoming contaminated with micro-organisms and biofilms. Sample water will require to be drawn off from sensor taps to monitor the adequacy of maintenance.

f. automatic flushing WCs should be considered for similar areas. e.g. wards;

g. in the case of a dual function delivery device, i.e. shower/bath diverter, a risk assessment will be necessary to establish what temperature setting is required;

h. there has been much debate as to whether swan neck taps constitute any additional risk associated with stagnant water remaining un-drained when the tap is switched off. There is no evidence as yet to suggest that there is any particular cause for concern given that the permitted lengths of dead-legs are not compromised by their inclusion. There is therefore no need to embark on unnecessary planned replacements for Swan Neck taps;

i. taps should be ideally removable and easily dismantled for cleaning and disinfection.

Accommodation periodically used

9.59 Departments within hospitals and healthcare premises closed at weekends, overnight or similar (such as clinics and GP or Dental premises similarly utilised) will require their stored water temperatures at all times to be maintained within the same parameters as during normal usage. There is no practical alternative to this if re-pasteurisation with hot water at 70°C is to be avoided every time prior to putting accommodation back into use. Ignoring this requirement involves non-compliance with Workplace Regulations and the issue affects all NHS contractors.

10. Building and energy management systems

10.1 The continued safe operation of domestic hot and cold water systems requires a number of routine checks to be made by physical means using separate thermometric equipment. Consideration should be given to the incorporation of intelligent water systems whereby a number of the control parameters can be monitored by Building and Energy Management Systems (BEMS) continuously, even though routine checks will still be required for “calibration purposes”. Parameters that should be monitored are as follows:

- incoming mains temperature (at the water meter), inlet, outlet, and surface water temperatures of cisterns and cold water feed tanks for hot water calorifiers;
- calorifier flow and return temperatures;
- hot water service flow and circulation temperatures at the furthermost outlets in individual wards;
- cold water service at the furthermost point from the pipeline entry to the ward/department;
- consideration should be given to the frequency, timing and monitoring of taps etc. with automatic flushing facilities.

Smaller premises without a Building and Energy Management System will require the same routine checks and monitoring carried out manually with the interval between checks determined by experience and risk assessments.

10.2 In addition to temperature, the BEMS should also monitor pressurisation and circulating pumps, and water treatment systems for fault conditions or change of status likely to result in a fault.

11. Materials of construction

General

11.1 Any materials that come into contact with the water in a hot and cold water installation must comply with the requirements of the Scottish Water Byelaws 2004. A list of products and materials that have been assessed for compliance with the requirements of these Regulations is given in the current edition of 'Water Fittings and Materials Directory', which is updated every six months. Further information on the selection of materials can be found in BS6700:2006, BS EN 806-2: 2005, BS8558: 2011 and BS6920-1: 2000.

11.2 Materials of construction should be selected to take account of water quality and its potential corrosive properties. The water supply authority should be asked to provide details of any specific requirements and variability from standard conditions.

11.3 Water supplied by the water supply authority, although remaining uniformly wholesome, will nevertheless differ chemically. Some waters are slightly acidic while others are slightly alkaline, and this affects the choice of materials for pipes, fittings and cisterns. The water supply authority also blends water and accordingly, the character of the water supply may vary from time to time. It will therefore be necessary to consult the water supply authority for advice on what materials should be avoided.

11.4 The choice of materials for buried piping and fittings should also take into account the nature of the soil in which the piping is to be laid. The materials selected should, where necessary, resist possible corrosion both inside and outside. The extent, if any, of anti-corrosion treatment of the outside of the piping will depend on the analysis of the soil. The advice of the water authority (see Note 3); should be sought on the protective measures usually adopted in the area.

11.5 Corrosion (or erosion) can be caused by the motion of water when it is in a turbulent state and thus subject to rapid changes in pressure. Minute vapour or gas bubbles may be released at instants of low pressure. The bubbles collapse with implosive force the moment the pressure is increased. Their collapse upon a metallic or concrete surface will quickly cause deep pitting or erosion of that surface. The designer should therefore avoid high velocities, the sudden increase of pressures or pulsating pressures.

11.6 Metallic piping should not be installed in contact with corrosive building products and materials.

11.7 Corrosion may result from galvanic action where dissimilar metals are connected. Dissimilar metals should be avoided as far as practicable, but if that is not possible, it should be determined that deterioration through galvanic action is unlikely to occur, or else effective measures should be taken to avoid deterioration.

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11.8 The materials generally used for the conveyance of water in healthcare premises are stainless steel or plastics. Copper is only used in exceptional circumstances such as, an extension to existing premises with short life expectancy, or very small stand alone premises. Where this is specified, only lead-free solders should be used.

11.9 Substances leached from materials of construction of pipes, cisterns or other water fittings in contact with water must not adversely affect the quality of water stored or drawn for domestic or food production purposes (Scottish Water Byelaws 2004).

11.10 Direct gas-fired water heaters are particularly prone to corrosion and scale formation, and the inside of these heaters should be provided with suitable linings to limit these effects.

Steel pipes and fittings

11.11 Where steel is used for bolts, nuts and slip-on couplings, adequate protection from corrosion should be provided. This usually takes the form of bitumen coating, but bitumen is not permitted in contact with water required to be wholesome (that is, to be used for normal domestic or food production purposes).

11.12 The character of water in Scotland is such that steel, whether galvanised or not, should not be used at all for domestic hot and cold water installations. Any existing premises with such pipework shall have this scheduled for early replacement.

Stainless steel

11.13 Stainless steel has been increasingly used in hot and cold water service systems. Reference should be made to Part E of this SHTM: 'Alternative materials and filtration'.

Copper pipes and copper/copper alloy fittings

11.14 As described previously, very careful consideration will be required if copper pipework and fittings are to be specified for healthcare premises in Scotland. Where this is considered to be acceptable either due to the size of the project or the anticipated lifespan of the facility, the following will apply.

11.15 Copper in general has been resistant to corrosion. Unless resistant to dezincification, brass fittings must not be used where water conveyed is capable of dissolving undue amounts of zinc from the fitting. External protection from corrosion for buried pipework may be obtained by using copper tube with a factory-applied polythene sheath. Dezincification-resistant material must be used for fittings that are concealed or inaccessible, for backflow prevention devices, and for temperature and pressure-relief devices on heating systems. Copper piping should conform to BS EN 1057: 1996 as appropriate for underground or above - ground installations. When soldering copper tube and fittings, refer to WRAS Information and Guidance Note 9-04-02: 'Solder and fluxes'. If wax-based soldering fluxes must be used, they should be used sparingly. They pose a risk of bacterial contamination to the system, which can be difficult to eradicate.

11.16 Fittings should comply with the requirements of BS EN 1254-1−5:1998. Copper piping may be jointed by means of compression joints or capillary joints. Effective capillary joints in copper pipes can be achieved if care is taken in their construction. Where compression joints are used with fully annealed copper piping, these should be manipulative joints; that is, joints in which the tube ends are flared or grooved.

11.17 Lead-free materials must be used in the formation of all potable water pipe capillary joints.

Plastics

11.18 Most water systems operate at modest pressures and at a maximum temperature of 70°C. Such operating conditions are within the specified performance of plastics being produced in a range of sizes and costs suitable for healthcare premises. Most ranges of plastic pipework are not suitable for renal dialysis applications where water at a temperature of 95ºC is regularly circulated for sanitisation and there is an incompatibility with reverse osmosis treated water used in renal dialysis and in endoscope cleaning.

11.19 Advantages of plastic include corrosion resistance, lightness of weight and ease of handling.

11.20 Disadvantages include poorer mechanical strengths than metals, greater thermal expansion (about seven times that of metallic pipework), low temperature (and possible long-term embrittlement [20–25 years]) and shorter distances between pipe supports. The latter can be alleviated by employing the manufacturer's profiled longitudinal tray that snaps into place and extends the distances between supports.

There have also been difficulties with ring seal failures that have required wholesale replacements of all fittings. In the longer term (approx.20 years) glues used for jointing have failed.

11.21 Materials in common use for plastic pipework are medium-density and high-density polythene, the latter being stronger. Unplasticised polyvinyl chloride (PVC-U) pipework has mainly been replaced by the stronger chlorinated polyvinyl chloride (PVC-C) equivalent. All materials used for the transportation of water can give rise to contamination by differing processes. It is therefore important when introducing new materials that care is taken to ensure that appropriate standards are maintained. In the case of plastic materials, this can often be achieved by introducing a suitable 'flushing' routine during the commissioning period.

11.22 PVC pipes to BS3505:1986, BS EN 1452: 2000 (parts 1−5) and BS3506:1969 are of a rigid material that has a greater tensile strength than polythene, but is less resistant to fracture. These materials are less susceptible to frost damage than metal pipes. Although freezing is unlikely to damage the pipe, it will result in interruption of supply, and subsequent leakage from joints may occur.

11.23 Polythene pipes are generally not susceptible to corrosion from either the water or the ground in which they are laid. However, they are not recommended in any soils contaminated with organic materials likely to permeate the plastics and taint the water such as coal gas, methane, oils, petrol or other organic solvents. Further advice is available in the WRAS Information and Guidance Note 9-04-03: 'The selection of materials for water supply pipes to be laid in contaminated land'.

11.24 It is essential to consider the locality of exposed plastic pipes to ensure that there is no likelihood of mechanical damage and effects of UV daylight; otherwise suitable protection around the pipe will be necessary.

11.25 Further advice on flushing is given Part E of this SHTM: 'Alternative materials and filtration'.

11.26 Methods of jointing employed include compression joints with insert liners, flanged, screwed and fusion-welded joints, as well as joints of the spigot and socket type. The method of jointing employed is dependent on the bore of the pipe and the applied internal pressure, and should be in accordance with the manufacturer's recommendations. A competent fitter who has been trained under an approved scheme should make joints.

Composite materials

11.27 Less proven, but available on the market, are composite pipes, for example aluminium pipe with an external and internal sheath of plastic. Little evidence on the performance of such pipes is so far available, and questions remain over earth bonding.

Iron pipes and fittings

11.28 Ductile iron is little used nowadays but it may be encountered in the course of a refurbishment project or in areas with hostile soil conditions. Iron has good resistance to corrosion, and this is further enhanced if the casting skin on the metal is still intact. Although ductile iron pipes are thinner than grey iron pipes, their resistance to corrosion is at least as good, and there is evidence that they tend to be rather more resistant. In assessing the life expectancy of ductile iron pipelines, account should be taken of any intended higher operating pressures that may be used or permitted. Any iron pipework encountered should be risk assessed with a view to early replacement, dependent upon the anticipated life span of the accommodation served.

11.29 In made ground containing ashes and clinker, or in certain natural soils, such as aggressive waterlogged clays, saline and peat marshes, additional external protection may be required. This may be provided by the use of protective coatings such as bitumen, by protective tapes, by loose polythene sleeving or, in certain circumstances, by concrete. The water supply authority is using more composite materials in pipework to overcome the risks.

Lead

11.30 No new lead piping should be installed in any building. In the unlikely event of any lead pipework being discovered in existing healthcare premises, it should be removed as soon as practical.

Concrete

11.31 Protection of concrete pipes may be required against sulphate and acid attack. The minimum size available in concrete pipework is 150mm diameter, and therefore its practical use for healthcare premises is very limited.

11.32 Standard concrete pipes may be used when not subjected to internal pressure. Pre-stressed concrete pipes are available as pressure pipes, but only in larger sizes.

Asbestos cement pipes and fittings

11.33 Asbestos cement pipework should not be used and, if encountered in the course of a refurbishment project, it should be stripped out and replaced as a high priority with modern materials such as medium density polyethylene

11.34 Specialist advice should be obtained if stripping out materials containing, or suspected of containing, asbestos is carried out.

Flexible water supply hoses

11.35 Flexible hoses (also known as “tails”) have become a convenient method of connecting between hard pipework and sanitary fittings or equipment. They typically comprise a steel braided outer sheath with a synthetic rubber inner lining.

Reports have been received intimating that high levels of *Pseudomonas* and *Legionella* bacteria have been found in water samples taken from outlets fed by flexible hoses lined with ethylene propylene diene monomer (EPDM) due to colonisation of the lining, although it is possible that other lining materials and washers within couplings could be similarly affected.

New lining materials are now available such as polyethylene (PE), cross-linked polyethylene (PEX), linear low-density polyethylene (LLDPE) and post chlorinated PVC (PVC-C).

In view of this, it is recommended that the use of flexible hoses in potable water supplies should be identified and risk assessed, taking account of areas of highest risk involving persons vulnerable to infection. An action plan should be developed for existing premises to address replacing flexible hoses by fixed piping where they had been installed solely for speed or convenience. In new-build projects flexible hoses should not be specified in such situations. Where flexible hoses must be used for the likes of essential equipment subject to vibration or articulation, such as hi-low baths, consideration would be given to using the above listed alternative lining materials. Care would be required to avoid kinking or distortion during installation. Reference should be made to paragraph 7.49 regarding disinfecting of hoses connected between shower mixing valves and related shower heads. Such hoses are not presently covered by the content of this paragraph.

Risk assessments should be reviewed regularly and whenever changes take place to the patient user group or to the potable water system.

All flexible hoses must be WRAS approved.

12. Pipework installations

General

12.1 All hot and cold water pipework should be designed and installed in full accordance with the Scottish Water Byelaws 2004 and relevant parts of BS6700:2006, BS EN 806-2: 2005 and BS8558: 2011.

12.2 It is essential to include within the system facilities for measuring, regulating, isolating, venting, draining and controlling the flow of water. Regulating valves with built-in pressure tappings or orifice plates with manometer tappings will be required for the measurement of pressure drop, which enables the volume rates of flow to be determined. Care must be taken to ensure that regulating valves or orifice plates are sited well away from bends or fittings.

Sizing

12.3 Mains should be capable of a rate of flow to satisfy the combined maximum demand of all the services to be supplied. All the maximum demands of the separate services may not occur simultaneously, and the actual combined maximum demand may be a proportion of the sum of the separate maximum demands, which will be determined by the number and character of the services.

12.4 Hot and cold water pipework should be sized using the procedure outlined in CIBSE Guide G: 'Public health engineering.

Routeing of pipework

12.5 Pipework in buildings should be designed and routed in a manner that will promote good turnover of water particularly in cold water service systems (see Figure 3). It should be installed so that it is accessible for inspection, maintenance and repair as far as is practicable. Ducts, trenches and chases containing pipework should be large enough to facilitate repairs.

12.6 Pipework distribution networks should be divided into sections by the provision of isolating valves in accessible locations to facilitate isolation for repairs, maintenance and flushing.

12.7 Underground mains need not be laid at unvarying gradients but may follow the general contour of the ground. As far as possible, however, they should fall continuously towards drain points and rise continuously towards the air vent. They should not rise above the hydraulic gradient; that is, there should always be a positive pressure, greater than atmospheric, at every point under working conditions. The gradient between air release and drainage valves should be not less than 1:500 rising in the direction of flow and not less than 1:200 falling in the direction of flow.

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12.8 Underground pipes entering a building should do so with a cover of not less than 0.75m below the external ground surface and should pass through the wall within a watertight built-in sleeve. The sleeve should be filled in around the pipe with a suitable material for a minimum length of 152mm at both ends to prevent the ingress of water or vermin. External underground pipes should be at a depth, or otherwise sufficiently protected, to prevent damage by traffic and any consequent vibrations. A minimum depth under roadways of 1m measured from the top of the pipe to the surface of the roadway is necessary. In other underground locations the depth should not be less than 0.75m, subject to this depth being sufficient protection against frost; frost penetration depends on the nature of the subsoil and the ground surface. Freezing can occur at depths of up to 1.1m. Local information on the prevalence of frost should be sought.

12.9 Marker tapes should be laid over the whole length of all underground water services pipework. The tapes should be clearly marked with the description of the service and should be coloured blue (red for fire mains). Tapes should be spirally wound around pipes.

Vents and drains

12.10 Air-release valves should be provided at summits and drainage valves at low points between summits, unless adequate provision is made for the discharge of air and water by the presence of service connections. Large-orifice air valves will discharge displaced air when mains are being charged with water. When air is liable to collect at summits under ordinary conditions of flow, small orifice air valves, which discharge air under pressure, may be required. “Double-acting” air valves having both large and small orifices should be provided where necessary. Air-valve chambers should be adequately drained to avoid the possibility of contamination.

12.11 Automatic air-release valves should be installed where accessible for maintenance. Installation in ceiling voids is not recommended.

12.12 Drain points should not discharge directly into a drain or sewer or into a manhole or chamber connected thereto without a type ‘A’ air gap. Where a washout discharges into a natural watercourse, the discharge should at all times be well above the highest possible water level in the watercourse. Consent for this discharge may be required from the Scottish Environment Protection Agency. In some cases it may be necessary for the washout to discharge into a watertight sump, which has to be emptied while in use by portable pumping equipment.

12.13 In order to minimise quantities of water that may collect in stub pipes at drain points, the length of such stub pipes should be kept to an absolute minimum. This relates in particular to drains from hot water calorifiers, storage cisterns and distribution pipework.

Valves

12.14 A clear indication should be given on all valves of the direction of rotation needed to close the valve. Normal practice is to have clockwise closing when looking down on the valve.

12.15 Where blending valves have been installed at the end of a run of hot water pipework, consideration should be given to the inclusion of a drain valve adjacent to the mixer. This should be located upstream of the mixing valve so as to facilitate flushing out and routine temperature testing of the hot water without having to dismantle the blending valve.

Prevention of contamination

12.16 In all cold water installations it is important that adequate protection be provided to all supplies against backflow. In healthcare facilities, there should be a high degree of protection not only to the water in the water supply authority's mains, but also within the installations to protect the patients and staff. In addition to backflow protection at all points of use, the whole installation protection should be provided as required by the Scottish Water Byelaws 2004.

12.17 Healthcare buildings and medical premises have been identified as involving Fluid Category 5 backflow risks (see Schedule 1 "Fluid Categories" from Byelaw 1 in the Scottish Water Byelaws 2004 which are defined as points of use or delivery of water where backflow is likely to involve fluids contaminated with human waste.) Within healthcare facilities, water usage covers a wide range of applications, from domestic use by patients and staff to specialised use in operating departments and pathology laboratories, and with equipment such as bedpan washers and haemodialysis machines. In addition, many apparently "commercial" usages may be classed as high-risk because they are for healthcare purposes, such as centralised laundries.

12.18 The hot and cold water storage and distribution systems should be designed so as to avoid the risk of contamination of the water supply. Such contamination may be caused by backflow, interconnections between potable and non-potable water supplies, stagnation, contact with unsuitable materials or substances, *Legionella* growth etc. The Scottish Water Byelaws 2004 require the identification, by colour-coding or labelling, of all pipework carrying fluids other than wholesome water.

12.19 Comprehensive guidance on the measures required to prevent contamination of the water supply is given in the WRAS 'Water Regulations Guide' and in relevant parts of BS6700: 2006, BS EN 806-2: 2005 and BS8558: 2011.

12.20 Certain departments such as pathology laboratories present particular risks of water contamination. Attention is drawn to section G15.24 in the WRAS 'Water Regulations Guide' on supplementing point-of-use protection by zone protection, where the pipes supplying a high-risk area can be given additional protection by installation of a secondary backflow protection device.

12.21 Instances of water use in hospitals where backflow is likely to be harmful to health include bidets, bedpan washers, dental spittoons and equipment, mortuary equipment, and water outlets located in laboratories.

12.22 Where any doubt exists with regard to the level of protection required against water supply contamination, reference should be made to the Scottish Water Byelaws 2004 and guidance contained in the WRAS ‘Water Regulations Guide’, or water supply authority.

Frost protection

12.23 The Scottish Water Byelaws 2004 require that all cold water pipework and fittings be adequately protected against damage from freezing.

12.24 In the case of external pipework that is run underground, the Regulations require that consent be sought from the water supply authority if pipes are to be run at depths of less than 750mm or greater than 1,350mm. Permission from the water supply authority must be sought if any deviation is required.

12.25 Particular care is required when routeing pipework externally above ground or through unheated areas within buildings. The WRAS ‘Water Regulations Guide’ gives guidance on the minimum thickness of thermal insulating materials that should be applied in such cases.

12.26 Adequate provisions for isolating and draining sections of cold water distribution pipework will ensure that disruption caused by frost damage can be minimised.

12.27 For further guidance on frost protection, refer to the WRAS ‘Water Regulations Guide’.

Flushing

12.28 Prior to taking systems into use, they should be subject to a thorough regime of flushing before disinfection (see paragraph 17.15).

13. Noise and vibration

Pump noise

13.1 Noise generated by centrifugal pumps will not cause problems if water velocity in the pipes and the speed of the pumps are low, for example about 1 m/s and 960 rpm respectively.

13.2 Care should be taken in locating water-boosting pumps within healthcare buildings to ensure that they will not cause interference to wards and other quiet zones.

13.3 Such interference may result from breakout noise from the boosting equipment, or noise transmitted through the pipework system or through the building structure. Pump noise may also result from cavitation caused by low suction head.

13.4 Where pumps are located close to sensitive areas, provision for noise and vibration reduction must be incorporated within the design. Such provision will include selection of quiet-running motors, vibration isolation of boosting equipment from pipework and structure and, if required, acoustic lining to the booster plant enclosure.

13.5 Guidance on recommended noise levels for various locations is given in CIBSE Guide A: ‘Environmental design’.

Other forms of system noise

13.6 Other forms of nuisance noise that may be generated by hot and cold water distribution systems are listed below:

- noise from pipework due to excessive water velocity;
- water hammer caused by rapid closure of valves or taps;
- oscillation of the float of a float-operated valve;
- tap washer oscillation;
- noise caused by water discharging from float-operated valves into cisterns;
- noise caused by thermal movement of pipes;
- noise due to trapping of air within pipework, particularly on hot water systems.

13.7 Further details on the above sources of noise, including guidance on avoiding such noise problems, are given in the WRAS ‘Water Regulations Guide’.

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14. Water economy and energy conservation

Water

14.1 Hot and cold water distribution systems for healthcare buildings should be designed so as to minimise the use of water. The cold water distribution systems should incorporate an adequate number of water meters to allow for close monitoring of water consumption. Where practicable, consideration should be given to linking water meters to a building management system.

14.2 Measures to minimise water consumption that should be considered at design stage include:

- provision of automatic systems to control flushing of urinals;
- use of showers rather than baths wherever practicable;
- WC pans and flushing cisterns that use more than 6 litres per flush are prohibited by Scottish Water Byelaws 2004;
- control of water pressure to a level that is not excessive for the purpose required;
- use of percussion taps in appropriate circumstances;
- locating warning pipes from cisterns and discharge pipes from relief valves in such a way that any discharge can be readily observed, and/ or fitting alarms on such pipes.

14.3 Further guidance on the prevention of wastage of water is given in the WRAS 'Water Regulations Guide'. Reference should also be made to the Audit Commission's (1993) 'Untapped savings: water services in the NHS'.

Energy

14.4 Energy used in the generation of hot water can be minimised by ensuring that the hot water storage and distribution system is adequately insulated and that thermostats controlling water temperature in hot water storage vessels are set no higher than is necessary for the control of *Legionella*.

14.5 Hot and cold water systems should be designed to operate by gravity as far as possible. Where water-boosting pumps are necessary, the pump motors should be selected to operate at maximum efficiency at the required duty.

14.6 The practice of pre-heating of the cold feed to calorifiers should not be carried out. The only time it is acceptable is when under all flow/demand conditions a temperature greater than 45°C can be guaranteed at the entry to the calorifier. Any pre-heater should have a low water capacity.

14.7 Further guidance on energy conservation in relation to hot and cold water systems is given in Scottish Health Technical Memorandum 07-02: EnCO$_2$de –

making energy work in healthcare, environment and sustainability, 2006 (see also the Carbon Trust's website, http://www.carbontrust.co.uk).

BREEAM (Building Research Establishment Environmental Assessment Method)

General Scope

14.8 BREEAM was established to set standards for best practice in sustainable design and is used to describe a building's environmental performance. The concept has been through various stages of development. Most recently "BREEAM New Construction 2011" has replaced "BREEAM Healthcare". It uses a scoring system to prove environmental credentials, setting and maintaining robust technical standards, positively influencing design, construction and management of buildings.

On 1st August 2008 its scope was extended to include

- a new 2-stage assessment process (Design Stage and Post Construction Stage);
- introduction of mandatory credits.

"BREEAM Healthcare" replaced NEAT (NHS Environmental Assessment Tool) after which all new healthcare buildings required to achieve an "excellent" rating while refurbishment projects should be rated as "very good".

External audits must be undertaken by BREEAM Healthcare-licensed assessors with credits awarded for a whole range of environmental issues. The various ratings comprise Pass, Good, Very Good, Excellent and Outstanding.

They are to apply to

- new buildings (whole buildings only);
- major refurbishments of existing buildings;
- new build extensions to existing buildings.

Among the environmental issues covered by BREEAM Healthcare are those relevant to Scottish Health Technical Memorandum 04-01 regarding water consumption and efficiency. Therefore the practicalities of the following should be examined at the design stage of any project to verify their suitability given the use of the premises, control of infection requirements and vulnerability of patients concerned.

- use of water efficient appliances (low-flush toilets, P.I.R.-operated or percussion taps);
- incorporation of leak detection systems;
- use of timed or PIR-instigated urinal flushing;
- provision of water metering.

Many of these issues are routinely incorporated in new works and figure in this Scottish Health Technical Memorandum but there are issues arising as set out below that require further investigation and are *not yet recommended* for automatic adoption in Scotland.

BREEAM	email enquiries	breeam@bre.co.uk
	website	http://www.breeam.org

Limitations of BREEAM

14.9 BREEAM Healthcare has been encouraging the incorporation of solar panels for pre-heating of domestic hot water installations and adoption of rainwater harvesting to promote energy efficiency and sustainability.

There is a temptation for those responsible for issuing design briefs to require such installations to be incorporated into new and refurbishment projects and, equally, for designers to offer them in order to achieve more easily the best possible BREEAM rating. This ignores real issues that could be detrimental to patients' health and wellbeing. Several installations have been set up as pilot projects and are, or will be, subject to monitoring.

Solar Panel Pre-heating

14.10 Paragraph 14.6 states that pre-heating of the cold feed to calorifiers should not be carried out. Variable availability of solar power and its effect on performance, together with the impact of intermittent usage would result in situations whereby the stored temperatures of water would lie within the *Legionella* breeding range. Further information will be found in SHTM 04-02 Part A "Solar Water Heating".

Rainwater Harvesting

14.11 This relies on the ingathering of water from roofs and gutters where it would have been contaminated by bird droppings and general unwanted detritus. The volume of water would also require to be treated (decontaminated) by filtration and either heating or chemical treatment, neither of which is conducive to energy conservation. If this were not done, even when restricted to toilet flushing, the dispersal of potentially contaminated aerosols into the patients' breathing zone is not compatible with patient safety or control of infection. A standard NHS-pattern risk assessment should be undertaken when users with compromised immune systems were involved. Further information will be found in SHTM 04-02 Part B "Rainwater Harvesting".

Action required: Neither solar panel pre-heating nor rainwater harvesting should be incorporated into new schemes as a matter of routine until further research has been carried out into the practicalities and avoidance of risk.

15. Water treatment

Introduction

15.1 The European Drinking Water Directive (98/83/EC), which is translated into the Water Supply (Water Quality) (Scotland) Regulations 2001 & 2010, lay down that Bodies must "…*take measures to ensure that water intended for human consumption is wholesome and clean…"* and it further states that this requirement is to be measured at the point of supply which, for the purposes of this Guidance Document, is to be taken to mean the outlet of the tap.

The introduction of chemical treatment to the potable water supply is an admission that the physical installation and/or the management process is incapable of maintaining that water supply in a wholesome condition.

Before any water treatment regimes are considered, a risk assessment should be carried out to verify that there are no other management processes or mechanical steps that can be taken regarding pipework configuration, plant or equipment that would avoid the need to introduce some form of treatment. For the avoidance of doubt, this risk assessment must compare any risk to health from contamination of the water supply as a result of the growth of bacteria or other contaminants against the potential risk to health from the proposed chemical additives.

15.2 Any decision to introduce water treatment should be externally validated by the Authorising Engineer (or equivalent). Certain treatments are not suitable in all circumstances.

Note 18: Further guidance on this particular matter can be found in Part "D" of this SHTM.

15.3 Whichever treatment regime is adopted will have an impact on the discharge to the foul sewer. Consequently, the Scottish Environment Protection Agency (SEPA) must be informed and acceptance verified. Consideration could be given to liaising with the water supply authority although their responsibility ends with supplying wholesome water at the point of entry to the premises.

Treatment options

15.4 There are various forms of water treatment that may be considered. However, continuous dosing of any disinfectant into potable water supplies cannot be recommended as a first course of action although either "shock" or "campaign" dosing may offer a short-term solution in a crisis situation.

15.5 If the disinfecting measures are related to the elimination of recurring *Legionella* problems, they should be regarded as short-term solutions pending resolution of issues relating to pipework configuration, dead-legs, etc. Attention is better placed in the elimination of infrastructure contributory factors leading to inadequate temperature control. If intractable problems remain in relation to this, trace heating of affected lengths of pipework may be considered. It should be noted, however, that reliance on trace heating on its own cannot be recommended and, should such a system be adopted, it must be supplemented by a robust monitoring regime, including temperature measurement, to ensure system operability within the design temperature parameters.

15.6 The following forms of treatment are available for consideration as listed below. Each has its own range of concerns. Pending issue of the Addendum to this Guidance Document referred to in paragraph 15.2, extreme care should be exercised

Chlorine dioxide

15.7 Chlorine dioxide is an oxidising biocide that is capable of reacting with a wide range of organic substances and has been shown to be effective in the control of organisms in water systems. Use of chlorine dioxide as a chemical treatment for drinking water treatment is now subject to a European Standard (BS EN 12671: 2009).

There are two aspects to be taken into consideration:

- in the cold water distribution system, chlorine dioxide may be injected into the system upstream of all parts of the distribution, storage and boosting equipment or at the break-tank serving the booster set. There must be close monitoring and control of the dose, which must comply with the Water Supply (Water Quality) Regulations 2001 and 2010 for the equivalent use of chlorine dioxide in the treatment of water supplies by the water authority;
- in the case of hot water distribution systems with calorifiers/water heaters operating conventionally, that is, at 60°C, there will be a tendency for chlorine dioxide to be lost by ‘gassing off’, especially if the retention time in a vented calorifier/water heater is long. In most cases, however, some total oxidant should be found in the hot water, although at levels far less than the minimum 0.5 ppm to be maintained at the taps.

Where copper supply pipes are used, chlorine dioxide can result in high concentrations of copper being measurable in the water supplies.

Additional information on chlorine dioxide is given in Appendix 4 of this document.

Silver/copper ionisation

15.8 Ionisation systems release copper and silver ions into the water stream by means of electrolytic action. Ionisation as a water treatment method is covered in BSRIA’s Technical Note TN 6/96 following a study in which it was shown that copper and silver ion concentrations maintained at 400 μg/litre and 40 μg/litre respectively can be effective against planktonic *Legionella* in hot water systems. In soft waters a silver level as low as 20 μg/litre can be effective.

The use of ionisation as a control measure should only be considered strategically on a complete site/campus basis to ensure continuity of control measures. This will depend on the water supply quality and on the design of the systems in use and, in an existing system, their operational history.

The electrodes can be susceptible to accumulation of scale unless effective anti-scaling electrode cells are fitted. The system should be designed to take account of water quality; otherwise additional treatment may be necessary. Copper and silver ion treatment is also sensitive to pH, and thus pH control may be required.

In hard water areas there have been cases of staining of sanitaryware, but in a properly controlled system where dosing levels of silver are not exceeded, this should not be a major problem.

The opinion of the Committee on Products and Processes for Use in Public Water Supply concerning the use of silver as a disinfectant in public water supplies can be found on the Drinking Water Regulator website: http://www.dwi.gov.uk/cpp/silver.htm.

Additional information on copper and silver ions is given in Appendix 5 and attention is particularly drawn to Note 26 in the Appendix.

Ozone and ultraviolet treatment

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

Ultraviolet and ozone are methods that are suitable for water systems used for dialysis equipment. However, allowance must be made for the aggressive effects of ozone on materials exposed to it, particularly the degradation of rubber compounds and the corrosion of metallic materials.

The systems should be fail-safe and have adequate instrumentation to monitor operation. For example, UV systems should be preceded by particle filtration to prevent microorganisms being shielded by particles, and incorporate a detector so that any loss of transmission can be corrected immediately. They require appropriate pre-filtration to remove particulate matter that may shield bacteria from the UV rays.

Silver catalysed hydrogen peroxide

15.10 Silver catalysed hydrogen peroxide should not be dosed into the potable water supplies on a continuous basis. Periodic dozes on a “shock” basis at varying concentrations might be employed. A typical situation could arise from the discovery of *Legionella* in a domestic water services system where reconfiguration of the pipework installation proved to be prohibitively costly. Paragraph 2.40 of Part D of this SHTM also refers. It also appears that this form of treatment is effective in removing biofilm.

Note 19: Whichever form of treatment is adopted, a change in potability will occur and it will be necessary carry out a risk assessment and have proposals audited by an independent authority.

Purging the systems

15.11 Immediately after initial dosing, checks should be made at various parts of the system to ensure that satisfactory concentrations of treatment chemicals are being achieved.

16. Testing and commissioning

Introduction

16.1 While testing and commissioning is regarded as a discrete activity, continuous monitoring is required throughout the installation to ensure that:

- materials and equipment installed comply with the Scottish Water Byelaws 2004 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 will comply;
- the work is done entirely within the specification for the scheme;
- 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 etc Act 1974.

The design and commissioning procedures should be signed off on behalf of the client by a suitably experienced public health Engineer.

Installation checks

16.2 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 subsequent operation. 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. Equipment that requires to be maintained or which is likely to fail or be replaced during the life of the system should be de-mounted and re-instated during the installation process to ensure that it is maintainable and that appropriate isolation is provided to ensure safety and continuity during operational use.

Inspection of joints

16.3 Before pressure testing, the site engineer should identify a number of fittings to be cut out for examination to establish whether the quality of the finished joint meets the specification. The exact number to be cut out will vary according to the size of the installation, but as a guide, a ratio of one fitting per 400 installations should be cut out. In any event, a minimum of two, and not normally more than five, fittings should be cut out for examination.

16.4 The fittings cut out should be cut open (quartered longitudinally) and examined. If unacceptable joints are found, adjacent fittings should be cut out until the extent of any faulty workmanship has been established.

16.5 The pipeline should be made good.

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16.6 The tube and fitting should be internally clean and free from particulate matter. Some oxidation will be evident when hot 'joints' are made on copper piping.

16.7 When copper pipe and capillary fittings are used, because of the viscosity of the brazing filler, full penetration may not be achieved.

16.8 The minimum penetration at any point must be three times the wall thickness of the tube or 3mm, whichever is the greater.

Commissioning

16.9 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 contractor's commissioning engineer. This brief should specify fully and clearly the extent of the commissioning and maintenance and the objectives which must be achieved, and should include:

- full design data on temperatures, water flow rates and pressures;
- plant and equipment data;
- number commissioning procedures for thermostatic mixing valves in accordance with specification MES D08;
- drawings and schematics;
- a list of test certificates to be provided.

16.10 The designer's attention is drawn to CIBSE Commissioning Code W: 'Water distribution', which provides guidance on information that will be required by the commissioning engineers.

16.11 In the preparation of commissioning instructions for domestic hot and cold water services, designers should ensure that their work is in accordance with up-to-date guidance from the Department of Health's Estates & Facilities Division.

16.12 The designer should prepare for inclusion in the contract documents a list of tests and measurements that are to be taken by the contractor and recorded by him/her. These should be witnessed by the contract supervising officer or project engineer on his/her behalf and he/she, if approved, will circulate the results, in accordance with the client's instructions.

16.13 The commissioning manual should be prepared by the contractor and submitted to the client's commissioning adviser for review before being issued in final form.

16.14 Typical schedules of checks and performance tests should be included in the commissioning manual together with record sheets. These should be amended and supplemented as the designer/client advisor considers necessary.

16.15 The supervising officer or project engineer, who should countersign any relevant test record documents, should witness commissioning and testing.

16.16 ‘As installed’ record drawings, schematic diagrams, operating and maintenance instructions must be supplied at the time of handover. Certified records of pressure testing and disinfection should also be made available.

16.17 The whole commissioning procedure should be carried out under the guidance of a single authority, although the involvement of specialists or manufacturers may be required for specific items of plant.

16.18 Valid calibration certificates should be submitted and checked for all measuring equipment to be used by the commissioning engineers prior to commencement of commissioning.

16.19 The commissioning should be carried out in a logical and methodical manner.

16.20 The installation, on completion, should be operated by the contractor as a whole, and subjected to specified functional or performance tests.

16.21 Once the system meets the design intent, the final completion record sheet(s) should be completed. In the event of performance not being acceptable, the matter should be dealt with in accordance with the contract requirements.

Commissioning and testing checklists

16.22 The following is a summary of the key activities associated with pre-commissioning and commissioning of hot and cold water storage and distribution systems. The list is not intended to be comprehensive.

Cold water installations

16.23 Pre-commissioning checks can be carried out on completion of the system installation, filling and pressure testing.

16.24 Pre-commissioning checks and tests to be applied are as follows. Check that:

- systems have been provided and installed in accordance with specification and drawings, and that the systems are charged with water, vented and free from leaks;
- water storage cisterns are free from distortion and leaks, are properly supported and secured, are provided with correctly fitting covers, and are in accordance with the Scottish Water Byelaws 2004;
- distribution pipework is rigidly supported, insulated, and incorporates adequate provisions for venting, draining, expansion, isolation and measurement of flow, temperature and pressure;
- pipework systems have been pressure tested;
- pipework systems and storage cisterns have been flushed, disinfected, appropriate certification received, and that specified residual chlorine levels are attained;
- pipework systems and storage/break tanks are correctly identified and marked;

- regulating valves and flow control devices operate freely;
- water meter(s) is/are fitted correctly;
- electrical isolation, cross-bonding and wiring of system components are installed in accordance with BS7671: 2008.

16.25 Upon satisfactory completion of the pre-commissioning tests, the commissioning tests can commence.

16.26 Commissioning checks and tests to be applied are as follows. Check that:

- overflows run freely and discharged water does not cause flooding or damage, and that drain-down points flow when released and are free from leaks when shut;
- float-operated valves function satisfactorily and are adjusted to give the correct water level;
- control valves operate correctly and shut-off valves close tightly;
- all electrical circuits are tested and the pump motor direction of rotation is correct, and that electrical controls and alarms function correctly;
- operation of any safety or anti-flood device is satisfactory;
- circulating or lifting pumps are free from excessive noise, vibration and leaks;
- remote control of pumps (if appropriate) is satisfactory;
- the installation is vented and regulated;
- the flow rate into, and out of, storage cisterns is recorded;
- all taps, mixers and outlets operate satisfactorily, and test and record mass flow from outlets in positions shown on contract drawings. (TMVs require hot and cold water for testing and commissioning. Type 3 TMVs are commissioned in accordance with MES D08);
- temperature of water in storage cisterns and at taps is appropriate;
- full load current of components does not exceed the recommended values;
- the running current of components does not exceed the recommended values;
- pump thermal overload trips are set;
- system schematic is displayed in a frame in the relevant plantroom, complete with valve schedule.

Hot water installations

16.27 Pre-commissioning checks can be carried out upon completion of system installation, filling and pressure testing.

16.28 Pre-commissioning checks and tests to be applied are as follows. Check that:

- systems have been provided and installed in accordance with the specification and drawings;
- the system is charged with cold water, vented, and free from leaks;
- hot water storage vessels are free from leaks and are properly supported and secured;
- distribution pipework is rigidly supported, insulated, and incorporates adequate provision for venting, drainage, expansion, isolation, and measurement of flow, temperature and pressure;
- pipework systems, storage cylinders etc have been pressure tested, flushed and disinfected, and appropriate certification has been received, and that specified residual chlorine levels are attained;
- pipework systems, calorifiers and cisterns are correctly identified and marked;
- regulating valves and flow control devices operate freely;
- all control and regulating valves are labelled or marked to correspond with reference numbers on contract drawings;
- electrical isolation, cross-bonding and wiring of system components is installed in accordance with BS7671: 2008;
- system schematic is displayed in a frame in the relevant plantroom.

16.29 Upon satisfactory completion of the pre-commissioning checks, the commissioning checks and tests can then be started.

16.30 Commissioning checks and tests to be applied are as follows. Check that:

- drain down points flow when released and are free from leaks when shut, and that air vents and release valves open correctly and are airtight when shut off;
- all temperature and other controls are adjusted and calibrated to agreed design limits of system performance;
- all electrical circuits are tested and the pump motor direction of rotation is correct, and that electrical controls and alarms function correctly;
- control valves operate correctly and shut-off valves close tightly;
- heat exchangers operate satisfactorily;
- primary heating circuits are adjusted and regulated, and thermostatic settings are correct; and that bypass circuits and automatic control valves operate correctly;
- circulating pumps are free from excessive noise, vibration and leaks;
- remote and automatic control of pumps (if appropriate) is satisfactory, and there are no leaks at joints under maximum flow conditions;
- secondary circuits are regulated and vented;

- thermostatic mixing devices and regulating valves are adjusted and set to desired values (TMVs require hot and cold water for testing and commissioning, and should be commissioned in accordance with MES D08);
- all taps, mixers and outlets operate satisfactorily;
- water flow quantities at all plant items, regulating valves and flow-measuring valves are recorded;
- mass flow from taps, main and other outlets in positions shown on contract drawings is satisfactory;
- pressure drop at heat exchangers at full design demand flow is tested and recorded;
- hydraulic balancing of hot water secondary circulation system is carried out to ensure that minimum temperatures are achieved in all parts of the circuit;
- full load current of components does not exceed the recommended values;
- the running current of components does not exceed the recommended values;
- pump thermal overload trips are set.

Pressure testing

16.31 Pressure testing must be carried out before disinfection. Except where otherwise specified, testing of underground pipelines should be carried out in accordance with the requirements of the Scottish Water Byelaws 2004.

16.32 Open pipes should be capped and valves closed to avoid contamination.

Temperature testing

16.33 These 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.

16.34 Tests should include:

- measuring the incoming water temperature at the main water meter;
- testing the inlet, outlet and surface water temperatures of cisterns and cold water feed/ header tanks for the hot water calorifiers. The temperature should not be greater than 2°C above that measured at the main water meter;
- 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;
- 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;

- testing single hot water outlets and inlets to mixing valves to ensure that a minimum of 55°C is achieved within 1 minute;

Note 20: The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of 1 minute to achieve an equilibrium temperature of 50°C. A minimum of 55°C may be required for the operation of suitable mixing devices required to provide 'safe' hot water at the upper limit of the recommended range. Hot water at 55°C is required in many cases for reasons of food hygiene or decontamination requirements, for example in kitchens and sluice rooms. In a properly balanced hot water circulating system, with the circulation taken close to the draw-off point, achieving temperature should be virtually instantaneous. (At a typical flow to a wash-hand basin of 4.5 litres/m, 1 min to achieve temperature would indicate a 25m dead-leg of 15mm pipe or that the system is out of balance.)

- testing single cold water outlets and inlets to mixing valves to ensure that temperature equilibrium below 20°C is achieved within 2 min;

Note 21: The Health and Safety Commission's (2000) Approved Code of Practice L8 permits a period of 2 min to achieve an equilibrium temperature below 20°C. Achieving this minimum requirement would be indicative of an exceptionally under-utilised water system in an unoccupied building. During commissioning, therefore, it is essential to encourage draw-off to simulate normal usage. (At a typical flow to a hand-wash basin of 4.5 litres/m, 2 min to achieve temperature would indicate a 50m dead-leg of 15mm pipe or that stagnation is occurring.)

- Testing the temperature at hot water draw-off points to ensure that they comply with the recommended temperatures in Table 4. (NB: the maximum temperatures should not exceed those shown in Table 4 by more than 2°C.).

Note 22: Further information on commissioning procedures can be found in Part E of this SHTM: Alternative materials and filtration.

17. Disinfection

17.1 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. When considering a contractor to carry out the work, preference should be given to companies/individuals who are members of the *Legionella* Control Association (formerly, the Code of Conduct Association for the Control of *Legionellosis*).

17.2 Alternative disinfectants may be used, provided satisfactory disinfection is achieved. The infection control team should be consulted, and advice should also be sought from the Drinking Water Quality Regulator.

Note 23: Disinfection is a requirement of the Water Regulations. Additional advice on the use of alternative disinfectants can be found in Part "D" of this SHTM which covers continuous dosing of installations in use.

17.3 Proprietary solutions of disinfectant should be used in accordance with the manufacturers' instructions. The COSHH Regulations require that the risks from using the disinfectant for each task be assessed to ensure that the control procedures adopted are suitable for the particular application.

17.4 Disinfection should not be undertaken before materials, for example linings in cisterns, have fully cured. Advice should be sought from equipment manufacturers to ensure that proposed disinfection chemicals will not adversely affect performance. No heat source should be applied during the disinfection procedure, including final flushing.

17.5 Pipework under pressure from the mains should be disinfected through an injection point and the disinfectant residual measured at the end of the pipeline. BS6700: 2006, BS EN 806-1-5: 2000-2012 and also BS8558: 2012 and the Approved Code of Practice L8 advise 50 mg/litre (ppm) for one hour or 20 mg/litre (ppm) for two hours; it is usual practice to leave the chlorine solution in the pipes for 24 hours before thoroughly flushing out with fresh water. Junctions that are to be inserted into existing pipelines should be disinfected prior to installation.

17.6 All disinfection of pipework under pressure from the mains must be carried out in accordance with the requirements of the water supply authority. Failure to ensure close liaison between the contractor and the water authority during design, construction, pressure testing or commissioning could present a potential risk of back-flow of contaminated materials or chemicals into the public water supply. Site supervision to ensure compliance with any requirements specified by the local water supply authority is recommended.

17.7 All cisterns should be internally cleaned to remove all visible dirt and debris. Cisterns and distributing pipework should be drained, filled with fresh water and then drained completely. The cisterns should then be refilled and the supply servicing valves closed. On re-fitting it is normal practice to add high doses of sodium hypochlorite to the water in the cisterns, for example, to give a calculated chlorine concentration of 50 ± 10 mg/litre (ppm) in the water, and leave the water to stand for one hour. Whatever disinfection method is used, the concentration should be adjusted if necessary. The use of a high dose ensures an adequate residual concentration to allow proper disinfection of the downstream services. Each tap or fitting should then be opened, progressively away from the cisterns, and water discharged until the disinfectant is detected. Each tap or fitting should then be closed, and the cistern and pipes left charged for a further hour. The tap(s) furthermost from the cisterns should be opened, and the level of disinfectant in the water discharged from the taps measured. If the levels set are not achieved, the disinfection process should be repeated.

17.8 As soon as possible after disinfection, the distribution pipework should be drained and thoroughly flushed through with fresh water and refilled (see paragraphs 17.14 and 17.15). Appropriate hazard warnings should be placed on all taps throughout the building during disinfection procedures.

17.9 After disinfection, microbiological tests for bacteria colony counts at 37°C and coliform bacteria, including *Escherichia coli*, should be carried out under the supervision of the infection prevention control team to establish that the work has been satisfactorily completed. Water samples should be taken from selected areas within the distribution system. The system should not be brought into service until the infection control team certifies that the water is of potable quality.

Discharge of waste water used during disinfection procedures within buildings

17.10 Contaminated water should not be run to drain without discussion and approval of the water or environmental authority.

Thermal disinfection (of hot water service systems)

17.11 The process introduces a serious scalding risk, and it is essential that steps are taken to ensure that access is limited to authorised personnel only until such time that the system has returned to normal operating temperature: it is unlikely to be a practicable alternative for a large system. It also requires the removal of thermostatic elements, thus introducing additional practical difficulties.

17.12 This process can be performed by raising the temperature of the entire contents of the calorifier, or hot water heater, followed by circulating the water throughout the system for at least an hour. The calorifier/heater temperature must be sufficiently high to ensure that the temperature in all parts of the circulating system, and at the return connection, does not fall below 60°C. After this period, each tap or draw-off-point should be run sequentially from the nearest point to the furthermost outlet. At branches it will be necessary to draw-off water to at least one outlet, the nearest, to ensure adequate purging. The draw-off at the tap or outlet should be for a period of at least five minutes at full temperature.

Maintaining control of systems

17.13 Once disinfection has taken place, it is essential to put in place measures to ensure that hot and cold water temperatures are maintained. This will require regular flushing, at least weekly, and possibly more frequently during periods of hot weather.

17.14 Once filled, systems should not be drained unless full disinfection is to be carried out prior to building occupancy and use. However, allowing water in newly installed capillary-jointed copper plumbing to stagnate can result in serious corrosion of the copper. To reduce the risk of this, it is recommended that flushing should take place on a weekly basis to introduce fresh water throughout the system.

17.15 To prevent the accumulation of biofilm during construction and testing, continuous dosing of water systems with appropriate biocides should be considered. Such treated systems should be regularly flushed to ensure that the biocide reaches all parts of the systems, and particularly outlets. Dosing with an appropriate level of biocide as soon as water hits a pipe or storage vessel, along with regular flushing, can control the accumulation of biofilm more effectively.

18. Documentation

General

18.1 It is essential that a full report of all commissioning and testing activities is compiled and handed over to be incorporated within the operation and maintenance manuals.

18.2 These commissioning and testing records will be required so that subsequent maintenance and periodic checks can be made to ensure that the installation continues to operate as intended. Such information will include results of temperature checks on the cold water supply and hot water circulating systems and commissioning and in-service test data for Type 3 TMVs. The information should also include identification of, and test results for, sentinel taps.

18.3 Where continuous water treatment is installed, the commissioning records should include details of settings of the equipment, dosing rates and requirements for testing.

18.4 Operation and maintenance manuals should be in accordance with BSRIA's (1990) Application Guide 1/87: 'Operation and maintenance manuals for building services installations'.

18.5 As a minimum, for new installations or major refurbishment, the contract should require the following documents and drawings to be supplied:

- full manufacturing details, including batch numbers of all pipes and fittings;
- full records and certificates of pressure tests for all sections of pipework;
- settings of all balancing valves, with readings of flow rates where applicable;
- full details of each item of plant, including arrangement drawings and appropriate test certificates;
- as-fitted drawings showing clearly the location of balancing valves, flows and settings, isolation valves, drain valves;
- schematic drawings for installation in plantrooms showing all valves and items of plant;
- full details of water treatment parameters and operating modes and settings;
- full details of maintenance requirements;
- detailed confirmation of disinfection procedures to BS6700: 2006, BS EN 806-1-5: 2000-2012 and BS 8558: 2011, and results of post-disinfection microbiological analysis;
- full records confirming that all materials and fittings hold WRAS or equivalent accreditation.

Appendix 1: Water consumption

Ward unit

1 For the purposes of this study, a ward unit is defined as a combination of all the rooms which make up the working area for patient care, that is, patients' bedrooms, day spaces, treatment, utility and test rooms, bathrooms, showers, WCs, pantry, staff rooms, cleaners' room etc and circulation spaces. Figure A1 shows the average daily consumption of stored water and Figure A2 shows the rate of supply of mains water to cistern.

Designers should consider the impact on water consumption of such specialist departments such as Renal Dialysis and the dumping of water as part of the filtration processes.

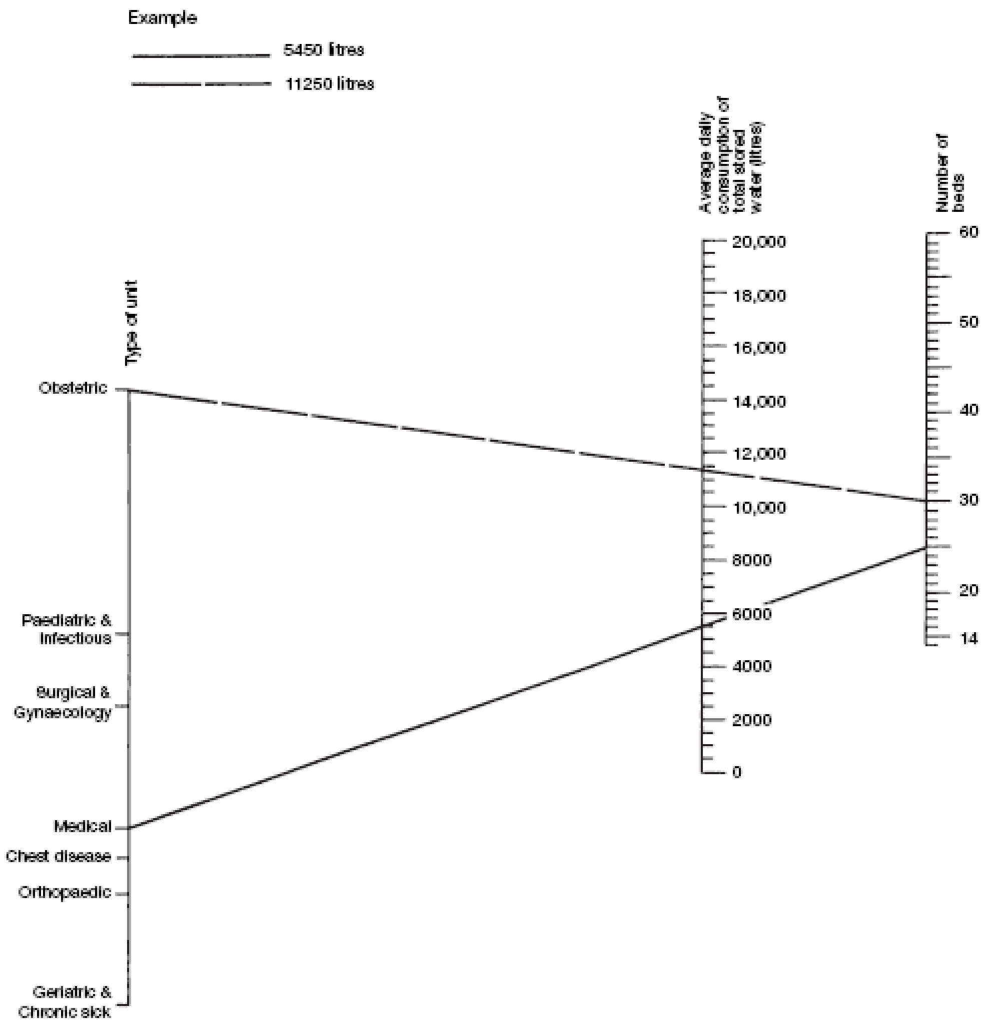

Figure A1: Average daily consumption of total stored water

Use of nomogram
Project line from point to number of beds. The intersection on 8000 scale gives rate of supply of mains water in litres/hour. The result obtained relates to one ward unit. For a given number of ward units, multiply by the number.

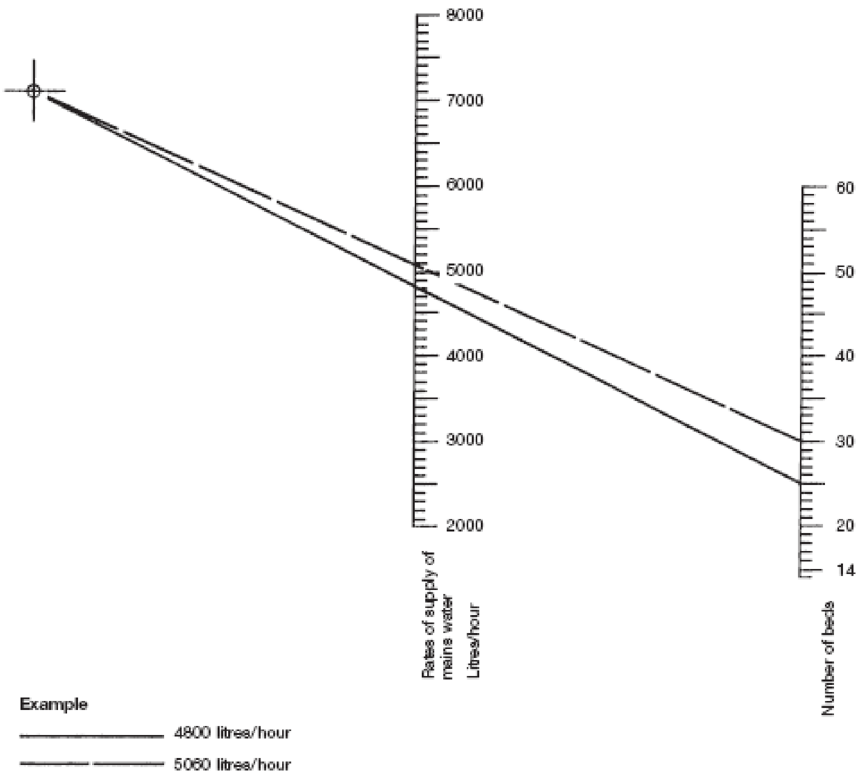

Figure A2: Rate of supply of mains water to cistern

Average water consumption by type and size of hospital

2 Table A1 (the results of a survey of NHS hospitals by the Department of Health and Social Security in 1974) provides basic data for design guidance on the estimation of water storage and consumption for whole hospitals.

The definitions that have been used for the classification of hospitals are shown in Table A2. 'Excluded departments' are those for psychiatry (mental illness), psychiatry (mental handicap), diseases of the chest, chronic sick, geriatrics and convalescence (including rehabilitation, but not pre-convalescence).

Relative intensity of water consumption

3 Whilst water consumption per bed content is a convenient estimating and planning yardstick, it does not show the widely differing floor areas which are provided per bed in hospitals of different sizes and type.

To illustrate the relative rates of consumption as seen against a basis of comparable patient density and showing the amount of water consumed − not only directly by the patient but also in the supporting treatment departments − a graphical presentation of the figures given in Table A1 is presented on a per bed and per floor area basis in Figures A3 and A4.

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Sire band (no of beds)	No of hospitals in sample	Total no of beds in sample	Average size of hospital (no of beds)	Total consumption m³ per annum	Average consumption litres/bed/day
Acute (Types 1, 2, 3 and 17)					
0-50	150	4,208	28	458,900	299
51-100	58	4,151	72	602,909	398
101-200	70	9,946	142	1,780,700	490
201-400	62	18,167	293	3,914,351	590
401-600	23	10,741	467	2,348,682	599
Over 600	3	2,023	674	721,887	978
Specialist acute (Types 11, 14, 15, 16 and 18)					
0-25	53	931	18	108,336	319
26-50	18	651	36	82,455	347
51-100	38	2,664	70	352,133	362
101-200	16	1,952	122	341,004	479
Over 200	7	1,633	233	316,874	531
Long stay (Types 4 and 5)					
0-50	30	1,126	38	74,009	180
51-100	45	3,463	77	339,791	569
101-200	44	6,222	141	560,731	247
201-300	10	2,300	230	182,617	217
Over 300	3	1,121	374	25,247	306
Recovery and convalescent					
0-25	6	126	21	9,965	216
26-50	35	1,339	38	100,721	206
51-100	19	1,357	71	91,947	185
Over 100	3	449	150	29,663	181
Geriatric and chronic sick (Type 19)					
0-50	18	573	32	51,520	246
51-100	20	1,460	73	108,163	203
101-200	6	788	131	46,987	164
Over 200	2	512	256	23,748	127
Psychiatric (Types 12 and 13)					
0-100	46	2,186	48	166,588	209
101-200	12	1,773	148	156,814	242
201-400	13	3,782	291	976,559	273
401-600	10	4,884	488	443,662	249

Table A1: Average water consumption by type and size of hospital

Sire band (no of beds)	No of hospitals in sample	Total no of beds in sample	Average size of hospital (no of beds)	Total consumption m³ per annum	Average consumption litres/bed/day
601-1,000	7	5,112	730	654,024	350
Over 1,000	5	6,098	1,220	747,676	336
London teaching (all types)					
0-100	20	1,161	58	789,422	680
101-200	15	1,896	126	1,642,106	866
201-300	10	2,580	258	2,141,166	830
301-500	8	3,161	395	2,859,434	904
Over 500	4	2,611	652	3,207,658	1,228

Table A1 continued: Average water consumption by type and size of hospital

Type of hospital	Type number	Definition
Acute	1	Hospitals with not more than 15 per cent of their beds allocated to the "excluded departments"
Mainly Acute	2	Hospitals with more than 15 per cent and up to 40 per cent of their beds allocated to the "excluded departments"
Partly Acute	3	Hospitals with more than 40 per cent and up to 60 per cent of their beds allocated to the "excluded departments"
Mainly Long-stay	4	Hospitals with more than 60 per cent and up to 85 per cent of their beds allocated to the "excluded departments"
Long-stay	5	Hospitals with more than 85 per cent of their beds allocated to the "excluded departments"
Pre-convalescent	7	Hospitals with 90 per cent or more of their beds allocated to patients who have already received elsewhere the most intensive part of their treatment, but who still require active nursing care and medical oversight
Convalescent	8	Hospitals with 90 per cent or more of their beds allocated to patients recovering from a disability who no longer require active medical supervision or nursing care in bed though they may need such simple nursing procedures as renewal of dressings or the administration of medicines

Table A2: Definition of types of hospital

Type of hospital	Type number	Definition
Rehabilitation	9	Hospitals with 90 per cent or more of their beds allocated to patients who no longer require nursing care in bed and who, with or without the aid of appliances, can get about and attend to their own needs with occasional assistance but who require remedial and re-educative treatment with a view to attaining the maximum degree of use of functions
Maternity	11	Hospitals (including General practice maternity Hospitals) with 90 per cent or more of their beds allocated to obstetrics
Psychiatric (Mental Illness)	12	Hospitals with 90 per cent or more of their beds allocated to mental disorder and 50 per cent or more of the psychiatric beds allocated to metal illness
Psychiatric (Mental Handicap)	13	Hospitals with 90 per cent or more of their beds allocated to mental disorder and more than 50 per cent of psychiatric beds allocated to handicapped and/or severely handicapped patients
Orthopaedic	14	Hospitals with 90 per cent or more of their beds allocated to traumatic and orthopaedic surgery, including bone and joint tuberculosis
Tuberculosis and Chest	15	Hospitals with 90 per cent or more of their beds allocated to tuberculosis (both respiratory and non-respiratory) or diseases of the chest (including thoracic surgery) or both
Tuberculosis and Chest Isolation	16	Hospitals with 90 per cent or more of their beds allocated to tuberculosis (both respiratory and non-respiratory) or diseases of the chest (including thoracic surgery) or both, and infectious diseases
Children's (Acute)	17	Hospitals with 90 per cent or more of their beds allocated as in Type 1 but for children only
Eye	18	Hospitals with 90 per cent or more of their beds allocated to that one function
Other hospitals	19	These include Dental and ENT hospitals and also: All hospitals with 90 per cent or more of their beds allocated to a single department not specifically named above unless that department is "General Medicine", "General Surgery" or "General Practice (Medical)", in which event the hospital would be classified as "Acute" (Type 1) Type 19 will include Geriatric and Chronic Sick Hospitals

Table A2 continued: Definition of types of hospital

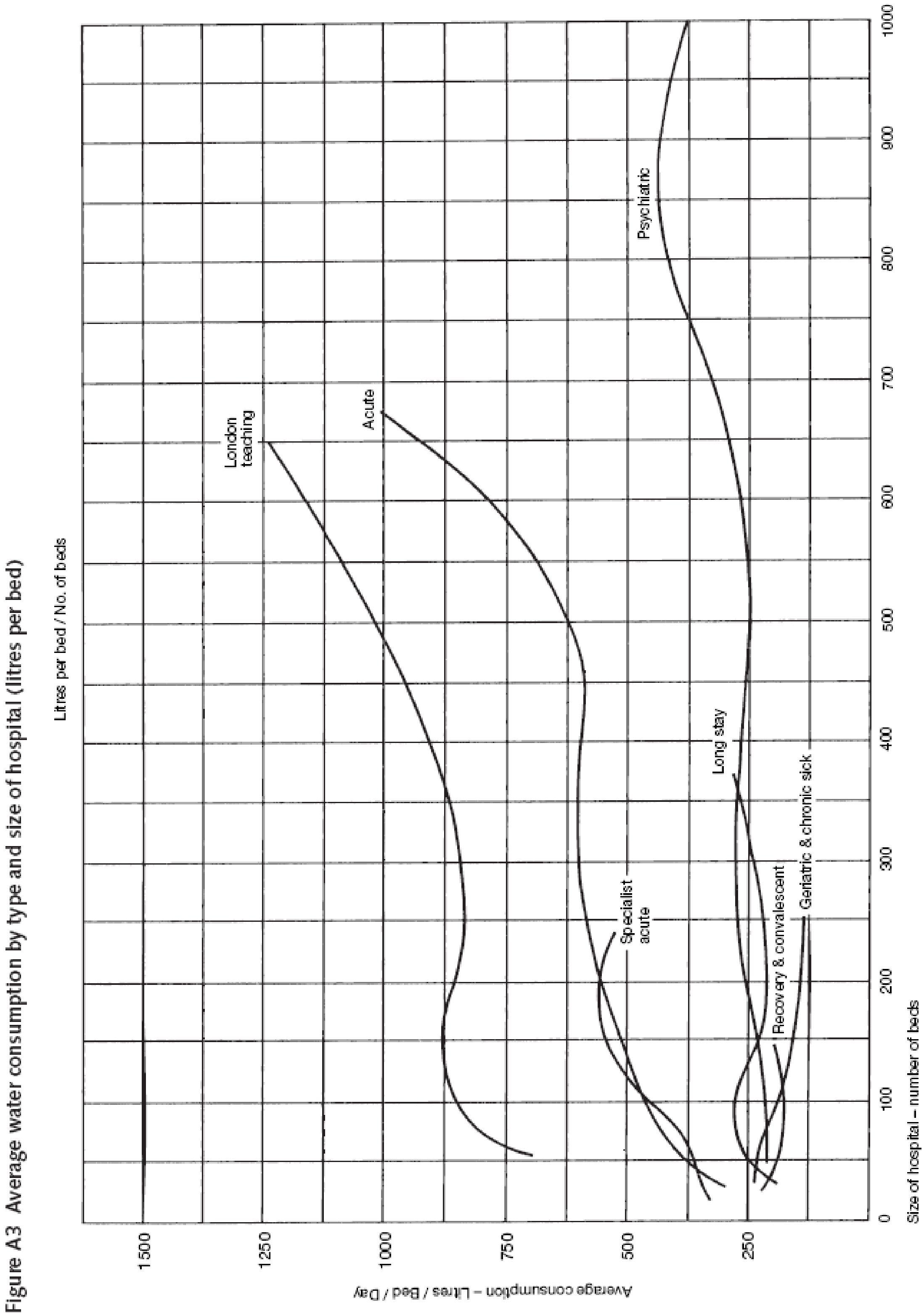

Figure A3: Average water consumption by type and size of hospital (litres per bed)

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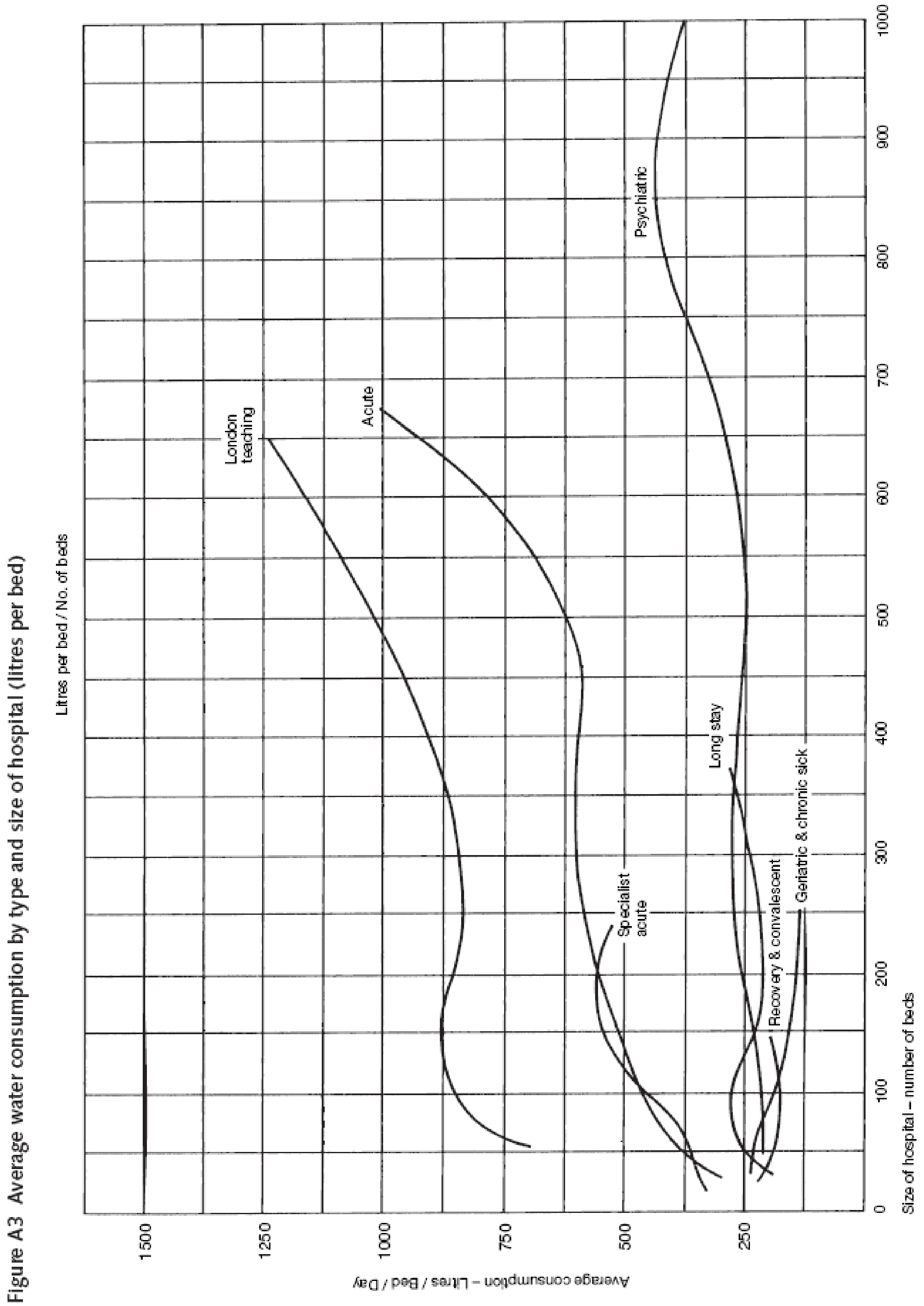

Figure A4: Average water consumption by type and size of hospital (litres per floor area)

Table A3 and Figure A5 provide a worked example of water consumption by nursing staff in residential accommodation.

Residential accommodation for nursing staff			
1. Data			
Type of accommodation	**Number of residents**	**Allocation of fittings**	**Total fittings**
A Student nurses	150	1 LB per person 1 Bath per 5 persons 1 WC per 5 persons 1 Sink per 5 persons 1 Laundry per 50 persons	150 LBs 30 Baths 30 WCs 30 Sinks 3 Laundries
B Staff nurses	50	1 LB per person 1 Bath per 4 person 1 WC per 4 persons 1 Sink per 4 persons	50 LBs 12 Baths 12 WCs 12 Sinks
C-F Deputy matrons MOs etc	50 plus 50 family residents	1LB per flat 1 Bath per flat 1 WC per flat 1 Sink per flat	50 LBs 50 Baths 50 WCs 50 Sinks
Totals	300	-	250 LBs 92 Baths 92 WCs 92 Sinks 3 laundries
2. Daily usage per fitting			
Type of fitting	**Accommodation A**	**Accommodation B**	**Accommodation C**
LB	3	3	6
Bath	2.5	2	1
WC	20	16	8
Sink	5	4	6
Washing machine	8	-	-
3. Consumption per use			
LB	4.5 litres		
Bath	72 litres		
WC	6 litres		
Sink	6 litres		
Washing machine	114 litres		
4. Estimated daily consumption - 34,090 litres Daily consumption per person - 114 litres			
5. Peak demands If two-thirds of resident staff work three shifts commencing at 06.00, 14.00 and 22.00 hours, peak demands will occur from 05.00 to 07.00, 13.00 to 15.00 and 21.00 to 23.00 hors. Peak demand may reach 1.5 litres per sec, with an average demand of 1.06 litres per sec over three periods.			

Table A3: Example of water consumption by nursing staff in residential accommodation

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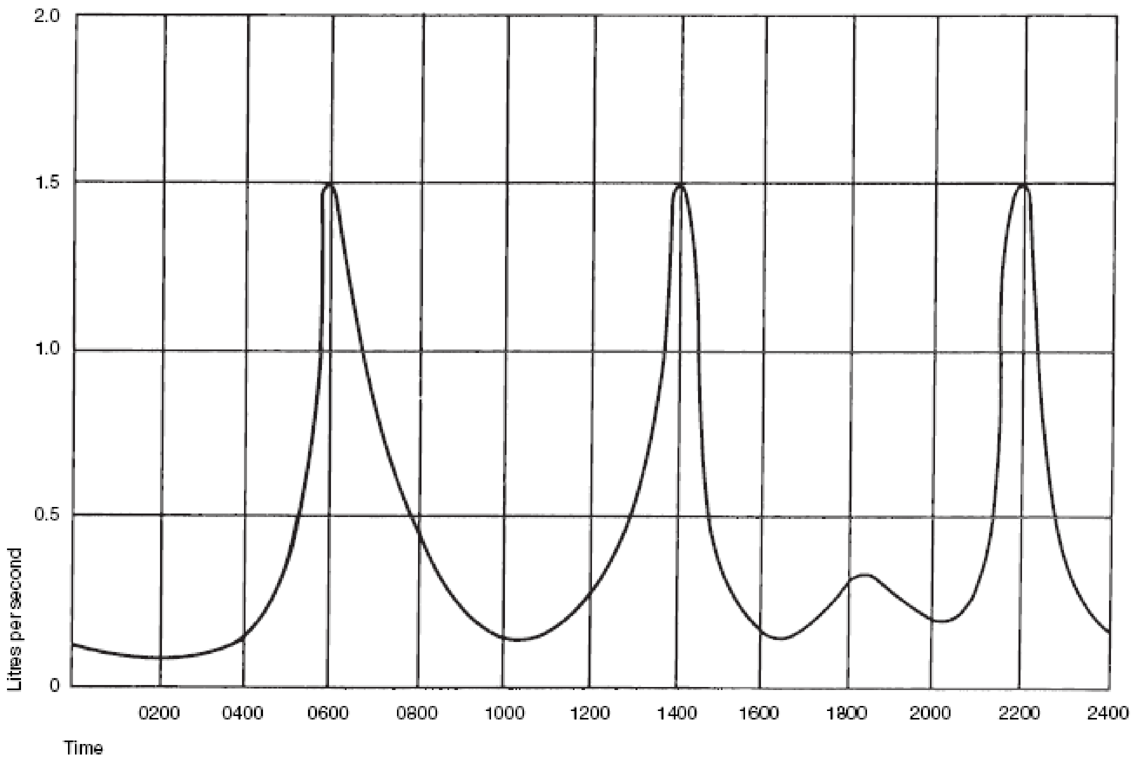

Demand incidence for 200 nursing staff & 100 senior staff flats

Figure A5: Water consumption profile for residential accommodation of nursing staff

Appendix 2: Water treatment

General

1 All water supplied to healthcare premises must comply with current legislation on water quality.

The following sections on water treatment are intended to provide a brief overview only. Further details can be found in BSRIA Application Guide 2/93: 'Water treatment for building services systems'. Some of the more common water treatment processes are mentioned below. The extent of treatment will vary for each application depending on water quality, intended usage etc, and specialist advice should be obtained when considering the adoption of any water treatment processes.

The needs for water treatment, and the treatment processes used, depend on the purposes for which the water is to be used and the quantity required for each purpose. While potability is not normally affected by such characteristics as hardness, colour, and (within limits) smell and/or taste, a measure of treatment may be necessary to provide a more acceptable supply.

A supply from a water supply authority should not normally require any further treatment when used for hospital purposes other than laundries, domestic hot water systems, humidification plant and steam boiler feed water. Private supplies, however, will require some measure of treatment, and in many cases the installation of pumping and treatment plant needs to be extensive to ensure a constant acceptable quality.

Water is not naturally found in a state of chemical purity. Surface waters in upland reservoirs, rivers and lakes often contain organic matter including algae, tree foliage and silt. River water may also be polluted by sewage and industrial effluents and chemicals leached from agricultural land etc. Groundwaters in springs, wells and boreholes collect impurities from the surrounding strata; shallow wells collect impurities from surrounding soil.

The impurities that must therefore be removed include tree foliage and matter in suspension consisting of mineral particles, algae, organic matter and various kinds of living organisms and bacteria. Other dissolved chemicals may also require removal.

Suspended matter in water covers a wide range of particle size varying from the large organic particles and silt found in fast-flowing rivers, to colloidal matter with a size of 1 micron or less. Natural filtration takes place as water percolates through the permeable strata and generally reduces suspended solids.

Water treatment processes

2 For high quality groundwater sources, the only treatment that may be required is disinfection, which is covered in Section 17. However, for other water sources

such as grey water, further treatment will be required, and this may be extensive, depending on intended use.

There is a wide range of treatment options available, but the most relevant to health establishments are:

- coagulation and flocculation;
- settlement;
- dissolved air flotation;
- filtration;
- iron and manganese removal;
- pH adjustment;
- solids treatment and disposal.

Coagulation and flocculation

3 This is the addition of a coagulant (often aluminium sulphate or an organic polymer) followed by gentle agitation. The process is used to destabilise fine particles in the water so that they agglomerate together such that they will settle out more easily in the settlement process or that they can be removed more easily by filtration.

Settlement

4 In this process, water is passed through tanks in which solid particles settle out. Settlement covers a range of designs from simple horizontal flow tanks to complex upflow sludge blanket clarifiers and lamella flow separators. Settlement is basically a gravity process, although the sludge blanket used in some designs of tank is part of a flocculation process.

Dissolved air flotation

5 Dissolved air flotation uses fine bubbles of air to lift particles present in water to the surface of a tank, from where they are removed by a skimming system. Water to be treated passes through a rectangular tank. High-pressure water, saturated with air, is introduced into the bottom of the tank. The air in this water comes out of solution because of the pressure drop, and forms fine air bubbles on solids within the water; these solids then rise. The process is particularly suitable for the removal of low-density solids such as algae. It is a sophisticated process and is unlikely to be used except in special circumstances.

Filtration

6 Filtration is a solids removal process that involves passing water through a filtering medium, which is normally sand. The most likely form of sand filter to be found in a modern small treatment plant is a pressure filter; these are normally vertical cylindrical steel or GRP pressure vessels.

Water enters at the top of the vessel and passes down through 500mm of sand. The sand rests on gravel which, in turn, is supported on a perforated floor. After passing through the sand and gravel, the filtered water leaves through the bottom of the vessel.

As the water passes through the vessel, the sand becomes increasingly clogged with dirt and the pressure drop across the filter increases. Once the pressure drop becomes excessive, the filter is cleaned. This is done by flow reversal with water, and sometimes air, flowing up through the sand to waste. This expands the bed and frees the dirt from the sand.

The need to clean filters involves a fairly complex system of pipes and valves. On modern filters, cleaning is normally done automatically, with electrically operated valves.

Filtration removes solids, and for relatively clean waters it may be the only treatment process needed apart from disinfection. For dirtier waters, pre-treatment by settlement or dissolved air flotation is required in order to prevent too great a frequency of backwashing. For sources liable to pollution from animal waste, filtration is essential for the removal of cryptosporidium and/or giardia cysts. The filtering medium may be sand but may also be granular activated carbon, to remove tastes and odours, or a catalytic medium (for example manganese dioxide) to oxidise and remove iron and manganese.

Modern packaged plants may also use other sorts of filtration system.

Iron and manganese removal

7 A common problem, particularly with ground water, is excessive iron and manganese levels. This problem is often solved by oxidising the iron and manganese to an insoluble form by chlorination, pH adjustment and filtration to remove the iron and manganese. Filtration is often done in pressure filters with a catalytic medium.

pH adjustment

8 This is often needed either to oxidise iron and manganese or to render water less corrosive to the distribution system.

Solids treatment and disposal

9 It should always be borne in mind that a water treatment plant will produce wastes from settlement tanks and filters. These wastes will need to be disposed of, probably to the site foul sewerage system.

Contaminated water that is run to waste into a natural watercourse or a drain leading to it should be treated in accordance with the requirements of the authority responsible for land drainage and pollution control. The authority responsible for that sewer should be informed. Dechlorination can be achieved using either sulphur dioxide or sodium thiosulphate. 20g of sodium thiosulphate crystals are required to dechlorinate 500 litres of water containing 20 mg/litre free chlorine. For water requiring dechlorination, an automated system dosing bisulphite solution or similar solutions can be linked to the BEMS.

Further advice on filtration methods and standards can be found in Part E of this SHTM: Alternative materials and filtration.

Appendix 3: Chloramine (and chlorine) in public water supplies

1 The Water Authority in Scotland has been introducing chloramine as a disinfecting agent in water supplies as an alternative to free chlorine. Chloramines tend to be more stable and provide better residual antibacterial activity with lower total chlorine levels. The protection lasts longer and avoids or reduces the need for additional disinfectant dosing stations along the network between water treatment plant and the end–user to ensure that the strict microbiological standards set within the Regulations are met. This explains why chloraminated supplies have been introduced in rural areas.

In Scotland, the drinking water standards are identified in the water Supply (Water Quality) (Scotland) Regulations 2001 and 2010, in line with all European community (EC) requirements. This is a legal document with which the Water Authority is required to comply. The Drinking Water Quality Regulators (DWQR) monitor the Water Authority to ensure that the Regulations are complied with and the 2001 Regulations detail the acceptable levels of certain characteristics, elements and substances allowed in drinking water for which these permissible levels are known as Prescribed Concentration of Value (PCV).

It has been recognised by Scottish Water that the secondary disinfection of water supplies with chloramine offers a number of benefits, mainly comprising:

- a longer lasting treatment process within the distribution network than would apply if chlorine was used on its own;
- the process helps prevent the formation of trichloramine compounds that are formed with traditional chlorination;
- it removes the need to add further chlorine further along the pipework distribution network;
- there is the benefit of having no significant taste or odour when correct dosing rations are applied.

There is evidence that the use of free chlorine as a disinfecting agent in surface water supplies containing natural organic residues can combine to form trihalomethanes (THMs), for example chloroform ($CHCl_3$), bromodichloromethane ($CHCl_2Br$) and other compounds that are carcinogenic. (Free chlorine is still preferred for disinfecting borehole waters.)

The local water supply authority carries out chloramination at the water works by introducing both chlorine (Cl_2) and ammonia (NH_3), which combine in aqueous solution to form monochloramine (NH_2Cl), dichloramine ($NHCl_2$) and a small quantity of trichloramine (NCl_3).

The quantities of these depend upon the ratio of chlorine and ammonia and the acidity of the water; it is important to achieve the correct balance, as dichloramine and trichloramine can lead to problems of taste and odour and their formation needs to be minimised.

In the UK there is no standard for chloramines in water. The World Health Organisation (WHO) recommends a maximum concentration of 3 mg/litre. This is based on a tolerable daily intake that is derived from the 'no observable adverse effect level' (NOAEL) to which a safety factor of 100 is applied. The levels of chloramine that the UK will use (and dialysis treatments units should be designed to handle) is likely to be in the order of 1 mg/litre total chlorine, most of which is present as monochloramine.

Problems associated with aquaria have been reported in the USA, where much higher levels of chemicals are used than is proposed in the UK.

Chloramine is also extensively used in Europe for disinfection of public water supplies.

Implications for healthcare

2 In systems where free chlorine is rapidly lost, such as typical hot and cold water service systems, chloramines can remain for much longer, posing particular problems for dialysis patients. The effect of chloramine-induced acute haemolytic anaemia and methaemoglobinaemia has been well reported. Little other information is available on chloramine.

Chloramines, and to a lesser extent chlorine, in dialysis water can cause haemolysis – a condition whereby red blood cells are ruptured. In addition, all renal patients suffer from anaemia to some extent because they are lacking in erythropoietin (EPO). This natural hormone, which stimulates bone marrow to produce red blood cells, is not available in sufficient quantities in patients with damaged or diseased kidneys. Synthetic EPO is administered to dialysis patients but, apart from its high cost, can have unpleasant side effects. Where chlorine or chloramines are present, the need for EPO escalates, and therefore it is imperative to eliminate chlorine and chloramines from water supplies to dialysis equipment to minimise the dosage of EPO.

Dialysis requires a water supply that has the minimum of chemical and bacterial impurities. This requires water treatment – typically reverse osmosis and softening; neither process removes chloramines or chlorine.

Some reduction of chloramine occurs in deionisation equipment because of adsorption onto ion-exchange resin molecules, but performance of the ionisation process is unpredictable in this respect and cannot be relied upon. The Renal Association sets limits of 0.1 mg/litre and 0.5 mg/litre respectively for chloramines and total chlorine in water for dialysis. (The European Pharmacopoeia specifies a maximum limit of 0.1 mg/litre for chloramine: studies have shown, however, that levels as low as 0.25 mg/litre can cause haemolysis.) Therefore, it can be seen that the margin for error is low. (See also Health Building Note 53: 'Facilities for renal services', Volumes 1 and 2 which have not been adapted for Scotland but may be used with general caution.)

There remain some concerns about chloramine, but in the main, these are about high concentrations for bathing water disinfection. Further studies are taking place.

Removal of chloramines

3 The use of granular-activated carbon (GAC) filtration upstream of the reverse osmosis (RO) equipment) is recognised as an effective means of dealing with chloramine. (In hard water areas, water softening will also be required.)

Chemical reduction by use of ascorbic acid (vitamin C), which is capable of neutralising many oxidising agents, is also an effective method. There is some concern about the use of ascorbic acid because of its toxicity for dialysis patients. Management of vitamin C intake has to be carefully monitored in dialysis patients; therefore chemical reduction, particularly for domiciliary patients, is undesirable.

GAC is manufactured from a variety of products, but mostly bituminous coal. The charcoal derived is pulverised and "activated" by exposure to superheated steam. This increases the total surface area for adsorption, which can be as high as 1500 m^2/g. This highly porous substance is formed into disposable cartridges, or used in rechargeable tanks.

The critical factor in the selection of the carbon filter is the empty bed contact time (EBCT), which can be calculated as follows:

$$\text{EBCT} = \frac{\text{volume(GAC(litres))}}{\text{flow(water(litre/m))}} \times 50$$

The aim should be an EBCT of about 6 min.

As a yardstick, the Drinking Water Quality Regulator has advised the Renal Association to design water treatment systems, whether domiciliary or hospital-based, to remove up to 1 mg/litre total chlorine.

Summarising

4 The following facilities require special attention

Renal Departments

- the Renal association identifies that dialysis water purification plant should be capable of accepting 1mg/litre total chlorine, while setting limits of 0.1 mg/litre and 0.5 mg/litre, respectively, for chloramines and total chlorine in water for dialysis. Dialysis requires a water supply that has the minimum of chemical and bacterial impurities and to achieve this, further water purification is required, typically reverse osmosis and softening, neither of which is an effective means of removing chloramines and chlorine;
- the use of Granular Activated Carbon Filtration (GAC – filtration) upstream of the Reverse Osmosis (RO) equipment is recognised as an effective means of chloramines and chlorine and the impact of dealing with chloramines is limited only to the increased contact time within the activated carbon filters associated with the renal water purification plant because chloramines take longer to be absorbed than free chlorine. It has been

estimated that an increase in contact time of around 6 to 10 minutes will be required, increasing the total surface are for absorption. The assessment would normally be calculated by the specialist water treatment company specialising in renal water supply and plant selection.

Pharmacy Departments

- the residual levels of chloramines within a water supply can affect the manufacturing of pharmaceuticals and therefore pharmacy departments within healthcare premises may be more effected by a chloraminated water supply. For this reason, monitoring of the water supply is required and any subsequent review of any existing purification processes and procedures currently operating may have to be enhanced, upgraded or renewed.

Laboratories

- areas within healthcare facilities that require specialised water, such as science laboratories, would also require their water treatment and purification to be reviewed and, where necessary, enhanced, upgraded or renewed.

Hydrotherapy Departments

- water treatment processes and procedures to hydrotherapy pools, etc., may also require their water treatment processes to be reviewed as the introduction of additional chlorine may induce the production of dichloramine and trichloramine. The water treatment and procedures to these areas may require to be enhanced, upgraded or renewed where necessary;
- there have been instances in which chloraminated water supplies have been introduced in Scotland by the Water Authority without advance warning or consultation. To avoid this, the maintenance of close liaison with the Water Authority is essential and that the quality of incoming supplies is monitored at all times to avoid adverse effects, principally on vulnerable patients.

Chloramines and the effect on pipework materials

5 There is no test data available identifying that a chloraminated water supply affects pipework or pipework components, neither within the various UK water authorities' nor undertakings' infrastructure, nor within industrial, commercial or domestic premises. The Water Research Council (WRc) advises that no recent product testing had been carried out on any plumbing components or material to assess the long-term affects that chloramine may bring.

However, the fact that such supplies have been delivered in the Thames Water, Northumbrian and Anglian Water areas for so many years without any reported detrimental affects leads to the confidence that traditional and contemporary plumbing materials and components are unaffected as a result of handling chloraminated water supplies.

6 Further guidance on chloraminated water supplies can be found in Part F of this SHTM.

Appendix 4: Chlorine dioxide

Chlorine dioxide is an oxidising biocide that is capable of reacting with a wide range of organic substances. Its effectiveness in the control of organisms in water systems has been demonstrated in a study carried out by BSRIA (see BSRIA's (1998) TN 2/98: 'Chlorine dioxide water treatment − for hot and cold water services').

For hot and cold water services, chlorine dioxide is usually generated by sodium chlorite reacting with gaseous chlorine or hydrochloric acid:

$5NaClO_2 + \longrightarrow 4HCl \quad 4ClO_2 + 5NaCl + 2H_2O.$

Alternatively, a number of systems use proprietary solutions that release chlorine dioxide on acidification.

Use of chlorine dioxide as a chemical for drinking water treatment is now subject to a European Standard (BS EN 12671: 2000). National conditions of use require that the combined concentration of chlorine dioxide, chlorite and chlorate do not exceed 0.5 mg/litre as chlorine dioxide. Chlorine dioxide dissolves unchanged in water, but is very slowly hydrolysed to chloric and chlorous acids. In alkali, chlorate and chlorite are formed:

$2ClO_2 + 2OH^- \longrightarrow ClO_3^- \quad ClO_2^- + 2H_2O.$

It is essential that the maximum amount of chlorine dioxide is available for reaction with organic molecules and not total chlorite or chlorate.

In water, the oxidising properties of chlorine dioxide result from two reactions. Chlorine dioxide gains one electron to form chlorite:

$ClO_2 + 1e^- \longrightarrow ClO_2^-.$

If available, the chlorite gains four electrons to form chloride:

$ClO2^- + 2H2O + 4e^- \;\; Cl^- + 4OH^-1.$

The first of these reactions proceeds readily in the range of pH found in potable water.

The latter reaction, to complete the five-electron transfer, does not always occur.

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

Note 24: The difference between the chlorine dioxide injected into the system and the levels at the furthermost parts of the system, where its presence can be measured, is an indication of the bio-burden oxidised.

Chlorine dioxide is also effective in the destruction and removal of biofilms, which contribute to the nutrients within the systems and provide protection for bacteria against the effects of heat and chlorine.

Note 25: Further information on disinfection can be found in Part D of this SHTM.

Appendix 5: Copper and silver ionisation

Ionisation as a water treatment method has been shown to be effective against planktonic *Legionella* in hot and cold water systems at 400 µg/litre and 40 µg/litre respectively. In soft waters a silver level as low as 20 µg/litre can be effective. Ionisation systems release copper and silver ions into the water stream by means of electrolyte action. Copper and silver ionisation involves the release of copper and silver ions by electrolytic generation for use as a water treatment.

Copper and silver ionisation is concerned with releasing silver and copper ions into water by passing an electrical current between two copper electrodes and between two silver electrodes placed in running water.

The copper and silver ions attach, through electrostatic bonds, to negatively charged sites on bacterial cell walls. This distorts and weakens the cell wall, allowing penetration of the silver ions. The silver ions attack the cell by binding at specific sites to DNA, RNA, cellular protein and respiratory enzymes, denying all life support systems to the cell, causing paralysis and death. The copper and silver ions act synergistically to kill bacteria.

Silver/copper ionisation's effectiveness in the control of *Legionella* bacteria in water systems has been demonstrated in a study carried out by BSRIA (1996; TN 6/96: 'Ionisation water treatment for hot and cold water services'). Results show that where silver and copper ion concentrations could be maintained at 0.04 ppm and 0.4 ppm respectively, copper and silver ionisation was effective against *Legionella* bacteria in both cold and hot water systems with reduced water temperatures as low as 35°C. pH levels above 7.6 may affect the efficacy of this technology.

Water analysis certificates-of-analysis results from samples collected from outlets at sites that operate silver/copper ionisation systems in the UK show that where silver and copper ion concentrations are maintained at outlets at between 0.01 and 0.08 ppm and at between 0.2 and 0.8 ppm respectively, *Legionella* contamination is avoided and controlled.

The study carried out by BSRIA also showed that the copper and silver ions not only reduce the biofilm coverage in cisterns and within pipework circuits, they also reduce the number of *Legionella* bacteria present within the biofilm.

Further studies by Walker et al (1997) showed that when copper and silver ionisation was operated at concentrations of 0.04 ppm of silver and 0.4 ppm of copper, it is an effective non-chemical disinfectant for the control of bio-fouling.

However, attention is drawn to Note 26 overleaf.

Note 26: From February 2013 copper ionisation was banned and it become illegal to sell or use water treatment products that added copper into the water as a biocide under an EU ruling. At the time or preparing this text (January 2013) it was understood that HSE would pursue an “Essential use derogation”. This involves relaxations or appeals for use of copper for *Legionella* control in the UK. The outcome of this was unknown and the decision for special use was unlikely to be known before the ban was enforced. Water treatment regimes should therefore be reviewed. Silver ionisation systems will still be allowed together with silver hydrogen peroxide provided systems are flushed to ensure that silver levels are less than 0.1mg/litre.

Note 27: Further information on disinfection can be found in Part D of this SHTM.

Appendix 6: Temperature settings

Building Management Systems

Domestic hot & cold water systems should be temperature monitored by the Building Management Systems performing to SHTM 08-05 to ensure compliance with the temperature standards specified in the relevant regulations and guidance. System parameters must be detailed in the Written Scheme for the Water system.

The minimum Building Management System performance of the water system must be to ensure:

- Domestic Hot Water is continuously monitored and records the parameters highlighted above i.e. 60°C flow (minimum) from the water heating device to ensure 55°C at the supply to the farthest draw-off (sentinel) point in the circulating system under normal use and no less than 50°C return (lowest limit) to the water heating device;
- Cold Water is continuously monitored and records from the point where it enters a building as described above, i.e. no more than 20°C (highest limit);
- failures outwith the parameters are subject to alarms and service response messages;
- performance data require to be secured and retained for at least 5 years, but must be easily available to the Authorised Person (Water), the other independent professional advisors, assessors and others with an interest in system performance.

Definition of Sentinel Point

- Sentinel Point is the first and last outlet point on any hot water or any cold water recirculating system;
- Sentinel Point is the nearest and furthest from storage tanks on a non-recirculating cold water system;
- Sentinel Point is the nearest and furthest from the hot water source on a non-recirculating hot water system;
- Sentinel Point would also include any other outlet points considered to represent a particular risk in the Written Scheme.

TMV settings

The safe outlet temperatures (as also shown in other SHTMs, SHPNs, HBNs still applicable in Scotland and ADB Room Data Sheets) are

Application	Temperature Setting °C
Staff bases & consulting rooms etc., basins, inpatient & outpatient hand wash basins	41
Paediatric baths	40
General baths	43
Showers	41
Assisted baths	Not more than 46
Hair-wash facilities	41
Bidets	38

Other hot water settings

Where no thermostatic mixing valve (TMV) outlet is provided, each outlet should be provided with a "**Caution – Very Hot Water**" notice.

Application	Temperature Setting °C
Sinks: kitchens, pantries	55
Slop sinks, etc	55
Offices, staff-only access wash hand basins	43

Other water system settings

Application	Temperature Setting °C
Hot water flow from heat source	60 (minimum adjusted to ensure minimum of 55°C at sentinel point)
Hot water return to heat source	50 (minimum)
Minimum hot water temperature reaching most distant outlets	55 (minimum at sentinel point)
Hot water pre-pasteurisation temperature	70
Cold water temperature in high-risk departments	20 (maximum)
Cold water temperature at sentinel outlets	20 (maximum)
Manual re-set high limit thermostat setting at heat source	75

References

Acts and regulations

NB: Access to information related to the following Acts and Regulations can be gained via www.legislation.gov.uk.

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Food Safety (General Food Hygiene) Regulations 1995, SI 1995 No 1763. HMSO, 1995.

Food Safety (Temperature Control) Regulations 1995, SI 1995 No 2200. HMSO, 1995.

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

Private Water Supplies (Scotland) Regulations 1992, S75 (s.64) HMSO, 1991.

The Water Act 1989. HMSO, 1989.

The Water Services Etc (Scotland) Act 2005. **SI 2005 No 3172** HMSO, 2005 www.legislation.gov.uk/asp

Water Resources Act 1991. HMSO, 1991.

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The Water Supply (Water Quality)(Scotland) Regulations 2010. SI 2010 No 95. HMSO, 2010.

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MES C07 – Heating, hot and cold water systems. HMSO, 1997.

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

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Department for Environment, Food & Rural Affairs (DEFRA) (1999). Water Byelaws (Scotland) 2000 guidance document relating to Schedule 1: Fluid Categories and Schedule 2: Requirements for Water Fittings [See Regulation 4(3)].
http://www.defra.gov.uk/environment/water/industry/wsregs99/guide/index.htm

British Standards

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NHS National Services Scotland

Scottish Health Technical Memorandum 04-01

Water safety for healthcare premises
Part B: Operational management

Health Facilities Scotland
Engineering and Environment

July 2014

Contents

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HTM 04-01 Part B has been updated and amended by Health Facilities Scotland for use in NHSScotland as SHTM 04-01 Part B. The document has now been updated to reflect experience in use and recent guidance on harmful pathogens and re-titled ‘Water safety for healthcare premises’. The significant participation of the National Water Services Advisory Group is gratefully acknowledged.

Note: This version (2.0) of SHTM 04-01 Part B has been updated to take account of latest guidance forthcoming regarding measures to prevent build-up of waterborne bacteria and biofilm such as *Pseudomonas* as it affects design and specification of domestic hot and cold water systems and components. (Note 4 and paragraphs 1.1, 5.6, 7.30 and 7.39 together with new paragraphs 5.28 – 5.30 refer).

Preface

About Scottish Health Technical Memoranda

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

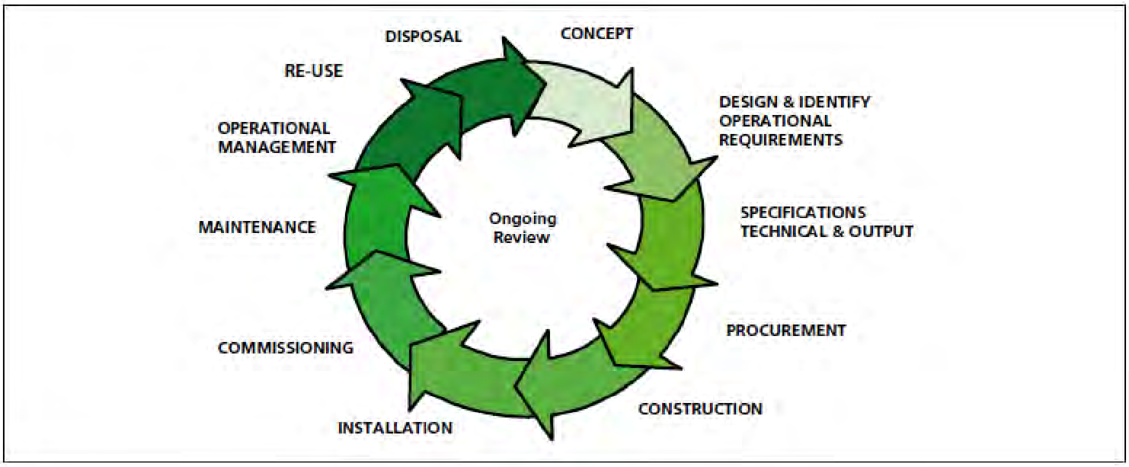
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle: Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

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

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

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

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



Healthcare building life-cycle

Structure of the Scottish Health Technical Memorandum suite

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

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

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

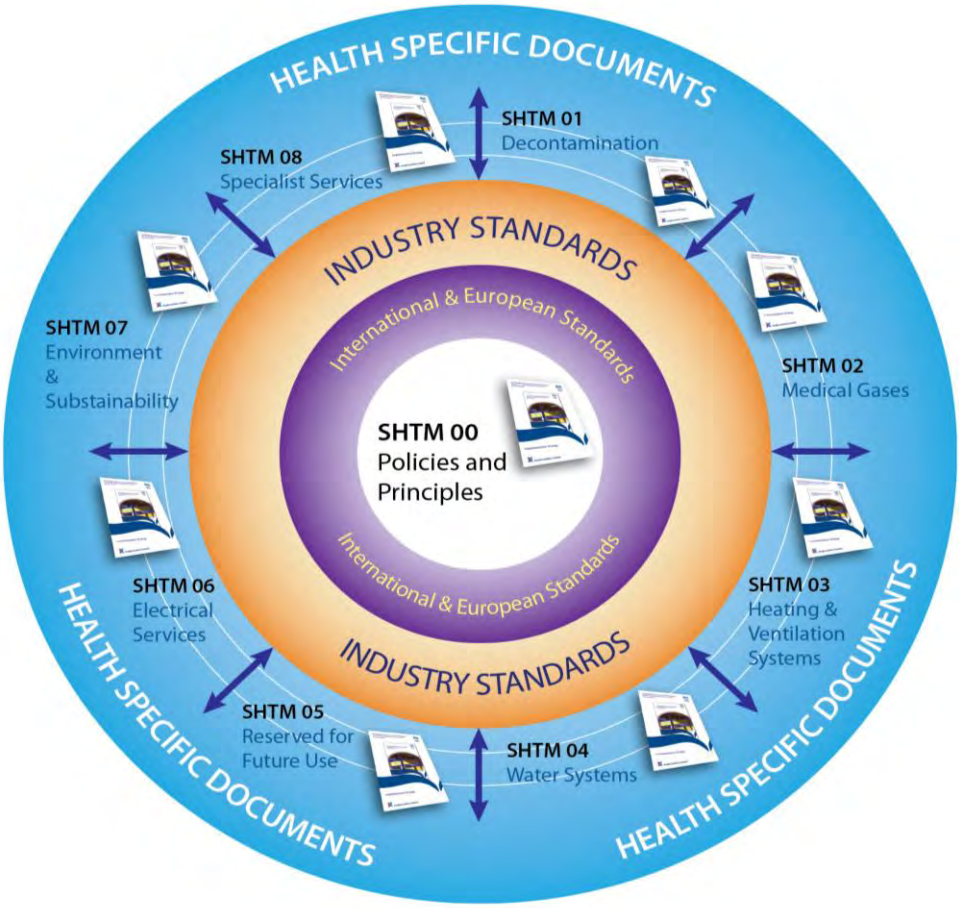
Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical safety guidance for low voltage systems

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent: Environment and Sustainability – EnCO$_2$de.

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

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

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



Engineering guidance structure

Executive summary

Preamble

Scottish Health Technical Memorandum 2027: 'Hot and cold water supply, storage and mains services' and Scottish Health Technical Memorandum 2040: 'The control of *Legionella* in healthcare premises: a code of practice' have both been revised, and have, at the same time, been combined into this single document: Scottish Health Technical Memorandum 04-01: 'Water safety for healthcare premises'.

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

Introduction

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

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

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

Aims of this guidance

This guidance has been written to:

- provide information on thermostatic mixing valve configurations, usage and maintenance requirements;
- outline how quality and hygiene of water supply can preserve system components and safe use by occupants;
- provide a point of reference to legislation, standards and other guidance pertaining to water systems;
- provide a basic overview of possible bacterial contaminants;

- outline key criteria and system arrangements to help stop bacteria proliferate;
- give an overview of some of the different water systems components and their safe installation and operation;
- provide typical system layouts and individual component location;
- illustrate the importance of ‘safe’ delivery of hot water;
- illustrate temperature regimes for sanitary outlets used in healthcare premises to reduce risk of occupant injury;
- identify key commissioning, testing and maintenance requirements for referral by designers, installers, operators and management.

Recommendations of Part B

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

Frequency	Check	Cold water	Hot water	Notes
Monthly	Sentinel outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute	These measurements are applicable to non-mixed outlets only
Monthly	Inlets to sentinel TMVs	Temperatures as above	Temperatures as above	Measurements can be made by means of surface temperature probes
Monthly	Water leaving and returning to calorifier			Also to be monitored continuously by BEMS i.e 60°C flow, 50°C return (minimum)
6-monthly	Incoming cold water at inlet to building – in the winter and in the summer	The water should be below 20°C		Also to be continuously monitored by BEMS
Annually	Representative outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute	

Table 1: Recommended Test Frequencies

Note: See Table 2 for definition of terms and explanatory notes

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

1. Introduction

Preamble

1.1 Scottish Health Technical Memorandum 2027: 'Hot and cold water supply, storage and mains services' (Property and Environment Forum Executive, 2001) and Scottish Health Technical Memorandum 2040: 'The control of Legionella in healthcare premises: a code of practice' (Property and Environment Forum Executive, 1999) have both been revised, and have, at the same time, been combined into this single document: Scottish Health Technical Memorandum 04-01: 'Water safety for healthcare premises'. The guidance has been revised in line with changes to relevant regulations, standards, other guidance and also technical developments. This Version 2.1 reflects experience in use with earlier versions and updates information related to *Pseudomonas Aeruginosa* (PA) in line with the latest Health Protection Scotland 'Guidance for neonatal units (NNUs) (levels 1, 2 & 3), adult and paediatric intensive care units (ICUs) in Scotland to minimise the risk of *Pseudomonas Aeruginosa* infection from water.

1.2 Scottish Health Technical Memorandum 04-01 now supersedes Scottish Health Technical Memorandum 2027 and Scottish Health Technical Memorandum 2040 and, in addition, absorbs information from Scottish Hospital Technical Note 6 and Scottish Guidance Note regarding 'safe' hot water and surface temperatures.

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

In its new form, the document is divided in seven parts. This part (Part B) covers operational management, including the control of *Legionella*. Part A outlines the principles involved in the design, installation and testing of the hot and cold water supply, and storage and distribution systems for healthcare premises. Parts C & D respectively cover a standard TVC testing protocol and Water Disinfection. Part E deals with alternative materials and filtration while Part F deals with chloramination of water supplies. Part G provides advice on the preparation of Written Schemes.

General

1.4 Current statutory legislation requires both management and staff to be aware of their individual and collective responsibility for the provision of wholesome, safe hot and cold water supplies, and storage and distribution systems in healthcare premises.

1.5 Healthcare premises are dependent upon water to maintain hygiene and a comfortable environment for patients and staff, and for clinical and surgical care.

The development, construction, installation and maintenance of hot and cold water supply systems are vital for public health.

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

Exclusions

1.6 Although many of this Scottish Health Technical Memorandum's recommendations will be applicable, it does not set out to cover water supply for fire-fighting services nor water supply for industrial or other specialist purposes, other than to indicate precautions that should be taken when these are used in association with 'domestic' water services. The point at which a domestic activity becomes an industrial process, for example in food preparation, has not been defined, and the applicability will need to be considered in each case.

1.7 This SHTM does not cover wet cooling systems such as cooling towers. Guidance on these systems is given in the Health & Safety Commission's Approved Code of Practice and guidance document L8. Although none remain within NHS Scotland estate there are some within close proximity to healthcare premises where wind-borne aerosols could be drawn in via air intakes or openable windows.

1.8 While some guidance on other water-service applications is included, it is not intended to cover them fully. For:

- laundry, see Health Building Note 25: 'Laundry' (now archived);
- sterile services departments, see SHPN 13: 'Decontamination';
- hydrotherapy pools, see the Public Health Laboratory Service's 'Hygiene for hydrotherapy pools';
- spa pools, see Management of spa pools: controlling the risks of infection. Health Protection Agency, 2006;
- guidance on birthing pools, see Health Building Note 09-02: 'Maternity care facilities'.

Definitions

1.9 Definition of terms is as those contained in the Scottish Water Byelaws 2004, BS6100: 1984-2000; BS6700: 2006; and BS EN 806-1-5: 2000-2012 and/or BS8558: 2011.

2. Management responsibility

2.1 Management has the overall responsibility for implementation procedures to ensure that safe, reliable hot and cold water supply, storage and distribution systems operate within the organisation. The Approved Code of Practice and guidance entitled ‘Legionnaires’ disease: The control of *Legionella* bacteria in water systems’ (L8) requires that there must be a Written Scheme in place in respect of controlling *Legionella* in water systems.

2.2 These procedures should demonstrate that any person on whom the statutory duty falls has fully appreciated the requirement to provide an adequate supply of hot and cold water of suitable quality. Though compliance with this guidance may be delegated to staff, or undertaken by contract, accountability cannot be delegated. The duty holder should appoint a person to take day-to-day responsibility for the control of the hot and cold water services and to be responsible for assessing and controlling any identified risks from *Legionella.*

2.3 A risk assessment for the water services will be necessary to identify potential problems in the system, for example excess storage capacity, temperature distribution problems, low water usage, inappropriate materials etc. The risk assessment should be carried out by a competent person. It is recommended that companies / individuals who carry out risk assessments should be members of the *Legionella* Control Association. A standard specification for, and guidance on, water risk assessment can be found in BSRIA’s (1999) FMS 4/99: ‘Guidance and the standard specification for water services risk assessment’.

2.4 Management procedures must ensure that compliance is continuing and not notional. The prime purpose of the assessment is to be able to demonstrate that management has identified all the relevant factors, has instituted corrective or preventive action, and is monitoring the plans being implemented.

2.5 This guidance should be applied to all healthcare premises, however small, where there is a duty of care under the Health and Safety at Work etc Act 1974.

2.6 Where new healthcare premises are to be built in separate phases, the water storage, supply and distribution service for the whole premises should as far as possible be planned and evaluated at the design stage. This will enable the total water supply requirement to be assessed in the planning stages, and appropriate areas of accommodation to be allocated. In situations where there is a phased hand-over or installations are brought into use in sections, temporarily unused pipework should remain filled with water, dosed, regularly flushed and labelled.

2.7 Management should also be aware of the legal duty to notify the water authority when it is proposed to carry out works on cold water distribution systems (See Note on page 18 of Part A of this SHTM).

2.8 All regular tests and checks set out in this document should be carried out even if they cause minor disruption to hospital services, and comprehensive records should be maintained.

2.9 While the ultimate responsibilities as set out in this SHTM in terms of overall management remain with NHS Boards, when a new or recent hospital has been procured via the Public-Private Partnership (PPP) or Private Finance Initiative (PFI) routes, there are changes in the chain of responsibilities.

2.10 More often than not, the operator of the facility will subcontract or enter into partnership with a Facilities Management (FM) Provider who will maintain and operate mechanical and electrical installations. It is not unknown for the FM provider to be the NHS Board's own estates staff. Whichever organisation carries out the functions set out in this SHTM, it will be necessary for the same practice and procedures to be carried out, records maintained and reports prepared to maintain an audit trail. These have to be submitted to the NHS Board for which the Hospital has been established. The NHS Board will in any case retain in-house estates staff and/or technical advisers to monitor these records and reports, having the right to comment where performance standards are not being achieved, inspect installations, and seek to ensure that remedial measures are put in hand and monitored as to their effect.

3. Statutory requirements

General

3.1 It is the responsibility of management to ensure that their premises comply with all statutes.

Management (owners or occupiers) of healthcare premises have an overriding general duty of care under the Health and Safety at Work etc Act 1974. Therefore, they should ensure that the water supply, storage and distribution services are installed and operated within the terms of the following legislation.

Health and Safety at Work etc Act 1974

3.2 Employers have a general duty under the Health and Safety at Work etc Act 1974 to ensure, so far as is reasonably practicable, the health, safety and welfare of their patients, staff and the public who may be affected by workplace activities.

These duties are legally enforceable, and the Health and Safety Executive has successfully prosecuted employers including NHS organisations under this statute. It falls upon owners and occupiers of premises to ensure that there is a management regime for the proper design, installation and maintenance of plant, equipment and systems. Failure to have a proper system of working and adequate control measures can also be an offence even if an outbreak of, for example, Legionnaires' disease or other such incident has not occurred.

The Management of Health and Safety at Work Regulations 1992 & (Amendment) Regulations 2006

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

Control of Substances Hazardous to Health (COSHH) Regulations 2002 & (Amendment) Regulations 2004

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

Public Health (Infectious Diseases) Regulations 1988

3.5 The Public Health (Notification of Infectious Diseases) Scottish Regulations 1988 require that a properly appointed officer shall inform the Chief Medical Officer for Scotland, as the case may be, of any serious outbreak of any disease that to his/her knowledge has occurred in the district.

Note 1: The Health and Safety Commission's (2000) Approved Code of Practice L8 (see paragraph 2.1) contains further advice and guidance on communication and cooperation with Public Health Doctors and arrangements for supporting them and for them to have access to provider units, including NHS Boards.

Water Supply (Water Quality) (Scotland) Regulations 2001

3.6 The Water Supply (Water Quality) (Scotland) Regulations 2001 (and 2010 amendments) apply to water supplied to any hospital which is used for domestic purposes such as drinking, washing or cooking. Two additional sources of advice on drinking water quality are:

- the director of public health;
- the World Health Organisation's (1993) 'Guidelines for drinking water quality'.

The Water Supply (Water Quality) (Scotland) Regulations 2001 also cover private water supplies such as boreholes and wells.

Food Safety Act 1990

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

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

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

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

Compliance with this guidance document SHTM 04-01: 'Water safety for healthcare premises' will generally satisfy the Approved Code of Practice L8.

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

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

The Scottish Water Byelaws 2004

3.10 The water authority (See Note 1 in Part A of this SHTM) responsible for water supply has a statutory duty to enforce the Regulations for the prevention of waste, undue consumption, misuse and contamination of water supplied in its area.

The Scottish Water, Water Byelaws 2004 are broadly equivalent to the Water Supply (Water Fittings) Regulations which came into effect in England and Wales 1999. These Regulations are set out – along with the Department for Environment, Food and Rural Affairs' (Defra) guidance on the Regulations and the water industry's recommendations for fulfilling these provisions – in the 'Water Regulations Guide' published by the Water Regulations Advisory Scheme ('WRAS'). WRAS provides advice on water fittings regulations on a national basis and administers the scheme, which tests and lists water fittings and materials for compliance with the Regulations. The 'Water Fittings and Materials Directory' contains information on suitable fittings and materials and is updated every six months.

British Standards

3.11 BS6700: 2006 has been the British Standard specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilage. This has been superseded by BS8558: 2011 which provides complementary guidance to BS EN 806, the final part of which (Part 5) was published in 2012. For a transitional period BS6700 will co-exist with these replacement British Standards.

BS1710: 1984 is the British Standard specification for identification of pipelines and services.

4. The Control of *Legionella*

Source of the bacteria

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

The risk is related to the number and types of *Legionella* in the water at the point of use.

Ecology

4.2 The following conditions have been found to influence the colonisation and growth rate of *Legionella*:

- water temperature between 20°C and 45°C is the range in which *Legionella* will proliferate most rapidly. The optimum laboratory temperature for the growth of the organism is 37°C. *Legionella* are killed within a few minutes at temperatures above 60°C.

Note 2: The death curve is logarithmic with time for a given temperature.

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

Note 3: Biofilm forms when bacteria adhere to surfaces in aqueous environments and begin to secrete a slimy, glue-like substance that can anchor them to many materials such as metals and plastics. A biofilm can be formed by a single bacterial species, but more often biofilms consist of many species of bacteria as well as fungi, algae, protozoa, debris and corrosion products. Essentially, biofilm may form on any wetted surface exposed to bacteria.

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

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

Epidemiology

4.3 *Legionella pneumophila* serogroup 1 is the commonest cause of Legionnaires' disease. *L. pneumophila* is also responsible for Pontiac fever. Another species, *L. micdadei*, is responsible for a similar illness called Lochgoilhead fever. To date, over 45 species of *Legionella* have been identified. The bacterium can be found naturally in many freshwater sources and can survive a variety of environmental conditions. Virulence may be enhanced when the bacteria have been exposed to temperatures around 37°C which are most favourable to its growth.

4.4 The risk of healthcare-associated Legionellosis depends on a number of factors such as:

- the presence of *Legionella* in sufficient numbers;
- conditions suitable for multiplication of the organisms (for example temperatures between 20°C and 45°C and stagnant water);
- a source of nutrients (for example sludge, scale, rust, protozoa, algae and other organic matter);
- a means of creating and disseminating respirable droplets (for example, nearby cooling towers, showers and most other water draw-offs that are capable of creating a spray or causing splashing); and
- the presence of people who may be exposed to contaminated aerosols, especially those who are vulnerable to *Legionella* infection (for example those with compromised immune or respiratory systems, and transplant patients).

Many, if not all, of these factors are likely to be encountered in healthcare premises.

Control measures

4.5 Original guidance on the control of *Legionella* in hot and cold water services relied on a temperature control regime: that is, maintaining cold water below 20°C and hot water above 50°C. Because of the complexity of hot and cold water systems found in hospitals and the difficulty of maintaining a temperature control regime at all times, chemical and other water treatments that have been shown to be capable of controlling *Legionella* may need to be considered to supplement a temperature control regime.

Residual biocidal techniques such as chlorine dioxide and silver/copper ionisation (evaluated by BSRIA in TN 2/98: 'Chlorine dioxide water treatment − for hot and cold water services'; and TN 6/96: 'Ionisation water treatment for hot and cold water services') are outlined in Section 15 and Appendix 4 of Part A. Due to their residual effect, these techniques can inhibit free-floating and attached bacteria with varying degrees of efficiency. Ozone and ultraviolet (UV) treatment are also mentioned. However, they have a limited effect as UV is non-dispersive, and ozone rapidly degrades and therefore has only a short-term residual effect. Ozone and UV are not effective at removing biofilm from hot and cold water distribution systems. Other techniques, such as the use of silver stabilised hydrogen peroxide, are beginning to be used but care is needed in their application to ensure compliance with legislation and other, related, guidance. **Attention is drawn to Note 23 in Appendix 5 of Part A of this guidance.**

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

4.7 It is essential to review water supply dosing procedures involving chemicals such as silver stabilised hydrogen peroxide, chlorine-based products, etc. and ensure that these cannot impact on patients. Particular attention should be given to sites where sensitive treatment such as haemodialysis (renal dialysis) is performed.

4.8 It is also necessary to ensure that procedures are in place to liaise with staff in all areas before chemical dosing of water supply systems is carried out. This should include all locations where haemodialysis takes place, including regular and home haemodialysis units, intensive care units, renal specialist wards and general wards with renal dialysis bays.

4.9 A risk assessment should be carried out to identify at-risk areas and sensitive processes which include equipment such as carbon filters and reverse osmosis plant. This risk assessment will identify the method and action to be taken regarding isolation or management of the systems affected.

Route of infection

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

Aerosol generation

4.11 Contaminated water presents a risk when dispersed into the air as an aerosol. This risk increases with reduced droplet size, as smaller droplets remain airborne for longer, and aerosols (5µm diameter or less) penetrate deeply into the lungs (alveoli) and cannot easily be expelled. However, larger droplets can evaporate and still contain the initial number of organisms. Amoebic vacuoles, typically 3µm, may contain many *Legionella* and potentially provide an infectious dose.

In both a cooling tower and an evaporative condenser, water is actively recirculated around these systems, which increases the opportunity for aerosols to be produced. Water services are also capable of generating aerosols from the impaction of water onto hand-wash basins, sinks, baths and showers. In whirlpools, spas and decorative water features, the agitation of the water is achieved by the combination of air jets and pulsating water flow. Splashing water and air bubbles bursting as they break through the water surface create an aerosol immediately above the water surface. The risk of *Legionella* infection increases with the number of infective particles in the aerosol generated, especially if the size of the aerosol is less than 5µm.

Number of infectious bacteria

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

Two factors determine the number of bacteria deeply inhaled:

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

source help to reduce the likelihood of water droplets containing *Legionella* entering the building;

- the duration of exposure to the contaminated air:
  - exposure in a shower is usually limited to a few minutes, while exposure in a bath, particularly a spa or decorative water feature in a reception or waiting area, or externally, is much longer. Exposure to airborne *Legionella* distributed from a contaminated water-system such as a nearby cooling tower may take place whenever it is operating – this could be most of the day and, if process-related, not confined to summer.
  - the risk increases with the extent of *Legionella* bacteria in the air, the respiratory rate of the individual and the length of time the person is exposed. The chances of *Legionella* infections occurring increase with the number, and susceptibility, of people exposed.

Susceptibility of individuals

4.13 While previously healthy people may develop Legionnaires' disease, there are a number of factors that increase susceptibility:

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

5. Operational management

General

5.1 Managers should ensure that an operational plan is in place for each site under their control. This document should comprise:

- up-to-date as-fitted drawings, schematic diagrams and descriptions of all the supply, storage and distribution systems within those premises;
- step-by-step instructions to operate, maintain, control and shut down the water supply, storage and distribution systems within those premises;
- a schedule of possible emergency incidents causing loss of the water supply from the water authority (See Note 1 in Part A of this SHTM). Each item in the emergency incident schedule should include guidance on operational procedures to re-establish a stable wholesome water supply.

All premises are required to have a *Legionella* risk assessment and a written scheme for controlling any identified risks in accordance with the Health and Safety Commission's Approved Code of Practice L8. Guidance on the preparation of Written Schemes can be found in Part G of this SHTM.

Competence

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

Safe hot water temperature

5.3 See paragraphs 9.54–9.58 in Part A for guidance on safe water temperatures and delivery devices.

To reduce the risk of scalding, thermostatic mixing devices should be installed for many hot water outlets. A risk assessment will be necessary to establish the need and type of device to be installed.

As with any safety device, routine checks will be essential to ensure continued satisfactory operation. Such devices, however, should not be a substitute for caution, and there are circumstances where nursing staff should always use a thermometer. For example, when performing assisted bathing, it is often necessary to set the delivery temperature to a higher level than that normally considered 'safe' to allow for the cooling effect of large baths that is required.

Before lowering or assisting patients into the bath, the water temperature should be checked with a thermometer to ensure that it has fallen to a 'safe' level. Thermometers should also be used whenever children are being bathed.

Utilisation

5.4 One of the critical factors affecting the quality of water within hot and cold water distribution systems is the extent of utilisation. In recent times the provision of alcohol-based hand rubs and additional provision of wash hand basins has resulted in a reduction in water usage per appliance.

Where stagnation occurs or utilisation is low, cold water temperature can increase significantly and approach the range that is conducive to the growth of a variety of water-borne pathogenic microorganisms such as *Legionella*. Where water is mixed, further opportunities arise for deterioration in water quality.

Particular problems occur where a separate thermostatic mixing device is used to provide a safe hot water supply to the inlet port of a second mixing outlet, or where there are separate hot and cold outlets. In this case, the pipe supplying the separate cold tap, or the cold supply to the inlet to the mixing tap, might not be used for periods of time; thus water will become stagnant. Consideration should be given to removal of the separate cold supply and any dead-leg resulting from this. All mixing valves should in any case be easily accessible for routine cleaning and maintenance.

Management needs to ensure that there is good liaison between the estates officers/maintenance providers and clinicians to ensure that the water services are sufficiently used.

5.5 Showers are the most critical facilities because of their capacity to generate an aerosol and the potential under-utilisation. Even when patients require assisted bathing, they are likely to use WCs and hand-wash basins, and water usage for these will be maintained. This may be less of a problem in multi-bed wards in which other patients are capable of using showers with or without assistance.

5.6 It will be essential to build into the management of the premises a mechanism to ensure that such facilities are routinely operated to draw off water. In healthcare facilities, a higher frequency is recommended, depending on the application, and water draw-off should form part of the daily cleaning process. The procedure for such practice should be fully documented and covered by written instructions. For control of infection purposes, there has been a growing tendency to specify and install non-touch taps for clinical wash hand basins. It is appreciated that this requires personnel to remain at the tap to create the water draw-off forming part of the daily cleaning process. While occupying time and resources, the benefits of these fittings outweigh any burdens. Consideration should be given to installing taps with automated programmable flushing facilities that can be monitored by an Intelligent Water Management System or hand-held computer.

Note 4: Regular flushing applies to all sporadically used outlets. If used less than once a week, showers should be removed. Safety showers should not be located at the end of lines.

Temporary closure of wards/departments

5.7 During temporary closure of wards or departments, a procedure for flushing the hot and cold water service systems should be instituted. This should include opening all taps and showers for a period of three minutes and flushing WC cisterns etc on a twice-weekly cycle. Alternatively, when this is impracticable, the disinfection procedure recommended for new installations may be carried out immediately prior to occupation. This should be applied upstream of the closed area. Taps that include flow regulation may need to be flushed for longer than three minutes. In determining the flushing period, consideration should be given to the water pressure and length of dead-legs and spurs in the connecting pipework.

High risk areas

5.8 In specialty departments where patients are particularly susceptible (such as renal wards, transplant units, cancer care areas), it may be preferable to provide separate small-scale systems. Such systems should have independent supply and local heating sources. The use of point of use, hands free water heaters mounted over sinks should be considered.

Additionally, local water treatment may be considered necessary. It is also vital that cold water should be maintained below 20°C.

Note 5: Circulation of cold water and refrigeration should normally only be considered in specialised units where people are at particular risk as a result of immunological deficiency, for example transplant units. For other accommodation, the aim should be to promote turnover of cold water by means of the design of the distribution circuitry. Cooling would, however, only be introduced as a last resort where incoming cold water temperatures dictate.

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

Water management policy

5.9 It is essential to check regularly systems and all components for signs of leakage; for example, a tap left dripping can waste in excess of 14,000 litres of water each year.

Consumption should be monitored and if it increases for no apparent reason, this may indicate a leak. Wet or soggy patches of ground may identify underground leaks, for example areas of greenery that are more lush than their surroundings.

WC pans and flushing cisterns that use more than 6 litres per flush are prohibited by the Scottish Water Regulations 2004. Further savings can be achieved by the use of dual-flush systems.

Water treatment policy

5.10 The water authority (see Note 1 in Part A of this SHTM) is increasingly using chloramines in public water supplies on the grounds that they are more stable and more effective in the control of a variety of water-borne organisms. *The Lancet* has published an article reporting that fewer sporadic cases of community Legionellosis had been reported in areas where the authorities had used chloramine treatment. Chloramines can, however, present problems for dialysis water systems (see Appendix 3 in Part A for further information on the impact of chloraminated water. SHTM 04-01 Part F also refers).

Energy management policy

5.11 An energy management policy should be set up to define actions that should be taken to minimise energy consumption. An effective maintenance plan will also contribute to minimising energy consumption. Further guidance is given in Scottish Health Technical Memorandum 07-02: ‘EnCO$_2$de’ and the Department of Health’s (2004) ‘Carbon/energy management in healthcare’.

Maintenance policy

5.12 There are legal, operational and economic reasons for introducing a maintenance policy.

There is a legal requirement to protect and preserve the safety of staff, patients and the public. Complying with the law is generally given the highest priority, and is the minimum requirement that must be satisfied. Section 3 lists specific statutes that must be complied with.

Maintenance will be required to achieve optimum economic life and maintain maximum operational efficiency of the plant.

To decide the appropriate level of maintenance (for example scheduled, corrective or condition-based) for the different items of plant, the following questions must be addressed:

- would a breakdown of a particular service during working, or outside normal, hours prove critical?
- how long can a breakdown of particular plant be tolerated?
- what cost can be justified to avoid breakdown of particular plant such as stand-by pumps?

Resolving these issues will set objectives for the maintenance policy. If response to failure is critical for certain items of plant, the maintenance organisation will require a planned strategy of calling out skilled staff to achieve an agreed response time and to minimise the interval between breakdown and the diagnosis and repair of the plant.

Management is ultimately responsible for the provision of a wholesome water supply in the premises under its authority.

5.13 The policy for healthcare premises should be based on that of planned preventive maintenance, as any failure in the water services would be seriously detrimental to the provision of healthcare.

Planned preventive maintenance involves a series of inspections at regular intervals and monitoring operating parameters to avoid failure by implementing timely remedial work.

Maintenance responsibility

5.14 A manager responsible for maintenance takes responsibility for implementation of the maintenance policy. These responsibilities will include:

- the provision of adequately trained and supervised manpower;
- clear definitions of the equipment and services to be maintained, together with the procedures to be carried out on them;
- monitoring of the quality of the work carried out to ensure that it is consistently acceptable;
- the implementation of financial control procedures.

Contract maintenance

5.15 The increasing complexity of building services equipment has resulted in a growing reliance on contractors for the provision of maintenance services. The decision to use either a contractor or in-house staff must be taken in the light of local circumstances.

Contracts between the hospital/healthcare premises and service providers should clearly define the responsibilities of both parties. BSRIA's (1992)

Application Guide AG 4/89.2: ‘Maintenance contracts for building engineering services’ provide advice on aspects to be considered when obtaining contract maintenance.

Reference should also be made to:

- Part E of this SHTM: Alternative materials and filtration;
- the Heating and Ventilating Contractors’ Association’s (HVCA) (2004) ‘Standard maintenance specification for mechanical services in buildings’.

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

Maintenance brief

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

- scope of work;
- budgeting – overall and single item limits;
- level of reliability;
- response time required to correct faults;
- criteria for quality of service;
- reporting procedure;
- accountability and responsibility;
- energy-saving policy;
- health and safety policy;
- environmental and sustainability factors.

The above requirements are necessary regardless of whether the work is carried out by PFI/PPP FM Providers, contractors or in-house staff.

Performance monitoring

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

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

Performance monitoring should establish that:

- the required level of service is met;
- all the required plant is being maintained;
- system performance is being maintained (where water treatment is provided as part of the control strategy, it will be necessary to test for *Legionella*);
- maintenance is being carried out to the agreed standard;
- correct replacement parts are being used;
- the agreed spares stocks are being held on site;
- records are being correctly maintained;
- the agreed standards, number of staff, and number of visits are being achieved;
- plant is being operated to achieve optimum energy usage;
- health and safety requirements are being complied with;
- only agreed subcontractors are being employed (see paragraphs 5.16 and 6.8);
- the client and typical users of the building are satisfied;
- invoices accurately reflect the work carried out, including materials expended;
- breakdowns do not occur too often;
- adequate consideration is being given to the potential environmental impact of contractors' action, for example disposal of lubricants, chemicals, worn parts etc that cannot be recycled.

Emergency action

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

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

Emergency action in an outbreak of healthcare associated Legionellosis is covered in Appendix 1.

Documentation

5.20 It is essential to have comprehensive operational manuals for all items of plant that include requirements for servicing, maintenance tasks and frequencies of inspection.

This information should be kept together with all commissioning data.

Documentation should also be drawn up as part of the health and safety file for the building or hospital (see Section 18, Part A).

As-fitted drawings

5.21 The availability of accurate as-fitted drawings is essential for the safe operation of hot and cold water service systems. The drawings will be necessary to perform the temperature control checks on the systems and will assist in identifying any potential problems with poor hot water circulation and cold water dead-legs where flow to sporadically used outlets can be low. Such information should identify all key components in the installations, for example water meters, storage tanks (filtration equipment, where fitted), calorifiers, and the location of isolating valves in the systems. Separate schematic drawings should be prepared and displayed in plantrooms such that all plant items, control valves etc can be identified. Record information should be stored electronically wherever possible in addition to hard copies.

5.22 In addition to drawings, there should be comprehensive schedules of outlets, lists of sentinel taps (outlets), other outlets to be tested annually and other components in the system.

Record-keeping

5.23 Management should ensure that an accurate record of all assets relating to the hot and cold water distribution systems is set up and regularly maintained. They must also ensure that records of all maintenance, inspection and testing activities are kept up-to-date and properly stored. Records should be kept for at least five years.

As a minimum, the following items should be recorded:

- the names and positions of those responsible for performing the various tasks under the written scheme;
- a *Legionella* risk assessment and a written scheme of actions and control measures;
- details of precautionary measures that have been carried out, including sufficient detail to identify that the work was completed correctly and when the work was carried out.

5.24 Planned preventive maintenance will help to ensure that systems perform correctly, and an essential element of this process is the maintenance of accurate records.

Maintenance records are normally required for the following purposes:

- verification of maintenance for local accountability;
- verification of maintenance for statutory obligations;
- as a means of monitoring the maintenance policy and its effectiveness;
- as a means of observing performance trends, initiating corrective action where necessary;
- as an aid to financial planning.

Maintenance records should include the following:

- details of remedial work required and work carried out;
- details of cleaning, disinfection procedures;
- results of chemical and microbiological analysis of water.

When alterations to plant or systems are implemented, the record drawings should be updated to reflect the modifications carried out.

5.25 An asset register for the engineering services would provide a structure for recording, retrieving and analysing information.

The asset register should be designed to provide the following information:

- an inventory of plant;
- a basis for identifying plant details;
- a basis for recording the maintenance requirements;
- a basis for recording and accessing information associated with maintenance;
- a basis for accounting to establish depreciation and the provision needed for plant replacement;
- information for insurance purposes.

5.26 When completing records, it is essential that the individual concerned signs and dates the entries, and that there is an audit trail in place. Pro forma log sheets for temperature checks are included in Appendix 2.

Further information on the monitoring of performance and effectiveness in carrying out maintenance tasks can be found in The Chartered Institution of Building Services Engineers' (CIBSE) (2000) 'Guide to ownership, operation and maintenance of building services'.

Accommodation periodically used

5.27 Departments within hospitals closed at weekends, clinics and GP or Dental premises similarly utilised will require their stored water temperatures at all times to be maintained within the same parameters as during normal usage. There is no practical alternative to this if re-pasteurisation with hot water at 70°C is to be avoided every time prior to putting accommodation back into use. Ignoring this requirement involves non-compliance with Workplace Regulations and the issue affects all NHS contractors.

Water Safety Plan and Risk Assessment of Water Distribution Systems

5.28 A risk assessment of the water distribution system in a healthcare facility is a legislative requirement. A water safety plan (WSP) approach, incorporating a risk assessment, is outlined in the World Health Organisation (WHO) document Water Safety in Buildings, 2011.

The latest HPS/HFS Guidance on *Pseudomonas aeruginosa* – advice for augmented care units, also recommends that a Water Safety Group (WSG) commissions and develops a WSP which includes a risk assessment. The key steps of a WSP, including a risk assessment, are outlined below.

5.29 Key steps of a Water Safety Plan for a Healthcare Facility

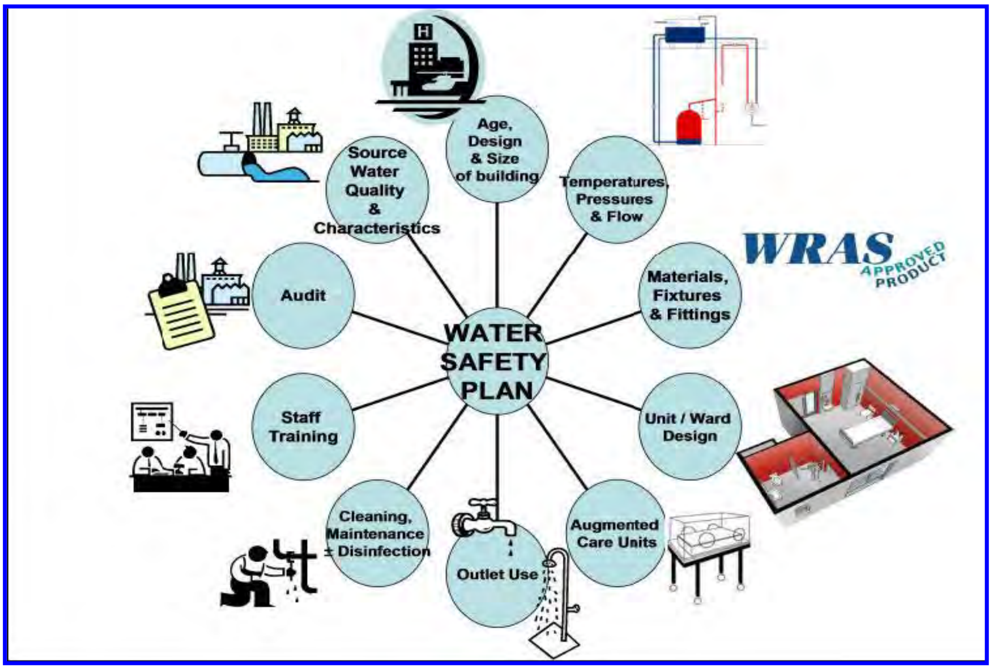
- establish an Environmental Monitoring Committee (or equivalent);
- document and describe the entire water distribution system including schematic diagrams;
- carry out a hazard analysis and risk characterisation, assessing likelihood and impact;
- assess the risks pertaining to all water, water systems, water uses, routes of exposure and patient risk groups;
- assess incoming source water quality and composition;
- identify and evaluate existing control measures;
- identify and implement additional control measures;
- carry out scalding risk assessments;
- enter ongoing risks onto the facility's risk register and manage appropriately;
- monitor and audit control measures;
- ensure maintenance is carried out in line with current recommendations;
- maintain an up-to-date hygiene logbook;
- develop written policies and procedures;
- develop a contingency plan for major disruptions to the incoming water supply;

- establish a communication plan;
- provide staff training and ensure competency;
- carry out the necessary validation, verification, and audit processes;
- a WSP is a dynamic working document. It is important that it is not seen as a one-off exercise. It must be kept up-to-date. Many factors in the day-to-day running of a facility can affect the risk of water system contamination such as:
  - planned/unplanned works or maintenance on the water system;
  - building renovation or refurbishment;
  - closure and re-opening of the facility or parts of it (planned or unplanned);
  - change of use of the building or part of it;
  - disruptions to the water supply to the facility.

5.30 The WSP should be reviewed on an annual basis and when there are alterations, repairs, changes of use, building works, or critical incidents.

Sites where there are mixed uses such as buildings for direct healthcare provision and buildings for administration are often supplied by the same mains water supply. However water systems use within both will be substantially different and can negatively impact in either direction. This must be addressed during the development of a WSP and there must be clear responsibility for the safety of water on the site.

The key factors that influence risk and that should be incorporated in a healthcare facility's WSP and assessed as part of the risk assessment are illustrated below.



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6. Hierarchy and designated staff functions

Management

6.1 Management is defined as the owner, occupier, employer, general manager, chief executive or other person who is ultimately accountable, and on whom the duty falls, for the safe operation of healthcare premises.

6.2 A person intending to fulfil any of the staff functions specified below should be able to prove that they possess sufficient skills, knowledge and experience to be able to perform safely the designated tasks.

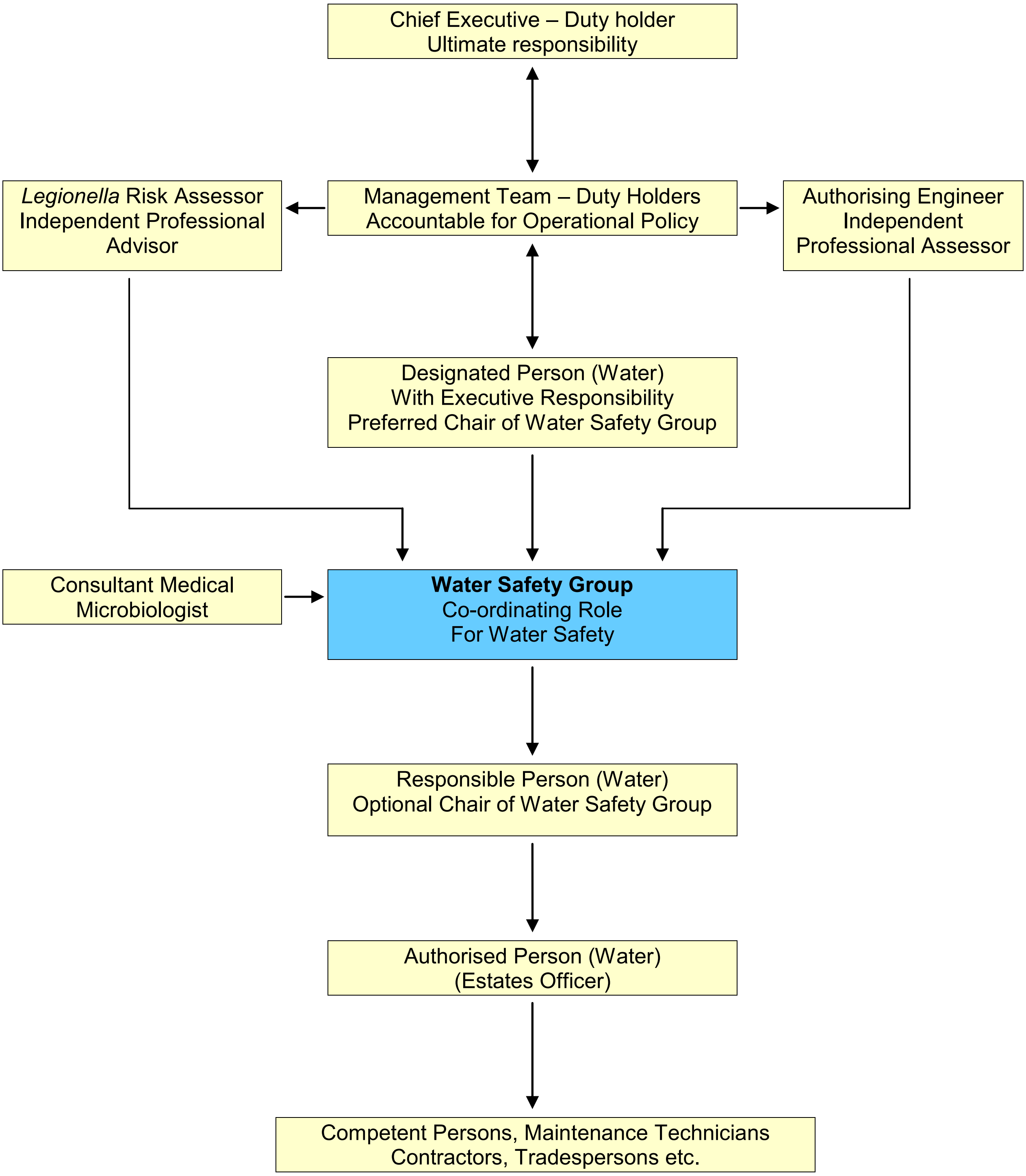
6.3 Management are required to have evidence of commitment and structure to meet the regulatory requirements and a scheme, setting in writing the detail of the principles and procedures for managing and controlling Legionellosis and Water safety risks. This will involve:

- ensuring the Chief Executive (The Duty Holder) and Management Teams (Duty Holders) are aware of and co-ordinate the policy and are familiar with their devolved responsibilities, duties and relevant procedures;
- providing adequate facilities, resources and competency training to support, implement and maintain all aspects of the policy;
- providing management and annual performance reports to Chief Executive, Management Teams, Infection Prevention & Control, Occupational Health & Safety, and Risk Management;
- reviewing the effectiveness of the policy across NHS Board;
- providing a Water Safety Group to support, co-ordinate and review operational management and controls in accordance with statutory and mandatory requirements;
- appointing in writing an independent professional advisor to act as "Authorising Engineer (Water*)" with a brief to provide services in accordance with SHTM and HSE guidance under the policy;
- appointing in writing an independent professional assessor to act as "*Legionella* Risk Assessor" with a terms of reference to provide services in accordance BS8580, SHTM and HSE guidance under this policy;
- nominating through the Designated Person (Water) the appropriate (Estates) Manager(s) to act as "Responsible Person (Water)" as defined in appointment letters, to adopt day-to-day responsibility for controlling and managing any identified risk from *Legionella* and *Pseudomonas* bacteria under the policy and lead the Water Safety Group. The Head of Maintenance (or appointed deputy) is the "Responsible Person (Water)" managing day–to–day risks and will be the estates lead in the event of an operational incident. In the event of *Pseudomonas* infection, Estates responsibility is limited and the Responsible Person (Water) will require to draw upon experience and specialist advice from a consultant medical

microbiologist, who shall also be a member of the Water Safety Group, to advise and lead on these issues;

- appointing in writing appropriate deputies and “Authorised Persons (Water)” who have authority, competence, knowledge and control of the water systems and installations identified in specific Written Schemes to ensure that all operational procedures and SHTM 04-01 requirements are carried out in a timely and effective manner to documented timescales. The Scheme will involve “Competent Persons”, “Maintenance Technicians”, “Tradespersons”, “Installers”, “Contractors” and “Contract Supervising Officers” co-ordinated with Duty Holders in accordance with SHTM and HSE guidance under the policy;
- A typical basic structure of hierarchy is shown below but this will vary to accommodate varying NHS Board policies or extent of requirement.

Note 6: *Where the designation “(Water)” is referred to throughout this section this embraces *Legionella* and Water Safety statutory and mandatory issues.



Typical structure of hierarchy

Water Safety Group

6.4 Water Safety Groups (WSG) within NHS Boards will be led and chaired, as a minimum, by the Responsible Person (Water) who will ensure that responsibility is taken for microbiological hazards and are identified by appropriate Group

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members They will assess risks, identify and monitor control measures and develop incident protocols. WSG should be a sub-group of and report to the Chair of the hospital Infection Control Committee and ensure a coordinated approach exists between Infection Prevention and Control Teams, clinical staff and Estates & Facilities on all water issues. There should be a clear line of responsibility to the Chief Executive through the Infection Control or other Committee.

The Water Safety Group will be responsible for supporting, co-ordinating and reviewing operational management and controls in accordance with statutory requirements (such as COSHH and HSE ACOP L8) and mandatory requirements (such as SHTM 04-01), for when and where water is supplied, stored, distributed and used safely, by:

- providing leadership for the overall provision of water services management and supervision for maintenance, operational and design procedures;
- facilitating Water Safety Group meetings (at least quarterly) with formal minutes, with stakeholders concerned on a regular basis;
- setting, promoting and maintaining consistent standards and practice;
- providing advice and preparation of safety and risk control notices;
- ensuring that Legionellosis risk assessments are compiled and refreshed every two years (with interim risk re-assessment being conducted as and when appropriate e.g. if there is a significant change to a water distribution system or change of use by the users);
- ensuring that Legionellosis risk assessments are reviewed at Water Safety Group meetings;
- ensuring that drinking water quality standards are maintained;
- ensuring that premises and site performance are reviewed in SCART and in the NHS Board (Datix) Risk Register;
- developing and agreeing risk based programmes of work to reduce risk;
- ensuring that the system to collect information and measure the efficiency, effectiveness and reliability of the management arrangements against set performance standards is regularly reviewed and instigating plans for corrective actions where required;
- ensuring that the policy, operational, maintenance and design procedures and training are regularly reviewed and updated as required to take account of new legislation, guidance, changes to personnel, procedures, protocols etc. and as a result of audit findings;
- promoting new technologies and encouraging innovation;
- the Water Safety Group will report quarterly to the NHS Board's Corporate Health & Safety Committee.

Membership will comprise representatives of Senior Nurses, Estates, Medical Physics, Health & Safety and Domestic Services Managers. An acceptable quorum will be determined by individual NHS Boards as appropriate.

Designated Person

6.5 The Designated Person (Water) provides the essential senior management link between the NHS Board and its professional support, which also provides independence of the audit-reporting process. The Designated Person will chair or maintain close liaison with the NHS Board Water Safety Groups to provide an informed position at Board level and by:

- making appointments in writing for 'the Authorising Engineer (Water)' and 'the *Legionella* Risk Assessor';
- making appointments in writing for ' Responsible Person and Deputy Responsible Person (Water)' and 'Authorised Persons' (Water);
- ensuring through the Water Safety Group that water for hygiene is safe;
- making appropriate Water Safety Group membership appointments.

Infection control officer

6.6 The Infection Control Manager, the Infection Prevention and Control Doctor (also known as the Infection Control Doctor) and the Consultant Microbiologist are nominated by management to advise on infection control policy and to have responsibility for the maintenance of water quality from the point it leaves the tap.

The policy should be acceptable to the Infection Prevention & Control Team and they should agree any amendment to that policy.

Responsible Person

6.7 The WSG will be lead and chaired by a Responsible Person (Water) appointed by the Designated Person who will possess sound professional knowledge of *Legionella* and water safety issues and appropriate training. The appointment should be in writing by management to devise and manage the necessary procedures to ensure that the quality of water in healthcare premises is maintained. The Responsible Person (Water) should have sufficient authority to ensure that all operational procedures are carried out in an effective and timely manner and be required to liaise closely with other professionals in various disciplines. In addition, the Responsible Person (Water) should possess a thorough knowledge of the control of *Legionella*. *Pseudomonas* outbreaks would have an over-bearing influence from clinical and cleaning procedures and would primarily come within the responsibility of the Infection Prevention and Control Team who would be represented on the Water Safety Group and from whom the Responsible Person (Water) would draw appropriate expertise via a consultant medical microbiologist.

Note 7: NHS Boards may consider that there are advantages in having the Water Safety Group chaired by Designated Person with executive responsibilities and the ability to exchange information to and from Board level while ensuring that all disciplines (i.e. beyond estates functions) fulfil their particular responsibilities (such as flushing and cleaning procedures)

The role of Responsible Person (Water), as part of the Water Safety Group, as described above involves:

- advising on the potential areas of water-related risks and identifying where systems do not adhere to this guidance;
- liaising with the water authority (See Note 1 in Part A of this SHTM) and environmental health departments and advising on the continuing procedures necessary to ensure acceptable water quality;
- monitoring the implementation and efficacy of those procedures;
- approving and identifying any changes to those procedures;
- ensuring equipment that is to be permanently connected to the water supply is properly installed;
- ensuring adequate operating and maintenance instructions exist and adequate records are kept.

Implementation of an effective maintenance policy must incorporate the preparation of fully detailed operating and maintenance documentation and the introduction of a Written Scheme and logbook system. The Responsible Person (Water) should appoint a deputy to whom delegated responsibilities may be given. The deputy should act for the Responsible Person (Water) as delegated and directed.

The Responsible Person (Water) should also be fully conversant with the design principles and requirements of water systems and should be fully briefed in respect of the cause and effect of water-borne organisms, for example *Legionella pneumophila.* The rôle can extend to the operation and maintenance of associated plant. It is recognised that the Responsible Person (Water) cannot be an expert on all matters and must be supported by specialists in specific subjects such as water treatment and microbiology, but he/she must undertake responsibility for calling upon and coordinating the activities of such specialists. Rôles and responsibilities may vary across NHS Boards depending on operational structures.

The Responsible Person (Water) should be aware that manufacturers, importers, suppliers, installers and service providers have specific responsibilities that are set out in the Health and Safety Executive’s Approved Code of Practice L8.

Authorised Person

6.8 The Authorised Person (Water) has the key operational responsibility for the service, qualified and sufficiently experienced and skilled for the purpose. He/she will be nominated by the Authorising Engineer (Water) and be able to demonstrate

- his/her application through familiarisation with the system and attendance at an appropriate professional course;
- a level of experience;
- evidence of knowledge and skills.

The Authorised Person (Water) will be appointed in writing as the single person with sole responsibility for the Written Scheme for an individual water system. No work will be carried out on the water system without the knowledge and written consent of the Authorised Person. An important element of the Authorised Person's role is the maintenance of records, quality of service and maintenance of system safety (integrity) together with responsibility for ensuring that delegated projects comply with the NHS Board's *Legionella* policy and procedures.

The Authorised Person (Water) will also be responsible for establishing and maintaining the roles and validation of Competent Person (Water) who may be employees of the organisation or appointed contractors.

Larger sites may require more than one Authorised Person (Water) for a particular service. Administration duties, such as record keeping, should be assigned to specific Authorised Persons (Water) and recorded in the operational policies.

Competent Person

6.9 The Competent Person (Water) provides skilled installation and/or maintenance of the specialist service. He/she will be appointed, or authorised to work (if a contractor) by the Authorised Person (Water). He/she will demonstrate a sound trade background and specific skill in the specialist service, working under the direction of the Authorised Person (Water) in accordance with operating procedures, policies and standards of the service.

Maintenance technician

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

Tradesperson

6.11 A Tradesperson is someone who is appointed in writing by the Authorised Person (Water) to carry out, under the control of the Maintenance Technician, work on the water, storage and distribution system.

Installer

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

Contractor

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

Contract Supervising Officer

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

Authorising Engineer

6.15 An Authorising Engineer (Water) acts as an independent professional advisor to the NHS Board, appointed by the organisation with a brief to provide services in accordance with SHTM guidance.

The Authorising Engineer (Water) acts as an assessor, making recommendations on Duty Holders and for the appointment of Designated Persons, Authorised Persons and Competent Persons, monitoring the performance of the service and providing an annual audit to the NHS Board's Designated Person.

Legionella Risk Assessor

6.16 The *Legionella* Risk Assessor acts as an independent professional advisor to the NHS Board, appointed by the Board with a brief to provide services in accordance with BS8580. The *Legionella* Risk Assessor shall:

- have demonstrable competence and proven knowledge of *Legionella* bacteria relevant to NHS healthcare water systems;

- be UKAS, or equivalent, accredited;
- be provided with NHS Policies, Procedural documents, any existing *Legionella* Risk Assessments and a current List of NHS Board owned and leased sites;
- provide under an agreed programme, to the General Manager, Facilities and Estates, a *Legionella* Risk Assessment, on an agreed template, for each individual Water System within NHS Board sites in a Microsoft Word (or Excel) format;
- use the formal criteria highlighted in the NHS Board Risk Assessment Policy and NHS Scotland National Risk Matrix to develop and determine specific (using Impact/Consequence and Likelihood definitions within the 5 x 5 Risk Matrix scoring system) *Legionella* Risk Assessments with BS8580 criteria. Highlight assumptions, prove calculations and individual responses to identified risks in each level (Risk Prioritised Action Plan).
- highlight in each Risk Assessment, considerations for:

Contamination	Host susceptibility
Amplification	Operational history
Transmission	New and emerging technologies
Exposure	Drinking water quality

- to an agreed template, provide an Executive Summary Report (including all information sortable in Microsoft Excel spreadsheet format) in prioritised risk level order, applicable to all *Legionella* Risk Assessments being undertaken on NHS Board owned and leased sites, premises/building blocks, plant and water systems. This will include review and re-audit where a Risk Assessment has been carried out prior to this appointment;
- identify operational safety issues;
- identify any Water Systems that cannot be fully assessed and highlight the reasons why not;
- identify any aspects of the Risk Assessment that require further specialist knowledge or equipment (including PPE, access, restrictions, permit to access/work, and the need for a competent escort who is familiar with the system(s)) in order to complete the assessment or avoid put themselves or others at risk during the assessment;
- identify whether a Written Scheme and or Schematic Drawing has to be prepared or redrawn as part of the assessment and its coverage;
- ensure that *Legionella* Risk Assessments will be made available to the Authorising Engineer (Water) and the Water Safety Group.

The above can be summarised as follows:

- provision of a descriptive plan of the extent, condition and design of installations;
- assessment of risk arising from bacterial contamination and scalding;

- preparation of Risk Assessment Score Matrix;
- identification of faults with comments, recommendations and priorities for remediation;
- provision of management systems and Planned Preventive Maintenance task analysis;
- provision of domestic hot & cold water services condition and temperature analysis;
- provision of a schedule of dead-legs and infrequently used facilities;
- provision of survey, inventory and assessment of shower thermostatic mixing valves and outlets;
- provision of a condition report for cold water storage tanks and calorifiers.

7. Description of systems, operational considerations and requirements

Source of supply

7.1 See Section 2 in Part A for comprehensive guidance and information on sources of water supply.

If supplies are taken from local boreholes or wells etc, the water should be tested to comply with the requirements of the Water Supply (Water Quality) (Scotland) Regulations 2001 and 2010. The results of all analyses should be kept and recorded.

Water supply hygiene

7.2 Normally a supply from a water authority (See Note 1 in Part A of this SHTM) should not require additional disinfection, but all piping, fittings and associated services used for the conveyance of water for domestic purposes must be disinfected before being brought into use. Such piping, fittings and storage cisterns must also be disinfected on completion of works which have entailed ‘opening up’ the system.

Private supplies taken from boreholes or wells etc will require regular testing, (see paragraph 7.1, above), and will generally require to be disinfected before being used for domestic purposes. Disinfection is effected by chemical or physical agents – the method generally used is chlorination.

7.3 Despite disinfection of systems, some outbreaks of disease related to treated water supplies still occur. To reduce the risk of such outbreaks, the design should eliminate:

- direct contact with the internal parts of water pipes and structures by people, animals or birds;
- backflow (back-siphonage) of contaminated water into systems conveying potable water (mains and storage structures).

Measures to protect against back-siphonage are set out in the WRAS ‘Water Regulations Guide’. The principle is that the design of piped water systems should be carried out in a manner that minimises the likelihood of contaminated material, or water, gaining access to those parts of any water service conveying potable water. All water from non-potable sources (rain, surface run-off water, private supplies, drainage of foul water etc) must be regarded as a potential source of pathogenic material. (Section 14 in Part A also refers)

Chlorination

7.4 Disinfection using chlorine should be carried out in accordance with BS6700: 2006 and its successors BS 8558 and BS EN 806 as described in paragraph 3.11 (see also Section 17 in Part A) and under the direct supervision of a nominated person.

Contaminated water that is run to waste into a natural watercourse, or a drain leading to it, should be treated in accordance with the requirements of the authority (SEPA) which is responsible for land drainage and pollution control. The authority responsible for pollution control should be informed. Dechlorination can be achieved using either sulphite or bisulphite or meta-bisulphite.

Thermal disinfection (of hot water service systems)

7.5 This process introduces a serious scalding risk, and it is essential that steps are in place to ensure that access is limited to authorised personnel only until such time that the system has returned to normal operating temperature. It is unlikely to be a practical alternative for a large system.

This process can be performed by raising the temperature of the entire contents of the calorifier, followed by circulating the water throughout the system for at least an hour. The process, however, is impractical for all but small systems. The calorifier temperature must be sufficiently high to ensure that the temperature in all parts of the circulating system, and at the calorifier return, does not fall below 60°C. After this period, each tap or outlet should be run sequentially, with the draw-off at the furthermost tap or outlet being for a period of five minutes. Then each tap should be flushed back to source for the same period of time.

In the case of non-recirculating systems that have trace heating, the whole system should similarly be raised to 60°C for at least an hour before draw-off commences. However, trace heating systems are not recommended for other then very small installations or where there are recurrent localised depressed temperatures forming part of circulation systems.

Water treatment

7.6 *Legionella*, like other opportunist pathogens including *Aeromonas hydrophila* and *Pseudomonas aeruginosa,* are common in the environment and therefore can seed untreated water systems during construction and subsequent use. Contamination of water systems by microorganisms can also be introduced during refurbishment, repair and alteration, or during routine inspection and sampling.

The need for water treatment and the method of application depend on the purposes for which the water is to be used and the quantity required for each purpose.

In a properly installed and commissioned hot water system, it should be possible to maintain a temperature of at least 55°C at the furthest draw-off point in the circulating system, and 50°C in the circulating system's return connection to the calorifier. In older premises, however, this may not be possible, and in the case of cold water systems it is not always possible or practicable to maintain temperature below 20°C because of utilisation and complexity. It may therefore be necessary to apply additional residual biocidal water treatment that has been shown to destroy and remove biofilm. Information on these techniques can be found in paragraphs 7.7 and 7.13.

Where automatic equipment is used for disinfection, it should indicate any change in the amount or concentration of material injected into the water so that immediate action can be taken.

Continuous dosing with appropriate biocides that have proven efficacy should be considered during construction to prevent the accumulation of biofilm. A regular flushing programme for all outlets should also be implemented.

The continuous on-site chlorination of hot and cold water service systems to control the growth of *Legionella* is not generally recommended. Treatment using chlorine dioxide can be used.

In defining their responsibilities, service providers should be asked to advise on test methods and anticipated concentrations of residual chemicals within the system. (See also Sections 3 and 15 in Part A for more guidance on water treatment regimes.)

Chlorine dioxide

7.7 Chlorine dioxide is an oxidising biocide that is capable of reacting with a wide range of organic substances. Its effectiveness in the control of organisms in water systems has been demonstrated in a study carried out by BSRIA (see BSRIA's (1998) TN 2/98: 'Chlorine dioxide water treatment − for hot and cold water services').

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

Chlorine dioxide as a control measure

7.8 The use of chlorine dioxide as a control measure will depend on the design of the systems in use and their operational history. (See also Appendix 4 in Part A.)

There are two aspects to be taken into consideration:

- in the cold water distribution system, chlorine dioxide will be injected into the system upstream of all parts of the distribution, storage and boosting equipment – that is, at the curtilage of the premises;

Note 8: Backflow prevention is required if chlorine dioxide is injected into a pipe connected to the mains supply.

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

Note 9: Chlorine dioxide and its breakdown products chlorite and chlorate can be deleterious to neonates and renal dialysis patients, and should be removed from the water supply to these units. For all practical purposes in water, ppm = mg/litre.

Maintenance of the control regime

7.9 This depends on four separate aspects, as follows:

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

Ensuring that the dosing equipment is operating satisfactorily

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

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

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

Note 10: DPD is an abbreviation for diethyl-p-phenylene diamine. DPD1 tablets are used for detecting oxidants in water.

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

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

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

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

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

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

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

Silver/copper ionisation

7.13 Ionisation systems release copper and silver ions into the water stream by means of electrolytic action (see also Appendix 5 in Part A). Ionisation as a water treatment method is covered in BSRIA's (1994) Technical Note TN 6/96: 'Ionisation water treatment for hot and cold water services' following a study in which it was shown that copper and silver ion concentrations maintained at 400 micron/litre and 40 micron/litre respectively can be effective against planktonic *Legionella* in hot water systems. In soft waters, a silver level as low as 20 micron/litre can be effective. **Attention is drawn to Note 23 in Appendix 5 of Part A of this guidance.**

Maintenance of the control regime

7.14 Stable and consistent emission of ions is essential. Manual setting is not recommended, since changes in water quality (conductivity) wear the electrodes, and the insulation of scale formation will affect the level of dosing.

As ions are released in direct proportion to the current flowing between the electrodes, irrespective of voltage, control systems having a constant current arrangement that automatically increase (or decrease) voltage are likely to be the most satisfactory.

It is also possible to control the dosing equipment by metering the incoming flow to the system or its individual sections.

Note 11: Continuous dosing of drinking water with silver ions is inadvisable (see the Drinking Water Inspectorate's recommendations at http://www.dwqr.org.uk).

7.15 For testing on site, two separate tests are required for each of the elements:

- silver is usually measured by means of a dip slide typically of sensitivity 5 micron/litre to 1 mg/litre. Prior to measurement, chlorine is neutralised by means of aminoacetic acid and the wetted dip slides are compared with a colour chart;
- copper is tested by means of a titration test whereby reagents are added to water that is then similarly compared with a colour chart. The concentration sensitivity is typically between 0.05 and 1.0 mg/litre.

The tests are not as accurate as atomic absorption. It is generally advised that, on initial introduction of ionisation, test kits are employed for the first few weeks, and when levels are thought to be under control, confirmation is obtained by atomic absorption. After this, test kits can then be used routinely.

Monitoring silver/copper ions

7.16 In addition to the above, the following should be monitored:

- on a weekly basis, the rate of release of copper and silver ions into the water supply;
- on a monthly basis, the silver ion concentration at sentinel outlets should be measured – this should be at least 20 micron/litre;
- on an annual basis, the concentration of silver ions should be measured at representative outlets – this should be at least 20 micron/litre;
- on a weekly basis, the condition and cleanliness of the electrodes;
- on a weekly basis, the pH of the water supply – any significant change should be drawn to the attention of the supplier of the equipment.

Purging the systems

7.17 Where chemical treatment is introduced, it is essential to ensure that all parts of the system are purged so that adequate concentrations are achieved.

As temperature monitoring is performed on sentinel and representative outlets on a rolling basis only, additional draw-off will be required at all points on a regular basis.

Ozone and ultraviolet treatment

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

Metal contamination

7.19 See Section 6 in Part A.

Filtration

7.20 Filtration of potable water to a particle size of 0.2 micron is not uncommon, typically using 'dead-end' filters or cross-flow membrane filters.

In all cases it is feasible for bacteria to colonise or 'grow through' the filter material even where backwashing is a feature.

It is essential for filter cartridge elements to be changed at appropriate intervals in accordance with the manufacturer's recommendations, taking into account local conditions.

Filter membranes should also be chemically cleaned or replaced at the recommended periods, and care must be taken to ensure that the "vessel" or "housing" containing the filter assembly is also disinfected appropriately during filter or membrane maintenance. Further information relating to on-site filtration is contained in Part E of this SHTM: Alternative materials and filtration. Section 5 in Part A also refers.

Water softening

7.21 Base-exchange softening removes permanent and temporary hardness from water. The technique uses an ion exchange process in which the calcium and magnesium ions in solution are removed and replaced by an equivalent number of sodium ions.

Daily or frequent backwashing and periodic cleaning and disinfection (six-monthly) must be undertaken in accordance with the manufacturer's/ supplier's instructions. Other proprietary cleaning agents are not recommended, particularly if the softened supply water serves apparatus such as dialysis machines.

Other water softening methods include physical water conditioning and magnetic water conditioning. The operation and maintenance of these systems should be in accordance with manufacturers' instructions. The efficacy of these water-conditioning measures needs to be considered.

Further information on water softening can be found in BSRIA's Applications Guide AG 2/93: 'Water treatment for building services systems'. See also Table 1 in Section 4 in Part A, which classifies the levels of water hardness.

Metering

7.22 Where water meters are installed in below-ground meter chambers, the chambers should be kept clean of debris and water; this will enable quick and accurate reading of the meters.

Meters should be periodically checked to ensure that they are operating and providing accurate readings.

Meters, other than the water authority's (See Note 1 in Part A of this SHTM) meter, should be removed at such intervals as recommended by the manufacturers for cleaning and renewal of worn parts and should be tested for accuracy prior to replacement.

Meters should be read on a regular basis (monthly) and consumption monitored. A bar graph will highlight unusually large consumption, which can then be investigated.

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

Water storage

7.23 For general information on water storage, see paragraphs 7.1–7.2 in Part A.

The Water Supply (Water Fittings) Regulations 1999 and relevant parts of BS6700:2006, BS EN 806 and BS8558: 2011 specify minimum standards for cold water storage cisterns to ensure that the stored water is retained at a potable standard suitable for domestic use. It is necessary to minimise stagnation and stratification of the stored water. A nominal 12 hours' total on-site storage capacity is recommended. The quantity of the water stored should be carefully assessed in relation to the daily requirement so that a reasonable rate of turnover is achieved. The storage capacity should be reduced where it is known or established that it is excessive and where it is practicable to do so.

All cold water storage cisterns and cold feed cisterns must be examined at least annually, paying particular attention to the presence of foreign objects, biological material and excessive corrosion. On completion of the examinations, the cisterns should be cleaned, if required, and any remedial work carried out. Before the cisterns and system are put back into use, they should be disinfected in accordance with the procedure detailed in Section 17 of Part A.

Any chemicals used in the cleaning or maintenance of cisterns must be listed in the 'Water Fittings and Materials Directory'.

Cistern insulation should be checked to ensure that it is adequately positioned and in good condition.

Float-operated valves should be checked to ensure that they are securely fixed and set to achieve a correct water level in accordance with the Water Supply (Water Fittings) Regulations 1999.

Overflow/warning pipes should be checked to ensure that they do not rise in level and they are clear and correctly routed to give an obvious visual alarm of an overflow condition. A weatherproof label fixed adjacent to the warning pipe, identifying the tank and its location together with the person/ department to be contacted in the event of a discharge, would contribute to a quick and accurate defect report which could then be acted upon, so minimising water wastage.

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

Pressurisation/supply pumps

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

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

Cold water distribution system

7.25 The design and installation of the cold water distribution system should comply with The Scottish Water Byelaws 2004 and relevant parts of BS6700:2006, BS EN 806 and BS8558. (See Section 8 of Part A for further information.)

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

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Note 12: Automatic flushing of urinals should also be used to assist in water turnover.

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

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

- system components show no sign of leakage or corrosion;
- system insulation is in good condition;
- system filters have been changed and/or cleaned in accordance with manufacturer's recommendations.
- strainers have been regularly checked and cleaned;
- all isolating valves have periodically been worked through their full range of travel;
- every water outlet complies with the backflow protection requirements of the Scottish Water Byelaws 2004.

Drinking water

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

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

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

Hot water storage and distribution

7.28 Hot water services should be designed and installed in accordance with the Scottish Water Byelaws 2004 and relevant parts of BS6700:12006, BS EN 806 and BS8558: 2011. The hot water system may be of either the vented or the unvented type. (See Section 9 of Part A for further information.)

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

Note 13: A minimum of 55°C may be required for the operation of suitable mixing devices to provide 'safe' hot water at the upper limit of the recommended range. In large, non-recirculating systems, the minimum of 55°C should be maintained by electric trace heating. Such systems are, however, not recommended.

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

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

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

7.31 Hot water circulating pumps should be of adequate performance to ensure a minimum available temperature at draw-off points of 55°C and an absolute minimum of 50°C at the return connection to the calorifier.

Note 14: Ball-type valves should be specified to avoid clogging. The drain from the gully should be of sufficient size to take the flow from the calorifier drain.

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

Instantaneous water heaters for single or multi-point outlets

7.32 These devices usually serve one draw-off only and are either electrically or gas-heated. The general principles and limitations of instantaneous water heaters are given in BS6700: 2006 and its successors BS EN 806 and BS 8558. In essence:

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

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

Safe hot water delivery devices

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

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

It is essential to check the temperature settings and operation of all water mixing devices regularly (six monthly, provided that there is no 'drift' in excess of 1°C). The method of testing should be in accordance with Model Engineering Specification D08. Other maintenance should be strictly in accordance with the manufacturer's instructions. The local water quality will influence the maintenance frequency for any installation. A relatively small piece of debris may restrict the operation of the temperature control and fail-safe mechanisms.

The recommendations regarding safe water temperature apply to all ward accommodation, residents' rooms and those areas to which patients, residents and visitors have free access (including public areas). Until the recommended precautions are put into effect, staff should be made aware of the potential danger and take the necessary steps to protect patients, residents and visitors. Areas that do not meet these recommendations should be identified, and plans to comply as soon as reasonably practicable should be devised. These recommendations apply equally to staff accommodation.

Materials of construction

7.35 Systems should comply with the requirements of the Water Supply (Water Fittings) Regulations 1999. Materials used in contact with water that is for drinking etc should comply with BS6920-1: 2000 and be listed in the latest edition of the 'Water Fittings and Materials Directory' published by WRAS.

Temperature control regime

7.36 Temperature control regime is the preferred strategy to maintain systems free from *Legionella* and other waterborne organisms. This will require monitoring on a regular basis. The test frequencies are listed in Table 1. (See also BSRIA's Application Guide AG 4/94: 'Guide to Legionellosis – temperature measurements for hot and cold water services'.)

Whereas many of the checks will, of necessity, require the use of separate thermometric equipment, some of the temperature checks can be carried out by continuous monitoring by a BEMS. Where a BEMS is used, it will be essential to ensure that regular calibration and physical tests are performed in accordance with the manufacturer's instructions.

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

Showers

7.37 Hyper-chlorination of showerheads and angle valve strainers has only a short-lived effect on *Legionella*. Manual cleaning to remove scale and other deposits should be carried out at least quarterly, and more frequently if required. Automatic drain valves are ineffective in maintaining a reduction in the number of *Legionella* in shower water, and *they should not be installed* (see the Health and Safety Commission's Approved Code of Practice L8). Regular flushing of showers reduces *Legionella*, but *Legionella* can significantly increase in number if regular flushing should cease. The most effective management of showers will be achieved by the removal of unnecessary ones and the regular use of others. Where showers are removed, it is important to cut back all the associated pipework and remove the redundant tee-piece on the circulating main to avoid creating dead-legs. (Paragraph 7.49 in Part A also refers)

7.38 Where it is difficult to carry out flushing to the recommended frequency, stagnant and potentially contaminated water from within the shower and associated dead-leg should be purged to drain immediately before the appliance is used. This procedure must be carried out with minimum production of aerosols. It is important to note the distinction between self-purging and self-draining showers. Self-purging showers can be an effective *Legionella* control procedure, while self-draining showers can support the proliferation of *Legionella*.

7.39 Where showers are confirmed as being used less than once per week, they should be removed.

Point-of-use filtration

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

Where point-of-use filters are no longer required, the outlet and associated pipework must be disinfected to remove any accumulated biofilm before the system is returned to service (see also paragraph 5.16 in Part A). Manufacturer's instructions should be followed at all times.

Summary checklist

7.41 A summary checklist for hot and cold water services showing recommended frequency of activity is given in Table 4.

Frequency	Check	Cold water	Hot water	Notes
Monthly	*Sentinel outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes [1]	The water temperature should equilibrate to at least 50°C after draw-off for1 minute [2]	These measurements are applicable to non-mixed outlets only
Monthly	Inlets to sentinel TMVs	Temperatures as above	Temperatures as above	Measurements can be made by means of surface temperature probes
Monthly	Water leaving and returning to calorifier			Also to be monitored continuously by BEMS i.e. 60°C flow and 50°C return minimum
6-monthly	Incoming cold water at inlet to building – in the winter and in the summer	The water should be below 20°C		Also to be continuously monitored by BEMS
Annually	**Representative outlets	The water temperature should equilibrate below 20°C after draw-off for 2 minutes [1]	The water temperature should equilibrate to at least 50°C after draw-off for 1 minute [2]	

Table 2: Tests for temperature performance

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

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

Notes associated with Table 2:

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

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

Procedure to be adopted for Cold Water Tanks following identification of water temperatures in excess of 20°C

7.42 Drinking water, to a relevant water quality under Regulations, is provided to NHS Boards by Business Stream, a Licensed Provider (LP), who work with Scottish Water to make sure that the water supply is connected properly, and the water is clean and ready to use.

7.43 These obligations cover the supply network up to the boundary point (normally the meter point), thereafter obligations rest with NHS Boards. Currently there is no legal maximum water supply temperature from the Licensed Provider. In practice the water supply temperature to boundary point will be subject to seasonal variation. In winter this would normally be expected to be in the 5 – 10 °C range and in summer up to 20°C. Estates managers require to take cognisance of HSE ACOP L8 and seasonal variations in risk assessments, covered by a Written Scheme for each water system with schematic drawings and a risk management system.

7.44 The following staged risk assessment escalation procedure should be employed where the water temperature in Cold Water Storage Tanks is greater than 20°C. (i.e. the water storage tanks for Domestic Cold Water Systems and for Domestic Hot Water Systems).

Stage 1 - Verification

- where tepid cold water occurrence (i.e. more than 20 °C) is reported from any numbers of cold water outlets, from maintenance procedures, from BEMS monitoring, or from the manual monitoring of storage tanks, the person identifying, or making a report must notify the relevant Authorised

Person (Water) as soon as the problem is identified and confirm this in writing within 24 hours;

- The Authorised Person (Water) should liaise with the person identifying the problem and verify the problem by independently re-checking by means of taking the water temperature of the appropriate cold water storage tank, the temperature of the incoming mains cold water at the site boundary point (and building entry point if there are multiple buildings served by the mains cold water system) and the outflow distribution temperature;
- if the cold water storage temperature is confirmed greater than 20°C, then the Authorised Person (Water) should record this in writing as well as conducting continuous monitoring of the incoming cold water mains, the cold water storage and the outflow temperatures to establish the temperature profiles and in more detail over at least a one week period to determine the level of risk;
- The Authorised Person (Water) should also review the Water Safety Log Book and take into account the recent water system history specifically to include:
  - the primary water treatment levels (for mains cold water supplied with Chlorine or Chloramination treatment);
  - any water sampling carried out following SHTM 04-01;
  - system monitoring data including temperature monitoring and water quality chlorine or chloramination checks;
  - recent maintenance history; recent alterations, changes or additions to the water system;
  - any other changes made by Duty Holders or users of the water system.
  - On reviewing continuous monitoring temperature profiles action as Stage 2 or Stage 3 or Stage 4 as appropriate should be undertaken. The Authorised Person (Water) will ensure that the Responsible Person (Water) is notified immediately in writing at each stage and also recorded in the Water Safety Log Book.

Stage 2 - Initial Action – high incoming mains cold water temperature

- where the incoming mains cold water is 18°C or greater for more than a 48 hour period the Responsible Person (Water) should contact Business Stream (the Licensed Provider) who will work with Scottish Water to establish the reasons and determine a resolution. Continuous monitoring should continue and recorded in the risk assessment.

Stage 3 - water temperatures fluctuating above and below 20°C (but no greater than 25°C)

- where water temperatures are fluctuating above and below 20°C in a regular cyclical manner over 72 hour periods in response to regular user water demand (but no greater than 25°C) and are more than 2°C higher than the incoming cold water mains supply temperature at the building entry point, then continuous monitoring should be continued by the Authorised Person

(Water). The reason(s) for failure(s) should be identified and rectified as soon as possible. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there may be increased risk and appropriate actions may be required to mitigate exposure).

- considerations for failures include:
  - accuracy of temperature sensors (requiring recalibration);
  - temperature sensors being located in water (requiring reposition where tank storage levels been reduced and sensor no longer sensing stored water);
  - inappropriate standby tank configuration;
  - temperature sensor in standby system;
  - temperature sensor measuring stagnation (requires reposition);
  - inappropriate siting (not in a cool location);
  - heat gain to the tank and pipework (due to lack of appropriate insulation or located close to heat gain from other heat sources);
  - storage capacity not minimised to match daily use;
  - ingress of hot water through cross connection or mixing valve failure (i.e. from DHW system or Steam systems);

Stage 4 - water temperatures fluctuating above and below 25°C (and rarely below 20°C)

- in this situation continuous monitoring should be continued by the Authorised Person (Water), the reason(s) for failure(s) (as Stage 3) identified and rectified on an urgent basis. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there will be an increased risk and appropriate actions will be required to mitigate exposure);
- in this situation a permanent solution, such as ventilation for the plant room, or changing the water storage arrangements, or forming a circulating distribution system (with or without chilling depending on the circumstances) would require to be implemented;
- The Authorised Person (Water) should, unless instructed in writing to the contrary by Responsible Person (Water) implement the following:
  - arrange to drain the tank contents and clean if necessary;
  - inform the users of the failed system that they must not draw off any cold water (and hot water if a single domestic hot water header) from the affected system until further notice;
  - chlorine (or other suitable) disinfection of the tank and distribution system shall be carried out;
  - thereafter the tank shall be brought back into service;
  - finally the users shall be informed that the system is back in operation.

7.45 The Authorised Person (Water) shall complete an Incident Report Record Form. An entry should also be made in the Water Safety Log Book and the Responsible Person (Water) should be notified in writing as soon as possible.

7.46 Water systems should be cleaned and disinfected under the circumstances in the following Table 3:-

System/ Service	Circumstance Requiring Cleaning and Disinfection	Frequency
Domestic Cold Water and Domestic Hot Water Tanks	New installations. Re-commissioning empty/unused tanks. Tank temperature exceeds 25°C. (Check with Risk Assessment). Tank contains moderate sediment, i.e. a complete covering of the tank base. Evidence of tank corrosion (check with Risk Assessment). Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Regular programme for high-risk healthcare category, with disinfection* where identified in the local Written Scheme (check with Risk Assessment). Regular programme for medium risk healthcare category, with disinfection* where identified in the local Written Scheme (check with Risk Assessment). Regular programme for non-healthcare premises, with disinfection* where identified in the local Written Scheme (check with Risk Assessment).	As required As required As required As required As required As required As required Annually 2 Yearly 5 Yearly
Domestic Cold Water Distribution System	New installations and modifications or additions. Temperature exceeds 25°C. (Check with Risk Assessment). Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc.	As required As required As required As required
Domestic Hot Water Calorifier, Storage/Buffer Vessels	New installations and modifications or additions. Temperature has fallen below 45°C. Re-commissioning of empty/unused plant. Any contamination of header tank (by organic, by vermin or vermin faeces or similar). Regular programme.	As required As required As required As required Annually
Domestic Hot Water Distribution System	New installations and modifications or additions. Temperature has fallen below 45°C. . Any contamination of header tank (by organic, by vermin or vermin faeces or similar).	As required As required As required
Air Handling Units	Any contamination (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Chiller battery, drip trays and drainage pipework.	As required As required 6 monthly

Table 3: Water systems cleaning and disinfection

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

Table 4: Summary operational checklist for hot and cold water services

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

Notes associated with Table 4:

[1.] For effective operation of hot water services, the minimum equilibrium temperature should be 55°C and be achieved within seconds.

[2.] For thermostatic mixing devices, temperatures should be measured at the inlet.

[3.] For satisfactory operation of cold water services, temperature equilibrium to below 20°C should be achieved well within one minute.

[4.] Temperatures should be continuously monitored by the BEMS. The extent of monitoring should not be restricted to the flow and return from calorifiers or inlets and outlets from cold water storage tanks. Extremities of piping networks should also be monitored.

[5.] Additional checks should be made on the hot water circulating system and systems using trace heating at distal points.

[6.] Risk assessment may indicate the need for more frequent flushing of outlets. It is preferable that this form part of the daily cleaning routine where appropriate. Alternatively, self-purging showers that discharge water to a drain prior to use and without the release of aerosols can be considered.

8. Other operational considerations

General

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

Hydrotherapy pools, spa pools, whirlpool baths etc

8.2 Hydrotherapy pools, spa pools, whirlpool baths and decorative internal and external water features provide conditions that potentially favour the growth of *Legionella*. While there have been no reported cases of *Legionella* infections associated with hydrotherapy pools, there have been several outbreaks associated with spa pools or whirlpools. These types of pool are ideally suited to the proliferation and dissemination of *Legionella*. In addition, because of the small volume of water in circulation and the number of bathers (typically three to six people), spa pools can become a source of infection. Careful maintenance and chemical treatment is essential to maintain water quality. A log must be kept of water treatment and filter cleaning, and the results of tests for pH, free residual halogen and other treatment parameters. (For further guidance on hydrotherapy pools, see the Health Protection Agency's 'Hygiene for hydrotherapy pools'. For further guidance on spa pools, see the Health Protection Agency's 'Management of spa pools: controlling the risks of infection'.)

Spa pools and whirlpool baths which provide a single fill for each individual use do not appear to present the same hazard. There remains concern, however, about retention of water in these systems.

Regular cleaning and disinfection after each use in accordance with manufacturer's instructions is recommended.

The Swimming Pool and Allied Trades Association (SPATA) and the Pool Water Treatment Advisory Group (PWTAG) provide advice on the operation of whirlpool baths.

8.3 All staff operating/maintaining this type of equipment should receive adequate training to ensure that appropriate safety procedures and effective water treatment regimes are adopted.

Maintenance for this equipment should be carried out in accordance with the manufacturer's recommendations.

Vending, chilled water and ice-making machines

8.4 See paragraphs 8.26–8.28 in Part A for guidance on installation of this equipment.

Where equipment is hand-filled, there should be clear instructions on the water used; it should be hygienically collected and decanted into the equipment from a clean vessel.

Note 15: Proprietary water containers for water dispensing machines should be returned to the supplier.

Chilled-water drinking fountains normally include a reservoir to assist in the cooling cycle; if machines are turned off, water quality can deteriorate.

Ice should not be allowed to stagnate in an ice-making machine's storage bin, but should be changed frequently.

For guidance on infection-control precautions with regard to ice-making machines, see Scottish Health Facilities Note 30: 'Infection control in the built environment'.

Maintenance for ice-making machines should be carried out in accordance with the manufacturer's recommendations. Care should be taken to ensure that the water supply to the ice-making machine is not subjected to heat gain.

Portable/room humidifiers

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

Non-potable water storage

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

Deluge showers

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

Trolley wash procedures

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

Lawn sprinklers and garden (or similar) hoses

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

Vehicle washing plant

8.10 Vehicle washing is carried out either using a handheld pressure spray or by a 'frame wash' that consists of a bay containing a rectangular pipework frame fitted with several high-pressure sprays. In the latter case, this equipment should be flushed regularly.

Permanent hard-standing areas for vehicle-washing purposes should have an even surface to avoid ponding and have a slope or dish to a suitable drain.

Ornamental fountains

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

The installation of an ornamental fountain or water feature on healthcare premises (for example a main entrance hall or courtyard) is not recommended.

Sanitary assemblies

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

Wet fire systems

8.13 Wet fire protection systems have been implicated in outbreaks of legionellosis. All hose reels, sprinkler systems and wet risers should be isolated from the potable water supply by a method permitted by the Water Supply (Water Fittings) Regulations 1999. Many fire authorities are not in favour of local fire-fighting, preferring early professional intervention. It may, therefore, be possible to remove hose reels, thus avoiding their hazards. (Any redundant pipework should be cut back to the main including replacement of the branch tee with a straight coupling.

Respiratory nebulisers

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

Flowers and plants

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

Summary checklist

8.16 A summary checklist for the systems covered in this Section, showing recommended frequency of activity, is given in L8.

9. Microbiological monitoring

9.1 Apart from situations where there are taste or odour problems, microbiological monitoring for TVCs is not considered to be necessary. However, many estates management staff continue to test for TVCs notwithstanding any conflict with the requirements of L8 as any obvious changes in monitored levels provide a useful rule of thumb early warning of possible emerging problems.

If performed for these purposes, the detection of low TVCs is not necessarily an indication of the absence of *Legionella*, but is an indication of the overall water quality and signifies a generally unfavourable environment for bacteria.

All microbiological measurements should be approved methods and/or be carried out by the appropriate United Kingdom Accreditation Service (UKAS)-accredited laboratories. Dip slides are not acceptable.

The procedures to be followed for sampling are set out in SHTM 04-01 Part C: TVC testing protocol.

10. Testing for *Legionella*

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

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

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

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

- from the cold water storage and the furthermost outlet from the tank, on every loop;
- from the calorifier flow, or the closest tap to the calorifier, and the furthermost tap on the hot water service circulating system;
- additional samples should be taken from the base of the calorifier where drain valves have been fitted;
- additional random samples may also be considered appropriate where systems are known to be susceptible to colonisation.

The temperature control regime is the preferred strategy for reducing the risk from *Legionella* and other waterborne organisms in water systems. This will require monitoring on a regular basis. The recommended test frequencies for various outlets are set out in Table 2 in Section 7.

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

> **Note 16:** Testing of water for *Pseudomonas aeruginosa* is only required if a very specific reason has been identified such as suspected or confirmed outbreak or a series of sequential cases, as guided by the Responsible Person (Pseudomonas).

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

***Legionella* bacteria (cfu/litre)**	**Action required**
>100 but <1,000	Either: If only one or two samples are positive, system should be re-sampled. If a similar count is found again, a review of the control measures and risk assessment should be carried out to identify any remedial action to be taken. Or: If the majority of the samples are positive, the system may be colonised 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.
>1,000	The system should be re-sampled and an immediate review of the control measures and risk assessment should be carried out to identify any remedial action, including disinfection of the system. Re-testing should take place a few days after disinfection and at frequent intervals thereafter until a satisfactory level of control has been achieved.

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

1 **Legionnaires' disease is notifiable in Scotland under public health legislation.**

2 The Public Health Laboratory Service (PHLS) (now subsumed under the Health Protection Agency) defined an outbreak as two or more confirmed cases of Legionellosis occurring in the same locality within a six-month period. Location is defined in terms of the geographical proximity of the cases, and requires a degree of judgement. It is the responsibility of the Public Health Doctor for the declaration of an outbreak. The Public Health Doctor is appointed by the local authority under public health legislation.

3 Local authorities will have established incident plans to investigate major outbreaks of infectious diseases such as legionellosis. These are activated by the proper officer, who evokes an outbreak committee, whose primary purpose is to protect public health and prevent further infection. This will normally be convened to manage the incident and will involve representatives of the agencies involved. The Health & Safety Executive (HSE) or the local EHO may be involved in the investigation of outbreaks, their aim being to pursue compliance with health and safety legislation.

4 The local authority, Public Health Doctor or EHO acting on their behalf (often with the relevant officer from the enforcing authorities – either HSE or the local authority) may make a visit.

5 As part of the outbreak investigation and control, the enforcing authority may make the following requests and recommendations:

- to shut down any processors that are capable of generating and disseminating air-borne water droplets and keep them shut down until sampling procedures and any remedial cleaning or other work has been done. Final clearance to restart the system may be required;
- to take water samples from the system before any emergency disinfection is undertaken. This will help the investigation of the cause of illness. The investigating officers from the local authority/authorities may take samples, or require them to be taken;
- to provide staff records to discern whether there are any further undiagnosed cases of illness, and to help prepare case histories of the people affected;
- to cooperate fully in an investigation of any plant that may be involved in the cause of the outbreak. This may involve, for example:
- tracing of pipework runs;
- detailed scrutiny of all operational records;
- statements from plant operatives and managers;

- statements from water treatment contractors or consultants.

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

Emergency cleaning and disinfection of water systems

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

Appendix 2: Exemplar temperature test sheets

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

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

Note 17: The Health and Safety Executive's Approved Code of Practice L8 permits a period of 1 minute to achieve an equilibrium temperature of 50°C. A minimum of 55°C may be required for the operation of suitable mixing devices required to provide 'safe' hot water at the upper limit of the recommended range. Hot water at 55°C is required in many cases for reasons of food hygiene or decontamination requirements, for example in kitchens and sluice rooms etc. In a properly balanced hot water circulating system, with the circulation taken close to the draw-off point, achieving temperature should be virtually instantaneous. (At a typical flow to a hand-wash basin of 4.5 litres/m, 1 minute to achieve temperature would indicate a 25m dead-leg of 15mm pipe.)

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

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

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

Note 18: The Health and Safety Executive's Approved Code of Practice L8 permits a period of 1 minute to achieve an equilibrium temperature of 50°C. A minimum of 55°C may be required for the operation of suitable mixing devices required to provide 'safe' hot water at the upper limit of the recommended range. Hot water at 55°C is required in many cases for reasons of food hygiene or decontamination requirements, for example in kitchens and sluice rooms etc. In a properly balanced hot water circulating system, with the circulation taken close to the draw-off point, achieving temperature should be virtually instantaneous. (At a typical flow to a hand-wash basin of 4.5 litres/m, 1 minute to achieve temperature would indicate a 25m dead-leg of 15mm pipe.)

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BS EN 806-1-5: 2000-2012 Specifications for installations inside buildings conveying water for human consumption. British Standards Institution, 2000-2012.

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Scottish Health Technical Memorandum 04-01: Water safety for healthcare premises

Part G: Operational procedures and Exemplar Written Scheme

Health Facilities Scotland
Engineering and Environment

July 2015

Contents

Disclaimer

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Health Facilities Scotland would like to thank Ken Walker of NHS Grampian for his considerable assistance and support in the preparation of this Scottish Health Technical Memorandum and for making available the results of his experience in the preparation of similar documentation.

The support of the National Water Services Advisory Group is also gratefully acknowledged, along with estates staff in NHS Dumfries & Galloway and NHS Ayrshire & Arran for their assistance in beta testing the guidance.

Preface

About Scottish Health Technical Memoranda

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

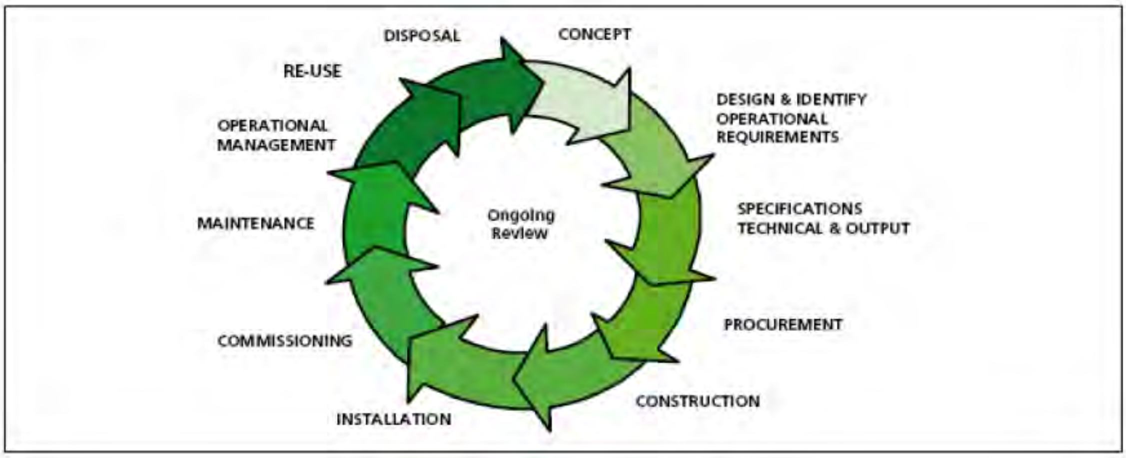
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle. Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

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

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

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

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



Healthcare building life-cycle

Structure of the Scottish Health Technical Memorandum suite

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

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water safety

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06 Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services

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

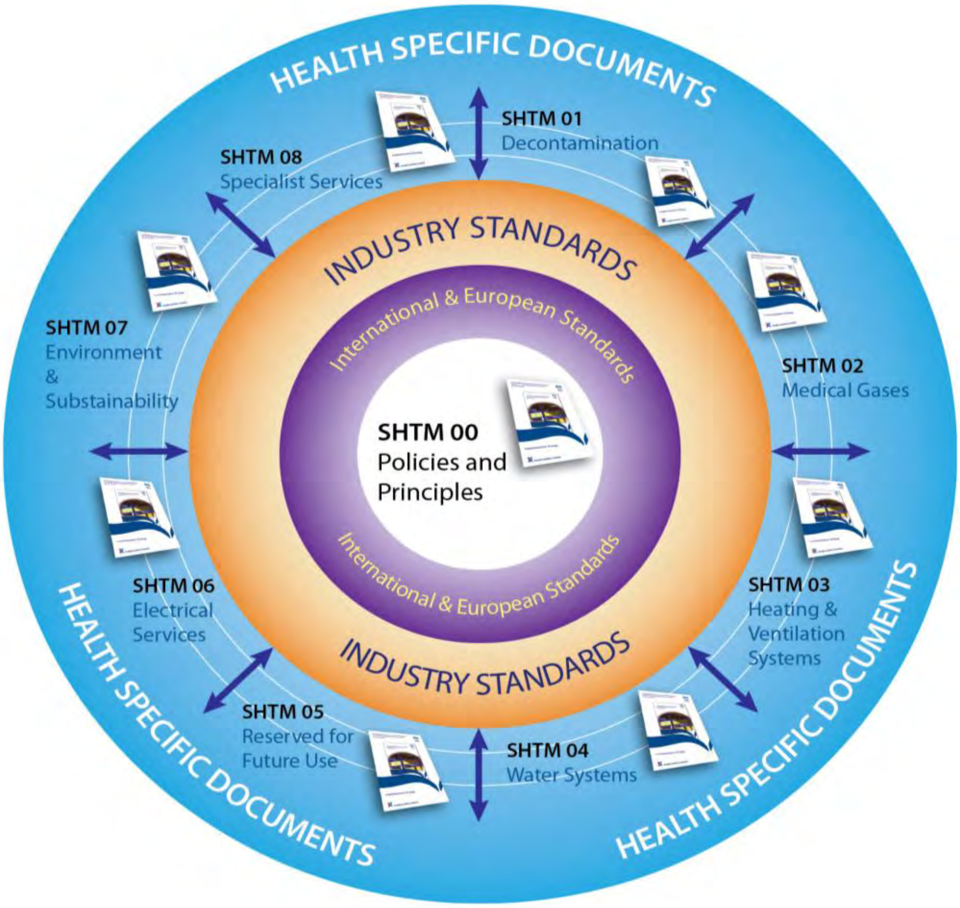
Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical safety guidance for low voltage systems

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent: Environment and Sustainability – EnCO_2de.

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

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

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



Engineering guidance structure

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Executive summary

Background information

The Health & Safety Executive's Approved Code of Practice L8 "Preventing or controlling the risk from exposure to *Legionella* bacteria" refers to Written Schemes in paragraph 53 as follows:

"There should be a Written Scheme for controlling the risk from exposure which should be implemented and properly managed. This should specify measures to be taken to ensure that it remains effective. The Written Scheme should comprise:

- *up to date plans of installations (schematic drawings would be acceptable);*
- *a description of correct and safe operation of systems;*
- *precautions to be taken;*
- *checks for efficacy and frequency of checks;*
- *remedial action to be taken if the Written Scheme is ineffective".*

Aim of the guidance

Experience has shown that the quality and acceptability of Written Schemes has been variable. This guidance has drawn upon experience in producing the most comprehensive documentation to date in the form of operational procedures leading to the production of Written Schemes, a relevant extract from the HSE Approved Code of Practice L8 and a template or exemplar for NHS Boards to follow in the preparation of a Written Scheme.

Note: The format of this document comprises two main parts. The first, consisting of Sections 1- 23, sets out operational procedures that can be adapted by NHS Boards to suit individual circumstances. As such, it would provide suitable evidence for Health & Safety Inspectorate that the NHS Board had procedures in place to allow preparation of Written Schemes which comprise the concluding part of this guidance in the form of exemplars.

1. Operational procedures for the Written Scheme

General overview

1.1 Premises used by the NHS for the delivery of healthcare are dependent upon water to maintain hygiene through a safe and comfortable risk assessed environment for all who may use, interface and support the delivery of functional healthcare.

1.2 ***NHS Board***** has a Management and Control of Water Safety Policy, which requires all management and staff across the organisation to be aware of statutory regulations, NHS Scotland mandatory guidance documents and responsibilities with specific arrangements.

*** The name of NHS Board would be inserted here.*

1.3 In the healthcare delivery environment, there are a number of reasonably foreseeable risks leading from potential exposure in the use of water that have to be avoided, as far as is reasonably practicable.

1.4 With respect to the responsibilities and duties identified in the Management and Control of Water Safety Policy devolved to the General Manager, Facilities and Estates, this document sets out in writing the scheme to manage and control the risks from potential exposure.

Introduction and legislative context

1.5 Legionnaires' disease is a potentially fatal form of pneumonia which can affect anybody but which principally affects those who are susceptible because of age, life-style, illness, or immuno-suppression. It is caused by the bacterium *Legionella pneumophila* and related bacteria. *Legionella* bacteria are common and can be found naturally in environmental ground and water sources such as rivers, lakes and reservoirs, usually in low numbers.

1.6 *Legionella* can survive under a wide variety of environmental conditions and have been found in water at temperatures between 6°C and 60°C. Water temperatures in the range 20°C to 45°C seem to favour growth. The organisms do not appear to multiply below 20°C and will not survive above 60°C. The organisms may, however, remain dormant in cool water and multiply only when water temperatures reach a suitable level. Temperatures may also influence virulence. *Legionella* bacteria held at 37°C have greater virulence than the same *Legionella* bacteria kept at a temperature below 25°C.

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

1.8 *Pseudomonas aeruginosa* is a Gram negative organism most commonly found in soil and water. It can be isolated from any moist environment. It is often termed an 'opportunistic pathogen'. Water within systems can periodically be contaminated with these organisms. Although mains supplied water is treated and disinfected, it contains at the point of use, only residual (relatively low) levels of disinfectant chemicals (e.g. chlorine). Water is therefore not sterile and has a (highly variable) background level of micro-organisms, measured in terms of the Total Viable Count (TVC). Levels of TVC organisms in water samples give an indication of the effectiveness of residual disinfection and consequently the likelihood of finding potentially pathogenic micro-organisms.

Note: An opportunistic pathogen is one which normally only causes an infection in a person with a weakened immune system.

1.9 Where TVCs are higher, there may be an increased risk that water systems are colonised by opportunistic pathogens (e.g. *Pseudomonas* Spp). However, clinical problems are only likely to arise if *Pseudomonas* Spp or other waterborne organisms are present in significant numbers in association with biofilms. There is a combination of factors that may have facilitated *Pseudomonas* Spp becoming a clinical problem. These factors include any or all of the following:

- water system materials which may have facilitated biofilm formation (e.g. plastic pipework, plastic and rubber components in TMVs and flexible hose liners etc);
- water outlets with thermostatic mixing valves (TMVs) designed to regulate water temperature and minimise the risk of scalding, which may also have increased the risk of other waterborne pathogens;
- the increased number of wash hand basins / sinks in clinical areas, combined with the increased use of alcohol based hand rubs (ABHRs) which may have resulted in a decreased use of water at individual wash hand basins / sinks;
- the use of non-touch (sensor) water fittings, resulting in low water volumes flowing through outlets. This combined with a column of standing water left in the pipework provides an ideal condition for bacterial growth.

1.10 There are a number of Regulations involved in the management and control of *Legionella*, *Pseudomonas* Spp and other similar harmful bacteria. The main requirements are covered in:

- The Health and Safety at Work etc Act 1974;
- The Control of Substances Hazardous to Health 2002;
- The Management of Health and Safety at Work Regulations 1999;

- The Water (Scotland) Act 1980.

1.11 The following documents are cited under these regulations (*statutory guidance*) and require to be read and used in conjunction with the policy

- L5 ACOP The Control of Substances Hazardous to Health Regulations 2002;
- L8 ACOP The Control of *Legionella* Bacteria in Water Systems 2000 and its part replacement HSG 274, 2013;
- Water Byelaws (Scotland) 2004.

Also relevant are:

- HSE – OC 255/12 Control of *Legionella*: Investigation of Outbreaks (and Single Cases) of *Legionellosis* from Water Systems;
- BS7592: 2008 Sampling for bacteria in water systems;
- BS8580: 2010 Water Quality – Risk Assessments for *Legionella* Control – Code of Practice;

  Water safety in buildings, World Health Organisation; http://whqlibdoc.who.int/publications/2011/9789241548106_eng.pdf

Reference should be made also to the healthcare specific guiding principles contained in the following NHS Scotland mandatory guidance documents:

- SHTM 03-01 'Ventilation for healthcare premises';
- SHTM 04-01 'Water Safety' Parts A – F;
- HPN2 'Guidance on Management of *Legionella* Incidents, Outbreaks and Clusters in the Community'.

Note: SHTN 2 'Domestic hot and cold water systems for Scottish Healthcare Premises' to which reference is widely made, has been withdrawn and the relevant sections are included in Part E of SHTM 04-01.

1.12 ***NHS Board*** is committed to meeting the requirements of the relevant current statutory and associated guidance. The purpose of this document is to detail the Scheme, set out in writing the principles and procedures by Facilities and Estates in compliance with the above, to manage and control the *Legionellosis* and water safety risks and in 'so far as is reasonably practicable' with respect to other requirements.

Responsibilities of the General Manager, Facilities and Estates (The Designated Person [Water]) appointed by the Duty Holder

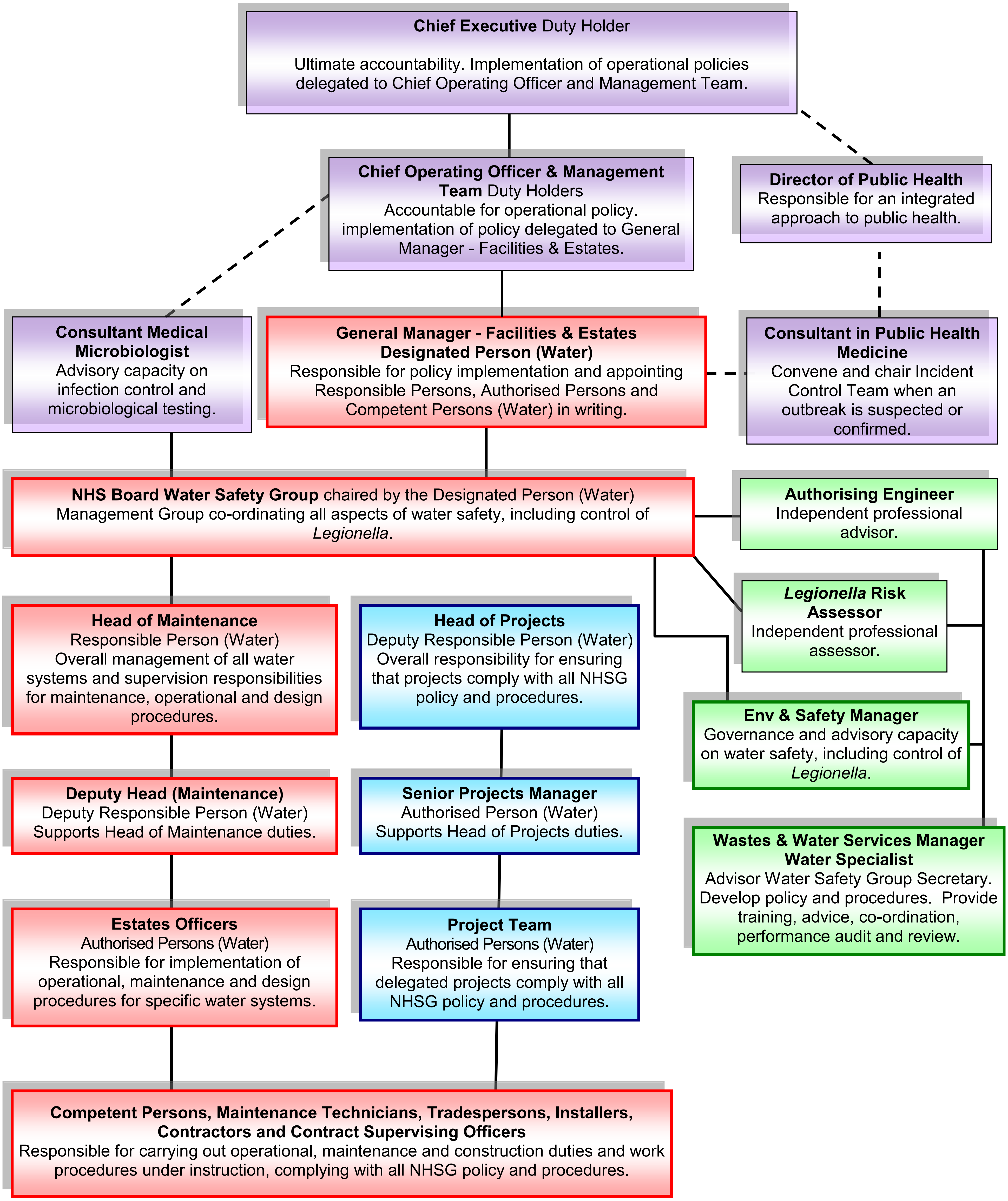
1.13 These comprise:

- ensuring the Chief Executive (The Duty Holder) and Management Teams (Duty Holders) and their devolved staff are aware of and co-ordinate with the policy and are familiar with their devolved responsibilities, duties and relevant procedures;

- identifying water safety risks and non-compliance;
- providing adequate facilities, resources and competency training to support, implement and maintain all aspects of the policy;
- providing management and annual performance reports to Chief Executive, Management Teams, Infection Prevention & Control, Occupational Health & Safety, and Risk Management;
- reviewing the effectiveness of the policy across *NHS Board*;
- establishing a Water Safety Group to provide appropriate expertise, to support, co-ordinate and review operational management and controls in accordance with statutory and mandatory requirements;
- seeking support from a consultant medical microbiologist in the event of suspected exposure to *Legionella*, *Pseudomonas* Spp and other similar harmful bacteria;
- appointing in writing an independent professional advisor to act as “Authorising Engineer” with a brief to provide services in accordance with SHTM and HSE guidance under the policy;
- appointing in writing an independent professional assessor to act as “*Legionella* Risk Assessor” with a terms of reference to provide services in accordance BS8580, SHTM and HSE guidance under this policy;
- appointing in writing appropriate Managers to act as “Responsible Person (Water)” as defined in appointment letters, to adopt day-to-day responsibility for controlling and managing any identified risk from potential exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria under the policy;

> **Note:** The Head of Maintenance (or appointed deputy) is the “Responsible Person (Water)” managing day-to-day risks and will be the estates lead in the event of an operational incident;

- appointing in writing appropriate deputies and “Authorised Persons (Water)” who have sufficient authority, competence and knowledge of the water systems and installations to ensure that all operational procedures and SHTM 04-01 requirements are carried out in a timely and effective manner. The Scheme will involve “Competent Persons”, “Maintenance Technicians”, “Tradespersons”, “Installers”, “Contractors” and “Contract Supervising Officers” co-ordinated with Duty Holders in accordance with SHTM and HSE guidance under the policy;
- The organisational structure for *NHS Board* inclusive of the above-mentioned local arrangements for the management and control of risk from potential exposure to *Legionella*, *Pseudomonas* Spp and other similar harmful bacteria under the Policy are now expanded as shown below and in the chart opposite:


Chief Executive Duty Holder
Ultimate accountability. Implementation of operational policies delegated to Chief Operating Officer and Management Team.
Chief Operating Officer & Management Team Duty Holders
Accountable for operational policy. implementation of policy delegated to General Manager - Facilities & Estates.
Director of Public Health
Responsible for an integrated approach to public health.
Consultant Medical Microbiologist
Advisory capacity on infection control and microbiological testing.
General Manager - Facilities & Estates Designated Person (Water)
Responsible for policy implementation and appointing Responsible Persons, Authorised Persons and Competent Persons (Water) in writing.
Consultant in Public Health Medicine
Convene and chair Incident Control Team when an outbreak is suspected or confirmed.
NHS Board Water Safety Group chaired by the Designated Person (Water)
Management Group co-ordinating all aspects of water safety, including control of *Legionella*.
Authorising Engineer
Independent professional advisor.
***Legionella* Risk Assessor**
Independent professional assessor.
Head of Maintenance
Responsible Person (Water)
Overall management of all water systems and supervision responsibilities for maintenance, operational and design procedures.
Head of Projects
Deputy Responsible Person (Water)
Overall responsibility for ensuring that projects comply with all NHSG policy and procedures.
Env & Safety Manager
Governance and advisory capacity on water safety, including control of *Legionella*.
Deputy Head (Maintenance)
Deputy Responsible Person (Water)
Supports Head of Maintenance duties.
Senior Projects Manager
Authorised Person (Water)
Supports Head of Projects duties.
Wastes & Water Services Manager Water Specialist
Advisor Water Safety Group Secretary. Develop policy and procedures. Provide training, advice, co-ordination, performance audit and review.
Estates Officers
Authorised Persons (Water)
Responsible for implementation of operational, maintenance and design procedures for specific water systems.
Project Team
Authorised Persons (Water)
Responsible for ensuring that delegated projects comply with all NHSG policy and procedures.
Competent Persons, Maintenance Technicians, Tradespersons, Installers, Contractors and Contract Supervising Officers
Responsible for carrying out operational, maintenance and construction duties and work procedures under instruction, complying with all NHSG policy and procedures.

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Authorised Persons (Water) will be selected from Table 1 and appointed to specific Written Schemes (as shown on Table 2).

Legionella Role	Name	Appointment	Generic Title	Phone
The Duty Holder			Chief Executive	
Duty Holders			Chief Operating Officer	
.. ..			General Manager *Enter General Managers for each site or division as appropriate*	
Designated Person (Water)		In writing by Chief Operating Officer for Chief Executive on xx	General Manager, Facilities and Estates	
Deputy Designated Person (Water)		In writing by Chief Operating Officer for Chief Executive on xx	Head of Soft FM	
Authorising Engineer (Water)		In writing by General Manager Facilities & Estates on xxx	Technical Director of independent appointed organisation	
Legionella Risk Assessor		In writing by General Manager Facilities & Estates on xxx	To be Appointed	
Responsible Person (Water) AP		In writing by General Manager Facilities & Estates on xxx	Head of Maintenance	
Deputy Responsible Person (Water) AP		In writing by General Manager Facilities & Estates on xxx	Head of Projects	
Deputy Responsible Person (Water)		In writing by General Manager Facilities & Estates on xxx	Deputy Head of Maintenance	
Authorised Person (Water)		In writing by General Manager Facilities & Estates on xxx	Estates Officer, Supervisor or Projects Manager *Enter names of all Authorised Persons as appropriate for sites or divisions*	

Table 1: Role Holders

Legionella Role	Name	Appointment	Generic Title	Phone
Competent Person (Water) New staff for AP training		In writing by General Manager Facilities & Estates on xxx	CAD Operator	
Competent Person (Water) AP		In writing by General Manager Facilities & Estates on xxx	Plumber / TSS Plumber *Enter names of all Competent Persons as appropriate for sites or divisions*	
Others involved				
Infection Prevention & Control			Consultant Medical Microbiologist	
Laboratory Services			Biomedical Scientist	
Governance and Advisor			Environment and Safety Support Team Manager	
Water Specialist Advisor			Wastes & Water Services Manager	
Public Health			Consultant in Public Health Medicine	
O H & S Auditor			Health & Safety Auditor	
HSE	Health and Safety Executive			

Table 1 continued: Role Holders

Note: The names of any member of staff yet to receive relevant training should be entered separately.

1.14 All training and competency assessments provided to and received by all NHS Board personnel involved in water systems will be recorded in the individual's personal training file and the national NHS eKSF system.

1.15 The Authorising Engineer (Water) shall conduct a regular annual assessment review of competency and training requirements and shall make Training Programme recommendations to the Responsible Person (Water) for approved courses run by approved training organisations and where appropriate by the manufacturers of equipment.

1.16 Authorised Persons (Water) shall be selected from Table 1 and appointed in writing. They will be given the role of the named person with sole responsibility for the water system(s) identified in specific Written Schemes. (Table 2 refers).

1.17 The Authorised Person shall conduct and record induction and familiarisation with Estates staff and any new Competent Persons, Maintenance Technicians, Tradespersons, Installers, Contractors and Contract Supervising Officers being introduced to water systems. The Authorised Person shall conduct a regular annual review of system familiarisation, operational maintenance, monitoring issues and report recommendations to the Responsible Person (Water).

NHS Board sites and blocks with water systems

1.18 Table 2 extracted from the Property & Asset Portfolio, details where there are known applicable piped water distribution systems in owned and leased premises. It is anticipated that additional systems will become evident within the various premises, as the risk assessments and Written Schemes (WS) are compiled. Non-applicable Sites, Blocks and Systems are shaded in red.

WS Ref No.	NHS Site Code	Site Name	Block No.	Block Name	GIA m^2	Potential Water Distribution Systems (normally each with 1 CW system & 1 DHW system)	WS Contact
WS1-6						6 systems	
WS7						1 system	
WS8-9						2 systems	
WS243						1 system	
WS244						1 system	

Table 2: Specific Written Schemes

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2. Managing the risks

Water systems

2.1 ***NHS Board*** has a property and asset base of circa xx sites (owned and leased) with circa xxx building blocks (including hospitals, health centres, clinics and support premises) ranging from large multi-hospital campus to small areas within shared buildings, covering circa xxx,000m^2 with a wide range of construction, age and condition criteria (e.g. which can include asbestos, contamination, PPE requirements, confined spaces, access restrictions, permit to access/work).

2.2 Most building blocks will have their own individual water system. However, some systems may cover more than one building block and some building blocks may have multiple water systems.

2.3 Water used in the each building block will be controlled to that of the Temperature Control Regime (as outlined in HSE ACOP L8 and HSG 274) with full temperature control as advocated in SHTM 04-01 to temperatures in the various parts of the water system.

2.4 Each Building Block has a Water Safety Log Book (located in the Estates Department Offices at xxxxxxxxx Campus and xxxx Hospital and Site Estates Offices) containing details of the specific local water system(s). This includes:

- confirmation of the location with site name, building block name, system name and the Authorised Person (Water) who has been appointed in writing as the sole person with knowledge and full control of the identified water system;
- the applicable Written Scheme;
- the current applicable *Legionella* Risk Assessment with summary details of system, equipment, safe operation criteria, precautions to be taken and an Action Plan for any remedial works or routine control measures that may be required to control *Legionellosis* and water safety risks;
- an up to date plan of the system identifying all system plant, to include:
  - water softeners, filters, strainers, pumps, non-return valves and all outlets including showers, wash hand basins, sinks, baths and equipment – such as ice-making machines, drinking fountains etc and any external connections to hoses, mobile units or equipment;
  - all standby equipment such as spare pumps, with details for incorporating into use;
  - all associated pipework and piping routes (including flexible hoses, residual dead legs, blind stub-ends and plugged tee-pieces);
  - all associated storage and header tanks;
  - details of the origin of the water supply;

- any parts that may be out of use temporarily;
- thermostatic mixing valves;
- sentinel hot and cold water outlets;
- schematic and detailed drawings of the system are also available at the Estates Department, xxxxxxx, and viewable electronically > Shared on Yaren > *Legionella* > Site Drawings.

Note: Plans must be kept up to date to include any alterations made to the water system. Notify xxxxxxx on tel 0xxxxxxx0 to make any changes to schematics or detailed drawings.

- insurance examination reports (where applicable) by the Competent Person (Pressure Systems);
- any Hazard and Safety Action Notices and/or operational restrictions;
- any depreciation and condition reports highlighting actions for planned (in whole or component parts) system replacement;
- a clear detailed description of the correct and safe operation of the system;
- the precautions to be taken in respect of any identified risks;
- the checks to be carried out to ensure efficacy of the scheme and the frequency of the checks;
- the remedial action to be taken in the event that the scheme is shown not to be effective.

Note: The Written Scheme Template to be used for specific locations is detailed in Appendix B.

3. Planned maintenance procedures

Operational criteria

3.1 Water used in the water systems will be controlled in accordance with the Temperature Control Regime (as outlined in HSE ACOP L8 / HSG274) with full temperature control as advocated in SHTM 04-01 to temperatures in the various parts of the water system as follows:

Note: Water must not be stored or circulated at temperatures within the range: above 20°C or below 50°C

3.2 Cold Water (CW) must be stored or distributed to outlets at or below 20°C.

3.3 Domestic Hot Water (DHW) must be at or above 60°C (at the flow point from heat exchangers/vessels) as it enters the supply system and circulated at no less than 50°C (at the return point to heat exchangers).

3.4 Domestic Hot Water supplied to Thermostatic Mixing Valves (TMV) or other outlets must be at no less than 55°C.

3.5 Cold Water supplied to Thermostatic Mixing Valves (TMV) or other outlets must be at or below 20°C.

3.6 Special attention and escalation in writing to the relevant Authorised Person (Water) and Responsible Person (Water) is required where and when any of the above criteria cannot be met.

Note: Hot water (and hot surfaces) above 45°C present risks of scalding and burning.

3.7 Point-of-Use Filters (P.O.U) Filters will only be installed and used where this is practical and there has been a written policy decision by the Water Safety Group, along with a complimentary managed maintenance change-filter process. This will be have to be put in place for life – or until a further policy decision is taken by the Water Safety Group confirming that they are satisfied that the affected outlet and pipework can be removed or disinfected without compromising the rest of the water system.

3.8 Taps or other water outlets should **not** be installed if they will not be used regularly, that is, less than twice in a week.

3.9 Where taps or water outlets are not, or are unlikely to be, in regular daily use, Management Team Duty Holders and their staff should be alerted and reminded to flush these through and purge to drain, or purge to drain immediately before use, without release of aerosols. In Neonatal Units (NNUs), Adult and Paediatric Intensive Care Units (ICUs) infrequently used taps should be flushed daily at the start of each day. The Maintenance Department and Designers have responsibilities to be alert to the Duty Holder requirements contained in

Risk Control Notice 11/04 – and the record keeping on Sample Record Sheet - or take steps to have the outlet removed and the resultant dead-legs eliminated by taking out redundant branch pipework back to the circulating mains, removing the tee-piece and replacing with a straight coupling.

3.10 Management Team Duty Holders and their staff should also be alerted on awareness and actions to minimise the risk of *Pseudomonas* Spp and other similar harmful bacteria in the use of equipment, transmission routes and requirements (such as in the use of hand wash stations and wash basins) in Risk Control Notice 12/04.

Maintenance schedules summary

Frequency	Item	Procedure	Description
Daily	Temperature Monitoring	P1C1 (with ALL incidents logged on Form 004 and BEMS alarms incidents on 021)	Incidents and Faults; BEMS monitoring & log of all alarms
Daily	DHW Temperature Monitoring	P1C1A (logged on Form 005A)	Manual monitoring or where BEMS not installed or BEMS not operational
Weekly	Water Quality	P1C2 (logged on Form 027)	Chloramine/chlorine checks (initially weekly)
	DHW Calorifiers	P1C3 (logged on Form 028)	Manual change over and log of circulating pumps not on BEMS control
Monthly	Temperature Monitoring	P1C4 (logged on Form 005)	a) Sentinel hot water taps b) Sentinel cold water taps c) Sentinel TMV taps d) DHW calorifier/heat exchanger flow & return temperatures e) Chilled Water heat exchanger flow & return temperatures
	Air Handling Plant	P1C5 (logged on Form 022)	Inspect, clean & log glass traps
3 Monthly	DHW Calorifiers, DHW & CW Storage/ Buffer Vessels	P1C6 (logged on Form 006)	Flushing of DHW calorifier(s) and Storage/Buffer Vessel(s) associated with Hot /Cold/Chilled Water Heat Exchanger(s)
Annually (April/May each year)	Water System Sampling (at random water outlets) in High Patient Risk Areas.	As described in Section 23. Post-Flush sampling without disinfection (as BS7592: 2008) at sentinel and other randomly selected outlet points.	Annual Water System Sampling (following the protocols and any actions as described in Section 23) in areas where patients may be most at risk. Sampling Reports to be tabled at Water Safety Group Meetings.

Frequency	Item	Procedure	Description
Quarterly during periods of Change	Water System Sampling (at random water outlets in High Risk Patient Areas) in Water Systems still serving High Patient Risk Areas.	As described in Section 23. Post-Flush sampling without disinfection (as BS7592: 2008) at sentinel and other randomly selected outlet points in High Risk Patient Areas.	In Water Systems serving multiple Wards or Departments, where during periods of change or decanting Section 7 Procedures may not be practical and there are still pockets of operational Wards or Departments with High Patient Risk areas - there will be Water System Sampling (following the protocols and any actions as described in Section 23) in areas where patients may be most at risk for the entire period of change or where there is reduced water use. Sampling Reports to be tabled at Water Safety Group Meetings.
3 Monthly for high risk areas and as required elsewhere, but at least once Annually	Shower Heads and Hoses	P1C12 (*logged on Form 005B*)	Dismantle, clean and de-scale / or replace with new disinfected Shower Head and Hose
6 Monthly	Summer and Winter Temperature Monitoring	P1C7 (*logged on Form 003*)	a) Cold Water at inlet to building block. Also to be continuously monitored by BEMS & log of all alarms
	Water Tanks	P1C7 (*logged on Form 003*)	a) Tank and temperature checks & log b) Tank inspection
	Air Handling Plant	P1C8 (*logged on Form 007*)	a) Humidity section inspection (if installed) b) Cooling section inspection c) Disinfection
Annually	DHW Calorifiers, DHW & CW Storage/ Buffer Vessels	P1C9 (*logged on Form 006*)	Drain & cleaning of DHW Calorifier(s) and Storage/Buffer Vessel(s) associated with Hot /Cold/Chilled Water Heat Exchanger(s)
	Temperature Monitoring	P1C10 (*logged on Form 005*)	a) Representative hot water taps b) Representative cold water taps c) Representative TMV taps d) DHW calorifier flow & return temps e) BEMS graphs printout

Other Procedures	Record	Description
Short / Limited Closure Record Form	Logged on Form *001*	For a period not exceeding 30 days
Indefinite Closure / Re – Occupation Record Form	Logged on Form *002*	For periods exceeding 30 days
Incident Report Record Form	Logged on Form *004*	For all incidents and resulting actions
Water Maintenance Frequencies Risk Based Assessment Form	Logged on Form *023*	For review and change of any maintenance frequency
Water Disinfection Risk Based Assessment Form	Logged on Form *024*	For assessment for disinfection of systems after work or alterations
Checklist for New Water System Designs	Logged on Form *025*	Checklist for designers
Flushing Water Outlets Record Form	Logged on Form *026*	Record sheet for Estates Department use
Estates Chloramine Record Form (*027*) *(where relevant)*	Logged on Form *027*	Record sheet for Estates Department use
Water Safety Control Log – Record Form	Logged on Form *028*	For plant status, maintenance tasks and resulting actions
Acceptance of Work to be Conducted and Completed Record Form	Logged on Form *029*	Record sheet for designers and Estates Department for alterations to existing and provision of new Water Systems
Risk Control Notice 11/04	Logged on Sample Record Sheet	For Duty Holders
Risk Control Notice 12/04	Actions to Estates Helpdesk	For Duty Holders

Temperature monitoring by BEMS – P1C1

(Where Building Energy Management Systems (BEMS) installed)

3.11 All hot and cold water systems fitted with BEMS monitoring and control devices should be set to give high priority alarms in the event of system failure and/or temperature variances outwith alarm set points. Temperature monitoring devices shall be physically tested annually and recalibrated in accordance with manufacturers' instructions.

3.12 All system failures and/or temperature alarms should be continually monitored 24 hours a day, with alarms being generated at Estate locations and by remote paging of Estates staff (i.e. controls engineer or duty engineer etc).

3.13 The Estates person carrying out the monitoring or being notified of an alarm condition should log all incidents in the Estates Incident Report Record Form (004) and also where appropriate in the Estates BEMS Record Form (021).

3.14 The incident should be investigated by the Estates staff and appropriate action taken (see *Legionella* Operational Procedures, SHTM 04-01 & *Legionella* ACOP L8 / HSG 274) and recorded in the Estates Incident Report Record Form (004)

Temperature monitoring where a BEMS is *not* installed or where the BEMS is not operational – P1CC1A

3.15 Check the flow and return temperatures on the domestic hot water calorifier system as defined in the local plan of the system being checked, using the temperature gauges fitted or a suitable surface temperature probe.

3.16 The flow temperature to be at least 60ºC and the return temperature to be no less than 50ºC.

3.17 Record all temperatures daily on the Record Form (005A).

3.18 Inspect cold water tank and conduct temperature checks – P1C7 as per 3.7 below and record all inspection and temperatures on the Record Form (003).

3.19 The frequency of manual temperature checks and recording shall be:

Policy Generic Areas	Frequency for Domestic Hot Water systems	Frequency for Cold Water Systems
High Risk – Acute and Primary Care Premises, Hospitals and any premises concerned with the treatment of care of the elderly and susceptible immuno-compromised patients.	Daily	6 Monthly
Moderate Risk – **all** other Hospital clinical premises	Daily	6 Monthly
Moderate Risk – **all** other Non Hospital (health centres, clinics and specialist clinical premises	Weekly	6 Monthly
Low Risk – **all** Non Clinical premises	Monthly	6 Monthly

Water dosing systems – P1C2

3.20 *(Applicable where chloramination disinfection is provided by the water authority)*

If, under the Water Supply (Water Quality) (Scotland) Regulations as amended, the water across the *NHS Board* area as supplied by the water authority is subject to a chloramination disinfection regime, sampling results of ***NHS Board*** water systems shall be recorded in the Estates Chloramine Record Form (027). Sampling will be taken from a hot or cold water outlet point, representative of each secondary distribution pipework system. These will initially be conducted weekly and then subject to ongoing trend based frequency risk assessment, limited to no less than at once per month sampling test frequency. Frequency risk assessments shall be held in the Water Safety Log Book.

Should the water authority's disinfection regime across the ***NHS Board*** area change, then all cold water tanks and any systems with water treatment dosing systems should be checked weekly in accordance with the manufacturers' recommended instructions as follows:

3.21 The relevant Authorised Person (Water) should produce and implement local planned maintenance tasks in accordance with the manufacturers recommended instructions for the approval of the Responsible Person (Water).

3.22 This and all maintenance tasks should be recorded in the Water Safety Log Book on Form (028).

3.23 All water test readings should also be recorded on an appropriate record sheet.

Manual changeover of circulating pumps – P1C3

(Where Building Energy Management Systems (BEMS) not installed)

3.24 Any plumbed-in duplicate circulating pump should be removed from the system. Where this is not practicable, the duty pump should be manually changed over a least once per week to reduce any danger of water stagnation. A spare pump should be kept for immediate replacement in the event of pump failure.

3.25 The relevant Authorised Person (Water) should produce and implement local maintenance tasks.

3.26 This and all maintenance tasks should be recorded in the Water Safety Log Book in Form (028).

Monthly temperature checks – P1C4

Sentinel hot and cold taps

3.27 Sentinel taps for hot water services (and any recirculating cold water systems) are the first and last taps on a recirculating system. For non-recirculating cold water systems (or non-circulating hot water systems), they will comprise the nearest and furthest taps from the storage tank. The choice of further sentinel taps may also include other taps that are considered to represent a particular risk.

3.28 Check the temperatures at the sentinel taps as defined in the local plan of the system being checked.

- Using a calibrated temperature probe, check the temperature of water from the cold water tap does not rise above 20ºC after running the tap for 2 minutes.
- Using a calibrated temperature probe, check the temperature of water from the hot water tap does not drop below 50ºC whilst running the tap for 1 minute.
- Record all temperatures on Record Form (005).

3.29 Sentinel Thermostatic Mixing Valves (TMV):

- check the temperatures at the TMVs on a sentinel basis as defined in the local plan of the system being checked. The system should achieve 55°C under normal use at the supply to the furthermost draw-off point in the circulating system;
- using a calibrated temperature surface probe check that the temperature of water in the hot water pipework to the TMV does not fall below 50ºC whilst running the tap for 1 minute;
- record all temperatures on Record Form (005).

3.30 Domestic Hot Water Calorifier(s) and Plate Heat Exchanger(s):

- check the flow and return temperatures on the domestic hot water system as defined in the local plan of the system being checked, using the temperature gauges fitted or a suitable surface temperature probe;
- the flow temperature to be at least 60ºC and the return temperature shall be no less than 50ºC;
- record all temperatures on the Record Form (005).

3.31 Domestic Cold / Chilled Water Heat Exchanger(s):

- check the flow and return temperatures on the domestic cold / chilled water system as defined in the local plan of the system being checked, using the temperature gauges fitted or a suitable surface temperature probe;

- the flow and return temperatures shall be no more than 20ºC;
- record all temperatures on the Record Form (005).

3.32 Frequency Risk Based Assessment:

Systems that continually conform to and have a database history of temperature readings within the control parameters should have a risk-based assessment carried out annually to determine if the maintenance frequency can be changed. This assessment should be recorded on Form 023 by the Authorised Person (Water) and ensure the Responsible Person (Water) is notified immediately in writing. Frequency risk assessments shall be held in the Water Safety Log Book.

Water glass trap drains on ventilation units – P1C5

3.33 Visually inspect condition of glass drain trap assembly:

- top up glass trap assembly with clean water to the desired level if required;
- remove any glass trap assemblies that are dirty, clean and top up with clean cold water;
- record checks on Estates monthly checks of water drain traps on ventilation plant Record Form (022).

Domestic hot water calorifier(s) and storage/buffer vessel(s) associated with hot /cold/chilled water heat exchanger(s), flushing – P1C6

3.34 Flush each domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel through its drain valve by opening the drain valve 3 times, each time for a 3 minute period. The hose from the drain valve should be discharged to the nearest drain.

3.35 Record all actions on the top section of Record Form (006).

3.36 Where the domestic hot water system has a stratification pump(s) fitted to circulate the hot water from the top to the base of the calorifier or the storage/buffer vessel, and the history data shows no sludge deposits during flushing, then this procedure should be risk assessed to determine if the maintenance frequency can be changed. This assessment should be recorded on Form 023.

Water tank inspection and temperature checks – P1C7

3.37 Summer / Winter Inspection of water tank as per Record Form (003).

3.38 Where the system has no BEMS temperature sensors connected the readings should be taken using a temperature sensor. The tank temperature should be below 20ºC.

3.39 Record all inspection and temperatures including the mains water supply at the building/block inlet on the Record Form (003).

Ventilation plant inspection and disinfection – P1C8

Disinfection procedure

3.40 Record all actions on "Air Handling Unit Disinfection Record Form" (007) for each system.

3.41 Prior to taking a plant into use or at intervals not exceeding six months, all parts of the plant that become damp in normal use shall be disinfected following the procedure given below. This will include humidifiers (where installed), cooler batteries/cooling coils, drainage systems and energy recovery devices.

3.42 All procedures must comply with the Health and Safety at Work etc Act, COSHH Regulations and other subordinate legislation.

3.43 Sodium Hypochlorite solution of strength 5ppm will normally be used. This can no longer be ordered from Pharmacy (Central Pharmacy at xxxxxx Health Campus). The solution may be made up using Actichlor (or equivalent) tablets and mains tap water. This should only be done by personnel who have relevant training and the authority from the Authorised Person (Water). Follow the instructions provided with the Actichlor, taking care to use appropriate PPE.

- the Sodium Hypochlorite solution 5ppm should be used without delay, normally within 2 hours of issue;
- notify all persons working in those areas served by the plant to be disinfected;
- switch off all ventilation systems containing devices to be disinfected;
- close the plant isolating dampers;
- open and remove the inspection covers/access doors on both sides of the devices;
- spray all internal surfaces of the humidifier section or cooler battery/cooling coil with a 5 ppm chlorine solution until all surfaces are thoroughly wetted, also flood drip trays and drainage system with the same solution and allow to stand for a minimum of 2 hours;
- spray all internal surfaces of the humidifier and cooler battery/cooling coil with sufficient clean water to remove all traces of the chlorine solution from the device, its drip trays and drainage system;
- restore the plant to normal operation.

Note: If any suspicion arises as to the possible contamination of the system then the microbiologist should be requested to take swab tests from all drain trays and cooler battery/cooling coil tubes and fins.

Domestic hot water calorifier(s) and storage/buffer vessel(s) associated with hot /cold/chilled water heat exchanger(s), drain and clean – P1C9

3.44 Follow the manufacturers' maintenance instructions (in Water Safety Log Book). Record all actions where applicable on the lower section of "Calorifier and Storage/Buffer Vessel Maintenance Record Form" (006) for each system.

- isolate domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel service valves;
- heat any domestic hot water calorifier or hot water storage/buffer vessel up until the contents has reached 60ºC and hold at this temperature for a period of at least 1 hour;
- drain domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel and remove inspection hatch;
- hose out the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel to remove any debris, scale or other deposit. Care should be taken to keep aerosols to a minimum;
- if the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel does not have an inspection hatch, the pipework at the top of the vessel should be disconnected to allow the insertion of a water hose to allow debris to be washed down off internal surfaces;
- examine the internal and external condition of the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel and pipework, any defects should be reported in writing to the relevant Authorised Person (Water). The safety valve should be checked, overhauled and reset as necessary. The temperature, altitude and pressure gauges to be checked for operation.

3.45 On completion of examination and any repairs, the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel should be re-constructed.

3.46 On completion of the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel assembly, the following sequence must be undertaken:

- refill with cold water;
- drain the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel;
- refill with cold water, leave cold feed valve open;
- run domestic hot water calorifier or hot water storage/buffer vessel at a temperature of 60ºC for at least 1 hour. Test the operation of high limit cut-out system if fitted. Check the temperature of the calorifier/vessel top and bottom with a surface thermometer;
- adjust any controls as necessary.

3.47 Take bacteriological samples from the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel drainage trap (where possible) and nearest and furthest outlet.

3.48 Record all actions on the Record Form (006).

Annual temperature monitoring – P1C10

Representative hot and cold taps

3.49 Check the temperatures at the hot and cold taps on a representative number of taps on a rotational basis as defined in the local plan of the system being checked.

- using a temperature probe check the temperature in the cold water tap does not go above 20ºC after running the tap for 2 minutes;
- using a temperature probe check the temperature in the hot water tap does not go below 50ºC within running the tap for 1 minute;
- record all inspection and temperatures on the Record Form (005). Add "Annual Monitoring Procedure" to the Comments / Action box to clarify.

BEMS data

3.50 DHW and CW system performance data is valuable for assurance and continuous improvement of *Legionellosis* risk control. Data should be reviewed and exploited as follows:

- produce a BMS plot covering a typical week, for each DHW and CW system;
- identify non-compliant systems and prioritise them for remedial actions by risk category;
- repeat the plots on an annual basis and when there is a change e.g. change of use, engineering modifications, etc;
- maintain hard copy records in the Water Safety Log Book.

Shower head and hoses replacement – P1C12

3.51 Planned Shower Head and Hose Replacement Programme conducted 3 monthly in High Risk Areas and as required elsewhere, but undertaken at least once per annum, as follows:

- remove the shower head and hose assembly. Place shower head and hose assembly into a plastic bag and seal;
- check that the new clean disinfected head and hose package is intact;
- open replacement new clean disinfected shower head and hose assembly sealed packaging, remove and fit following the manufacturer's instructions;
- run water and flush for 3 minutes in accordance with *Legionella* Risk

Assessment in such a way as to avoid the creation of aerosols;

- check final temperature for compliance and working order and return shower appliance to use;
- return redundant sealed bag with shower head and hose assembly to workshop for disposal in accordance with Waste Procedures;
- record all actions on the Record Form (005B).

4. Procedure for domestic hot water systems following plant failure, allowing system water temperature to drop below critical control levels

4.1 This escalation procedure should be employed if the Calorifier or Plate Heat Exchanger outflow temperature falls below 45°C.

4.2 Decision Table for Hot Water System Breakdown

The table below should be used to decide on the actions necessary in the event of a plant breakdown such as power failure or steam supply failure.

Breakdown leading to temperature <45ºC, lasting for:	Risk Category	Action
<12 hrs	High	Verify[1]
	Significant	Verify[1]
	Moderate	Verify[1]
>12 hrs	High	Thermally pasteurise[2]
	Significant	Verify[1]
	Moderate	Verify[1]
>24 hrs	High	Thermally pasteurise[2]
	Significant	Thermally pasteurise[2]
	Moderate	Verify[1]
>72 hrs	High	Thermally pasteurise[2]
	Significant	Thermally pasteurise[2]
	Moderate	Thermally pasteurise[2]

[1] Ensure that normal temperature performance has been resumed, i.e. 60°C.

[2] Calorifier or plate Heat Exchanger and complete distribution system.

4.3 In the event of a reduction in domestic hot water temperature the Authorised Person (Water) should be notified in writing as soon as possible. The reason for failure must be identified and rectified as soon as possible.

4.4 The Authorised Person (Water) shall notify the Duty Holder and users on the failed system that they must not draw off any hot water from the affected services until further notice.

4.5 The relevant Duty Holder shall ensure that their staff are aware of the situation, and that they in turn shall prevent patients from using affected services.

4.6 Where thermal pasteurisation is to be carried out, the temperature of the calorifier or plate heat exchanger shall be raised to 70°C, and the water shall be circulated throughout the affected distribution system for at least one 1 hour. Each tap or appliance should be run in sequence until full temperature is achieved (this should be measured). To be effective the temperature in the calorifier or plate heat exchanger should be high enough to ensure that all distribution outlets receive water at a temperature of greater than 60°C. Ensure the return flow to the calorifier or plate heat exchanger is no less than 50°C.

4.7 The Authorised Person (Water) shall inform users that the system is back in operation.

4.8 Bacteriological samples should be taken in consultation with the Infection Prevention and Control team.

4.9 The Authorised Person (Water) shall complete an Incident Report Record (004) and ensure the Responsible Person (Water) is notified in writing as soon as possible. Maintain hard copy records in the Water Safety Log Book.

5. Procedure for cold water tanks following the identification of water temperature greater than 20°C

5.1 Drinking water, to a relevant water quality under the Scottish Water Byelaws, is provided to ***NHS Board*** by Business Stream, a Licensed Provider (LP), which works with Scottish Water to make sure that the water supply is connected properly, and that the water is clean and ready to use.

5.2 These obligations cover the supply network up to the boundary point (normally the meter point). Thereafter obligations rest with ***NHS Board***. Currently there is no legal maximum water supply temperature from the Licensed Provider. In practice the water supply temperature to boundary point will be subject to seasonal variation. In winter this would normally be expected to be within the 5 to 10°C range and in summer up to 20°C.

5.3 The following staged risk assessment escalation procedure should be employed where the water temperature in Cold Water Storage Tanks is greater than 20°C. (i.e. the water storage tanks for Domestic Cold Water Systems and for Domestic Hot Water Systems).

5.4 **Stage 1** - Verification:

- Where tepid cold water occurrence (i.e. more than 20°C) is reported from any number of cold water outlets, from maintenance procedures, from BEMS monitoring, or from the manual monitoring of storage tanks, the person identifying, or making a report must notify the relevant Authorised Person (Water) as soon as the problem is identified and confirm this in writing within 24 hours.
- The Authorised Person (Water) should liaise with the person identifying the problem and verify the problem by independently rechecking by taking the water temperature of the appropriate cold water storage tank, the temperature of the incoming mains cold water at the site boundary point (and building entry point if there are multiple buildings served by the mains cold water system) and the outflow distribution temperature.
- If the cold water storage temperature is confirmed greater than 20°C, then the Authorised Person (Water) should record this in writing as well as conducting continuous monitoring of the incoming cold water mains, the cold water storage and the outflow temperatures to establish the temperature profiles and in more detail over at least a one week period to determine the level of risk.
- The Authorised Person (Water) should also review the Water Safety Log Book and take into account the recent water system history specifically to include the primary water treatment levels (for mains cold water supplied with chlorination or chloramination treatment); any water sampling carried out following SHTM 04-01; system monitoring data, including temperature monitoring and water quality chlorine or chloramine checks; recent

maintenance history; recent alterations, changes or additions to the water system; and any other changes made by Duty Holders or users of the water system.

- On reviewing continuous monitoring temperature profiles, in conjunction with Water Safety Log Book and recent history, action as Stage 2 or Stage 3 or Stage 4 as appropriate. The Authorised Person (Water) will ensure the Responsible Person (Water) is notified immediately in writing at each Stage and also recorded in the Water Safety Log Book.

5.5 **Stage 2** - Initial Action – high incoming mains cold water temperature:

- Where the incoming mains cold water is 18°C or greater for more than a 48 hour period the Responsible Person (Water) should contact Business Stream the Licensed Provider, who will work with Scottish Water to establish the reasons and determine a resolution. Continuous monitoring should continue and recorded in the risk assessment.

5.6 **Stage 3** - water temperatures fluctuating above and below 20°C (but no greater than 25°C):

- Where water temperatures are fluctuating above and below 20°C in a regular cyclic manner over 72 hour periods in response to regular user water demand (but no greater than 25°C) and are more than 2°C higher than the incoming cold water mains supply temperature at the building entry point, then continuous monitoring should be continued by the Authorised Person (Water), the reason(s) for failure(s) identified and rectified as soon as possible. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there may be increased risk and appropriate actions may be required to mitigate exposure);
- Considerations for failures include:
  - accuracy of temperature sensors (requiring recalibration);
  - temperature sensors being located in water (requiring reposition where tank storage levels have been reduced and sensor no longer sensing stored water);
  - inappropriate standby tank configuration;
  - temperature sensor in standby system;
  - temperature sensor measuring stagnation (requiring reposition);
  - inappropriate siting (not in a cool location);
  - heat gain to the tank and pipework (due to lack of appropriate insulation or located close to heat gain from other heat sources);
  - storage capacity not minimised to match daily use (changes in user water demand);
  - Ingress of hot water through cross connection or mixing valve failure (i.e. from DHW system or Steam systems).

5.7 **Stage 4** - water temperatures fluctuating above and below 25°C (and rarely below 20°C):

- In this situation continuous monitoring should be continued by the Authorised Person (Water), the reason(s) for failure(s) (as Stage 3) identified and rectified on an urgent basis. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there will be an increased risk and appropriate actions will be required to mitigate exposure);
- In this situation a permanent solution, such as ventilation for the plant room, or changing the water storage arrangements, or forming a circulating distribution system (with or without chilling depending on the circumstances) must be implemented;
- The Authorised Person (Water) should, unless instructed in writing to the contrary by Responsible Person (Water);
  - arrange to drain the tank contents and clean if necessary;
  - inform the users of the failed system that they must not draw off any cold water (and hot water if a single domestic hot water header) from the affected system until further notice;
  - chlorine (or other suitable) disinfection of the tank and distribution system shall be carried out;
  - thereafter the tank shall be brought back into service;
  - then the users shall be informed that the system is back in operation.

5.8 The Authorised Person (Water) shall complete an Incident Report Record Form (004). An entry should also be made in the Water Safety Log Book and ensure the Responsible Person (Water) is notified in writing as soon as possible.

5.9 Water systems should be cleaned and disinfected under the circumstances in the table overleaf

System/ Service	Circumstance Requiring Cleaning and Disinfection* (* for disinfection check current Risk Assessment)	Frequency
Domestic Cold Water and Domestic Hot Water Tanks	New installations. Re-commissioning empty/unused tanks. Tank temperature exceeds 25°C. (check with Risk Assessment). Tank contains moderate sediment, i.e. a complete covering of tank base. Evidence of tank corrosion (check with Risk Assessment). Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Regular programme for high-risk healthcare category, with disinfection* where identified in the local Written Scheme (check with Risk Assessment). Regular programme for medium risk healthcare category, with disinfection* where identified in the local Written Scheme (check with Risk Assessment). Regular programme for non-healthcare premises, with disinfection* where identified in the local Written Scheme (check with Risk Assessment).	As required As required As required As required As required As required As required Annually 2 Yearly 5 Yearly
Domestic Cold Water Distribution System	New installations and modifications or additions. Temperature exceeds 25°C. (check with Risk Assessment). Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc.	As required As required As required As required
Domestic Hot Water Calorifier and Storage/ Buffer Vessels	New installations and modifications or additions. Temperature has fallen below 45°C. Re-commissioning of empty/unused plant. Any contamination of header tank (by organic, by vermin or vermin faeces or similar). Regular programme.	As required As required As required As required Annually
Domestic Hot Water Distribution System	New installations and modifications or additions. Temperature has fallen below 45°C. . Any contamination of header tank (by organic, by vermin or vermin faeces or similar).	As required As required As required
Air Handling Units	Any contamination (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Chiller battery, drip trays and drainage pipework.	As required As required 6 monthly

6. Protection of maintenance personnel

6.1 The disinfection procedures presented for cold water storage tanks, domestic hot water vessels and water systems are designed to minimise the risk to staff and others that may come into contact with water which may have been contaminated with *Legionella* sp or other harmful bacteria. In all instances of draining, water should be drained in such a way as to avoid the creation of an aerosol.

6.2 Appropriate protective clothing should be worn during such procedures. 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 subsequent resistance to air can increase with consequent discomfort to the operator.

6.3 Where possible, cleaning methods which create an aerosol (e.g. high-pressure water jets) should be avoided. If this is not possible, the operation should be executed when the building is unoccupied or, in the case of permanently occupied building, windows in the vicinity should be closed and air inlets temporarily blanked off. As systems requiring cleaning will have high organic load the operator and others closely involved should wear suitable respiratory protective equipment.

6.4 If plant is located in confined spaces, reference on entry into confined spaces can be sought from Safe Work in Confined Spaces Approved Code of Practice, Regulations and Guidance (L101), and ***NHS Board's*** Confined Space Entry procedure. Personnel shall not be permitted to enter any water storage system (i.e. tank, calorifier, AHU) without working to the ***NHS Board*** safe system (GEMsoft7 or equivalent) for access or work. Health Facilities Scotland publication "Confined Spaces policies, procedures and guidance" (2012) also refers.

6.5 Because water treatment chemicals, including chlorine-containing chemicals and solutions, are often toxic or corrosive they should be used cautiously to ensure that they do not endanger the users or other occupants of the building. Caustic resistant gauntlet type gloves will be required. Water treatment should be carried out by, or under the direction of, people who are suitably qualified and experienced.

6.6 The use of water treatment chemicals should be subject to a COSHH assessment in advance and permission would be required from the Water Authority prior to any discharge to sewers, storm water drains and watercourses.

Note: Scottish Water and SEPA should always be contacted prior to direct discharge to watercourses.

Safe purging of stagnant water

6.7 Stagnant water may potentially contain large concentrations of *Legionella* bacteria. In order to avoid *Legionellosis* and water safety risks, precautions must be taken to avoid the creation of aerosols and to avoid the exposure of people to any unavoidable aerosols.

6.8 The specific precautions may vary according to the particular circumstances, but typically include:

- work on or removal of dead-leg pipework;
- running a hose from the outlet into a container of clean water;
- running hoses directly into a drain cover;
- running fire hoses at a distance from occupied buildings;
- testing fire mains or fire suppression systems;
- closing windows and air conditioning / ventilation intakes where aerosols are created outdoors;
- closing windows and air conditioning / ventilation intakes where excavations and soils removal is conducted outdoors;
- wearing respiratory protective equipment (remember this does not protect nearby members of the public and others who are not wearing masks).

Note: Care should be taken at all times to avoid the risk of contamination by the possibility of back siphonage into mains water supplies.

7. Procedure in the event of ward or department closure

Background

7.1 Where a ward or department is planned to close for a period of greater than 7 days, the Duty Holder must ensure that the manager of that department/ward has notified the relevant Authorised Person (Water) of the details so that the impact on the safety of the water system can be evaluated.

7.2 Following a decision to close a ward/department, full negotiations between the ward or department manager and the Authorised Person (Water) must take place to assess the risks and ensure that relevant safety procedures are established to mitigate the risks of exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria. The documented procedures shall clearly define responsibilities and the actions named individuals shall perform, including record keeping.

7.3 The period of closure should be established at the earliest point in negotiations as the duration can play an important part in assessing the likelihood of exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria, the cost implications and the arrangements involved in closure.

Short / Limited closure

7.4 Where a short term or limited closure of a ward/department is required (typically not exceeding 30 days) a nominated individual shall be identified to run every tap for three (3) minutes and to flush every toilet on a twice weekly cycle basis. The nominated individual should then complete the Record Form (001), signed by themselves and their relevant manager, the completed form being forwarded to the Estates Department for the attention of the Authorised Person (Water).

7.5 Before the department/ward is re-occupied the Estates Department shall organise an inspection and test of the water systems and report its condition to the Authorised Person (Water) for any remedial works that may be required.

Indefinite closure

7.6 When a ward/department is to close with no planned re-opening date, or where the closure period typically exceeds 30 days, the Estates Department must be consulted *and provided with funding* in order to alter or disconnect and drain the relevant water services ‘so far as is reasonably practicable’. The department or ward manager should be aware that considerable cost for modifications could be needed to achieve this requirement in some large properties with multiple wards/departments being served by the water system. The top section of Record Form (002) shall be completed “Indefinite Closure – System removed from operation from (*the date closed*)” by the Authorised Person (Water).

Detail of works for an indefinite closure (where relevant)

7.7 All water tanks associated with the affected area shall be drained, cleaned and dried out.

7.8 All pipework and devices shall be drained and domestic hot water calorifiers (or other storage vessels) shall be opened up, cleaned and left open to the atmosphere.

7.9 To avoid dead-legs, pipework shall be disconnected from the mains services and tees replaced with straight couplings. Mains cold water services shall be isolated at the mains, capped off from the system and all relevant pipework drained.

7.10 Notices shall be posted throughout the affected department or ward area stating that all water services are disconnected.

7.11 The Estates Department shall be responsible for ensuring that an adequate water seal exists in unused toilets etc to prevent odours from the foul drain system entering the premises.

Re-occupation of an indefinitely closed area

7.12 In the event of re-occupation of an indefinitely closed department or ward, full negotiations must take place between the ward/department manager and the Estates Department prior to the re-occupation exercise.

7.13 The Estates Department will require the following information:

- the planned re-opening date;
- any proposed changes in use of the department or ward;
- any areas which will not be used;
- the approval of the Authorised Person (Water) in advance.

7.14 The Estates Department will provide the department/ward manager with a cost to put the water systems back in service.

7.15 Before the water system is put back into service, any necessary modifications and maintenance shall be carried out prior to cleaning and disinfecting the system.

7.16 The bottom section of Record Form (002) shall be completed at re-occupation and operation from (*the date re-occupied*)" by the Authorised Person (Water).

8. Occupation after alterations to water systems including refurbished and new premises – safe operation of water systems

Procedure until occupation

8.1 This procedure is designed to prevent *Legionellosis* and other water safety risks developing during and after alterations to water systems, including the occupation of refurbished and new buildings through the interim period following alteration, construction, commissioning and hand over with interface with the Authorised Person (Water) for occupancy.

8.2 In design and build type contracts **-** outbreaks of Legionnaires' disease have been encountered, whereby the client did not retain a clerk of works on site and/or where there was no 'commissioning' period on completion of the work. It is vital that the measures outlined in SHTM 04-01 have been implemented immediately before re-occupation.

8.3 Disinfection and cleaning shall be in accordance with:

- SHTM 04-01 Part A: Testing and Commissioning (Section 16);
- SHTM 04-01 Part A: Disinfection (Section 17);
- SHTM 04-01 Part E: Flushing and Disinfection (Section 2) *which was formerly in SHTN 2 (section 2).*

8.4 Once the system is in use and has been cleaned and disinfected prior to hand over, an Authorised Person (Water) shall be nominated to monitor and observe the system. The Authorised Person (Water) shall ensure that the system is operated in accordance with ***NHS Board's*** 'procedure for ward/department closure - short/limited closure' and the relevant Record Forms (001) completed.

8.5 At the point of hand over **all** relevant information written on operating the system, system performance, together with accurate 'as-fitted' drawings and design criteria of the domestic hot water systems and cold water services shall be submitted to ***NHS Board*** (i.e. an appropriate current Written Scheme, accepted in writing by the relevant Authorised Person [Water]).

8.6 Full operation of the system and occupancy of the building/property should be as soon after hand over as possible to reduce the potential of *Legionellosis* and other water safety risks and avoid further costs being incurred due to of any further re-disinfection of the water systems.

Residential accommodation owned or leased by NHS Board

8.7 This sub-section applies to domestic residential properties served by individual water systems. Where domestic residential properties share a common water system, the procedures for the larger premises apply.

8.8 ***NHS Board*** recognises its obligations as a provider of residential accommodation. In practical terms it fulfils these by routine maintenance actions/checks immediately prior to the occupation of a domestic residential dwelling by a new tenant and by the provision of information to the new tenant.

Maintenance actions/checks prior to occupation by tenant

8.9 Whenever the expected time delay between vacation of accommodation by one tenant and occupation by the next is greater than one week, the following actions should be taken where appropriate.

8.10 A member of the Estates staff visits the accommodation unit within one week prior to occupation. The following actions are taken, in the order stated:

- the hot water is switched on;
- all WCs are flushed twice (one full flush where dual flush type WCs);
- the cold water storage tank, where present, is checked for contamination e.g. microbiological growth, the presence of organic debris or live organisms such as insects. In the event of discovering such contamination the Estates Officer shall arrange tank cleaning and disinfection. The remaining actions below are not undertaken until the cleaning and disinfection of the tank is complete;
- each hot and cold water outlet is run for three minutes, creating as little aerosol as possible;
- the shower head is removed and the shower hose run under water for three minutes;
- the hot water system is left switched on;
- any defects are reported to the Estates Officer and wherever possible, rectified prior to tenant occupation.

Note: These actions apply to accommodation served by either a conventional hot water system or a combination boiler.

Provision to inform new tenants

8.11 ***NHS Board*** can influence but not control the actions of its domestic tenants. It exerts its influence by the provision of the following guidance as part of the general information pack as provided to new tenants.

"The water systems in this accommodation have been prepared by the Estates Department in such a way as to protect water hygiene. Personal health and safety can be protected by:

- *Ensuring that all outlets are used regularly (preferably once per week) or run for a couple of minutes per week to keep water fresh.*
- *Reporting any water system defects, such as hot water temperatures failure or dirty drinking water, to the Estates Department as soon as possible".*

9. Domestic hot water systems

9.1 The default hot water treatment method used by ***NHS Board*** is that of the Temperature Control Regime (as outlined in HSE ACOP L8 / HSG 274) with full temperature control as advocated in SHTM 04-01.

9.2 Should an alternative water treatment regime be sought, the onus shall be on ***NHS Board*** to establish the efficacy of the system in its control of *Legionella* and water safety for each site, this shall be in the form of a trial to establish:

- a control level;
- the ability to achieve that control level;
- the assurance that the control levels will be maintained;
- develop a Written Scheme for operation and control.

9.3 With regard to scalding risk ***NHS Board*** will ensure that all that is reasonably practicable will be done to follow the requirements of the Safe Hot Water and Surface Temperature guidance in SHTM 04-01.

Hot water storage and distribution temperatures

9.4 The storage of domestic hot water should be arranged to ensure that a water outflow temperature of at least 60°C is achieved. No two water systems are the same and through periodic monitoring operational system performance, the system outflow temperature should be set to over 60°C to ensure an outflow of 60°C is achieved under normal draw-off demand and achieve 55°C at the supply to the furthermost draw-off point in the circulating system. It is important to maintain temperatures at above this figure (*Legionellae* organisms will survive for only a short period of time above this temperature - approximately two minutes).

9.5 Periodic performance monitoring and a system of continuous monitoring and recording of water temperatures via a building management system (BEMS) or data logger is essential to ensure compliant system performance.

9.6 The outflow water temperature, under prolonged maximum continuous demand (at least 20 minutes) from calorifiers should not be less than 60°C.

9.7 While it is accepted that occasionally under peak instantaneous or prolonged demand the water outflow temperature will fall, it is not acceptable if this occurs frequently (more than twice in any 24 hour period) and/or for long periods (exceeding 20 minutes).

9.8 Under no circumstances should the domestic hot water flow temperature fall below 50°C.

9.9 It is recommended that disinfection by pasteurisation is undertaken if the water temperature of the calorifier falls below 45°C.

9.10 A minimum domestic hot water circulation (return) temperature of 50°C shall be maintained during the hours of occupancy.

Water temperature checks (Including cold water outlets)

9.11 Temperature checks on calorifiers and distribution systems should be carried out on a monthly, six-monthly and annual basis. In the event of non-compliance, both the Authorised Person (Water) and the Responsible Person (Water) should be informed as soon as possible. Use of a digital thermometer with a touch and immersion probe is recommended.

9.12 Although the HSE recommends spot temperature checks, SHTM 04-01 requires a temperature excursion limit of less than 20 minutes; therefore continuous monitoring and recording will be necessary in certain circumstances.

Calorifier operation

9.13 Calorifiers are to **be run 24 hours per day, 7 days per week, with the domestic hot water circulation pump kept running**. Should it be necessary for interrupted operation or shutdown overnight, then the calorifier should be allowed to maintain its water storage temperature and the domestic hot water pump should be started up to ensure full temperature throughout the distribution system for at least one hour prior to occupation of the premises.

Plate heat exchangers

9.14 Plate heat exchangers and any associated storage/buffer vessels are to be run to the same temperature regime as calorifiers. The large contact area and lack of dead spots should ensure good kill of *Legionella* bacteria.

9.15 In the event of a plant failure the water outflow temperature will quickly fall below 60°C and it may be necessary to apply Section 4 - "Procedure for domestic hot water systems following plant failure, allowing system water temperature to drop below control levels".

DHW circulation pumps

9.16 Domestic hot water circulation pumps should perform in such a way to ensure a minimum water circulation (return) temperature of 50°C.

9.17 Where possible, any plumbed-in duplicate circulating pump should be removed. Where this is not practicable, the duty pump should be manually changed over a least once per week to reduce any danger of water stagnation. It may be more efficient to utilise an auto-changeover system. A spare pump should be kept for immediate replacement in the event of pump failure.

Stratification checks

9.18 Domestic hot water storage vessels and any associated storage/buffer vessels should be subject to water temperature stratification checks every two years for each calorifier/vessel. These checks should extend over a period of seven (7) days using a logging device. Logging should also be used where de-stratification pumps have been fitted to establish that such a pump will ensure that the water temperature at the base of the vessel achieves 50°C.

Quarterly flushing

9.19 Each calorifier and any associated storage/buffer vessels should be flushed quarterly through its drain valve by opening the drain valve 3 times, each time for a 3 minute period.

9.20 Calorifier and any associated storage/buffer vessels flushing should be carried out after temperature checks on the calorifier and system have been completed. Record Form (006) should be completed.

9.21 Hot Water Services Routine Inspection and Frequency Table:

Service	Task	Frequency
Hot Water Services	Arrange for samples to be taken from hot water calorifiers, in order to note condition of drain water. (on Procedure P1C9 – recorded on 006)	Annually
	Visual check on internal surfaces of calorifiers for scale and sludge. Clean and disinfect. Check representative taps for temperature as above on a rotational basis. (on Procedure P1C9 – recorded on 006)	Annually
	Check temperatures in flow and return at calorifiers. (on Procedure P1C4 – recorded on 005)	Monthly
	Check water temperature up to one minute to see if it has reached 50ºC in the sentinel taps. (on Procedure P1C4 – recorded on 005)	Monthly

10. Domestic cold water systems

Cold water cisterns and cold feed tanks

10.1 All new domestic cold water storage cisterns and tanks shall comply with the requirements of the Scottish Water Byelaws.

10.2 Duplicate tanks often create a risk of water becoming stagnant in one of them, leading to risk of *Legionella, Pseudomonas* Spp or similar contamination. Consideration should be given to taking one of the tanks out of service. See guidance in "Guidance for Alterations to Water Systems".

10.3 All cold water storage tanks are to be examined and the temperature tested on a regular summer / winter six monthly cycles and cleaned on an annual basis as required. (on Procedure P1C7 – recorded on Form (003).

10.4 Temperatures in cold water storage tanks and the mains inlet to them should be checked during periods of high ambient temperatures (e.g. summer afternoons between June and August). Water temperatures should be less than 20°C. At the same time, the furthest and nearest draw off points in the system should be checked to ensure that the water distribution temperatures are less than 20°C within 1 minute of running the water (at full flow). A similar temperature check regime should be undertaken during the winter months to identify the performance of cold water distribution systems and the impact of heat gain from heating systems.

Cold water services - Pressurisation/supply pumps

10.5 Where two or more pumps have been fitted for pressurisation systems, the lead pump shall be changed over at least once a week in order to avoid water stagnation.

10.6 Dates and times of the pump changeover should be recorded in the Water Safety Log Book (on Safety Control Log – Record Form 028). Printouts of regimes for automatic systems will be adequate.

10.7 Where pumps have not been in service for a period of four weeks or greater, or have been removed for any reason, the pump and associated pipework shall be thoroughly washed out and disinfected before being brought back into service. Disinfection of pumps shall be to 50ppm free residual chlorine for one hour and pumps shall be totally submerged during this period. Incident report Record Form (004) shall be completed giving details of why the pump was out of use.

Tank cleaning procedure

10.8 ***NHS Board*** staff or contract staff shall not be permitted to enter any water storage system (i.e. tank, calorifier, AHU) without working to the ***NHS Board*** safe system (GEMsoft7 or equivalent) for access, or work or if they are suffering or have recently suffered from any gastric or other communicable illness, or a condition which may result in their increased susceptibility to *Legionellosis, Pseudomonas* Spp and other similar harmful bacteria. It is the responsibility of the individual to inform the supervisor immediately if applicable.

10.9 The relevant Authorised Person (Water) shall notify all users of the proposed line of action, and of any disruption or modification to service.

10.10 All equipment and tools to be employed during the cleaning and disinfection process must be dedicated only to this task - this will include hire equipment. All equipment should be disinfected in a high concentration of chlorine solution prior to commencement of the process.

10.11 The Process Steps:

- isolate and shut down the cold water storage tank and remove the cover or inspection hatch. The operator shall display warning labels in and around the plant room stating disinfection in progress;
- permission must be obtained from Scottish Water before dumping the tank contents. The Water Authority will need to be informed of the volume to be discharged. Any further quantities of disinfected/chlorinated water that are to be dumped as a result of tank cleaning should be included;
- the tank shall be examined visually for signs of damage, corrosion, debris and biological growth. The water storage temperature and any such defects identified are recorded for report to the Estates Department;
- tank cleaning shall be performed using non-abrasive cleaning materials;
- protective clothing, footwear, face goggles and masks are to be employed. These items must be specific to the task of cleaning and chlorination, and must not have been used for other activities;
- where tanks are to be painted, only paints or coatings and materials that are recognised and approved by the WRc and detailed in "The Water Fittings and Materials Directory" shall be employed. The specification for any such product must be submitted to the Authorised Person (Water) or their nominated deputies for their approval prior to use;
- details of all cleaning and painting materials shall be listed on Record Form (003);
- on completion of the cleaning/painting exercise, and after the necessary paint maturing period (if required), the tank shall be thoroughly flushed and washed out with water, refilled to the tanks normal working level and dosed to a level of 50 ppm free residual chlorine. The tank shall be left to stand for a minimum period of one hour. During this period the level of free chlorine shall be monitored and maintained at 50 ppm;
- on completion of the tank chlorination period, the tank contents shall be discharged as previously detailed in (b) above. The tank is then refilled to its normal operating level with fresh water. The free chlorine level in the tank water shall be monitored until it matches that of the incoming water supply;
- on completion of this exercise the tank shall be put back into service immediately, and water samples taken for analysis - A sample of water

should be taken using sterile bacteriological techniques for deposit and examination at a UKAS accredited laboratory;

- the TVC and *Legionella* Sampling and Test Protocol are detailed in SHTM 04-01 Part C. As described, sampling must follow that set out in BS7592: 2008 Code of Practice and BS EN ISO 5667-1: 2008 on Water Quality Sampling. Those organising sampling must make clear in advance which water quality technique is to be undertaken in order that systematic conclusion on risk can be drawn;
- for initial water system sampling take a Post-Flush sample (as defined in BS7592: 2008) at sentinel points without disinfection. Where there is an initial concern with a particular outlet location – say, a combined system and outlet problem – a BS Pre-Flush sample should be taken. If concerns persist with an outlet location (typically, a known dead-leg issue or lack of, or low, water use, a further BS Pre-Flush sample should be taken followed by disinfection before a BS Post-Flush with disinfection sample. Water should be allowed to run hot for 1 minute and cold for 2 minutes by which sampling would be temperature calibrated;

Note: Samples following SHTM 04-01 Part C, taken for *Legionella* must be in a 1 litre container, available from the Microbiology Laboratory.

Samples from source sampling **must** reach the UKAS Laboratory within 2 hours, if there is a delay the samples should be stored between 6ºC and 18ºC for examination within 24 hours.

- on receipt of analysis results, these shall be submitted to the Authorised Person (Water). The assistance of Infection Prevention and Control team may be required to aid with the interpretation of the results, and the identification of remedial actions if necessary;
- on completion of the tank cleaning or inspection exercise, it is recommended that details should be entered onto a tank cleaning record label to be posted on or adjacent to the tank. Such a label must be robust, and able to withstand contact with water;
- details of findings, actions taken and test results are to be entered onto the Water Storage Tank Maintenance Record Form (003). Chlorination certificates are to be obtained and be retained in the Water Safety Log Book;

Note: Any defect shall be reported **immediately** to the Authorised Person (Water) or Nominated Deputies.

- once a system has been filled ***NHS Board*** and/or their Contractors **will not** drain that system unless full disinfection is to be undertaken before the system is brought into use again. The only exception is in the case of an emergency and with the consent of the Infection Prevention and Control Team.

Service	Task	Frequency
Cold Water Services	Check tank water temperature remote from ball valve and mains temperature at ball valve. Note maximum temperatures recorded by fixed maximum thermometers where fitted. (on Procedure P1C7 – recorded on 003)	Six monthly
	Check that temperature is below 20ºC after running the water for up to two minutes in the sentinel taps. (on Procedure P1C4 – recorded on 005)	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. (on Procedure P1C7 – recorded on 003)	Annually
Shower Heads	Dismantle, clean and de-scale shower heads and hoses / or replace with new disinfected Shower Head and Hose. (on Procedure P1C12 – recorded on 005B)	3 Monthly for high risk areas and as required elsewhere, but at least Once Annually
Little Used Outlets	Flush through and purge to drain, or purge to drain immediately before use, without release of aerosols. (on Risk Control Notice 11/04 – recorded on Sample Record Sheet by Duty Holder) NB Little-used outlets in ICUs should be flushed daily at the start of each day.	Twice weekly

Cold water services routine inspection and frequency table

11. Air conditioning plant

General

11.1 Air conditioning plant and ductwork should be inspected at the access point(s) on an annual basis in order to check cleanliness, general condition and assess risk. After several years of service, even a correctly filtered system may contain dirt accumulation. It may be necessary to consider cleaning of the system taking account of HAI-SCRIBE procedures and the risk assessment.

11.2 In particularly recurring polluted areas, it may be necessary to consider the installation of high grade final and pre-filters. The quality of filter housing design and in particular the seals are critical factors in maintaining the efficiency of the filtration system by ensuring that air does not bypass the filter panels.

11.3 All information on condition, cleanliness etc., to be recorded in the plant room log book, with any non-compliance or incidents being identified to the Authorised Person (Water) immediately on identification. An Incident Report Record Form (004) should be completed and the Responsible Person (Water) must be notified as soon as possible.

Draining traps and pipework

11.4 A drainage drip tray should be provided to collect condensation build-up on cooling coils (including the return bends and headers), for humidifiers (if installed), eliminators and, if necessary, heat recovery devices. The drainage drip tray should be constructed from a corrosion resistant material and be so arranged that it will completely drain - i.e. the drain connection should have no upstand in order to prevent 'pooling'. The drainage tray should be large enough to collect all the water produced by the device it serves. Provision should be made to allow for inspection of the drainage tray (i.e. viewing window/access panel). A slope of 1:20 in all directions towards the drain outlet position should be incorporated.

11.5 Drainage drip trays should be connected to a drainage trap assembly which should discharge via a Type ‘A’ air gap as laid down in BS6281: Part1: 1992.

11.6 The depth of any trap should be at least twice the static pressure head generated by the fan so that the water seal is not 'blown out' during plant start up.

11.7 A trap need not be directly under the drainage drip tray which it serves, provided that the connecting pipework has a continuous fall. Each trap shall be made of the clear (borosilicate) glass or transparent plastic type in order to show clearly the integral water seal level, and should be fitted with a screw-top cap to permit re-filling. The water seal level shall be permanently marked on the trap, to indicate the water seal levels when the fan is operational at its design duty.

11.8 Traps fitted to plant located outside or in unheated plant rooms may require trace heating to prevent freezing damage during the winter period. The trace heating system employed should not raise the temperature of the water in the trap to greater than 5°C. Similarly, it may be necessary to shield the trap from direct sunlight in mid-summer in order to prevent heat gain and algae growth.

11.9 The pipework from each trap should be constructed of thermoplastic, copper or stainless steel tube. Stainless steel may be particularly useful in instances where greater mechanical strength is required. The pipework shall have a minimum fall of 1 in 60 in the direction of water flow.

11.10 Water from each trap should discharge over an open tundish connected to a drainage stack via a second trap or a floor gully.

11.11 Where the drainage pipework from the tundish outlet, which should be ventilated, discharges to a surface water drainage stack or a dedicated plant drainage stack, then the connection shall be in the form of an easy-sweep tee.

11.12 It may be necessary to employ chlorine or other chemicals in order to clean humidifiers and cooling coils etc. Under such circumstances it is necessary to discharge the plant effluent produced to the foul drainage system.

11.13 Individual drain trap systems should be separate wherever possible. All drain trap systems are to be examined, cleaned and topped up on a monthly basis as required. (on Procedure P1C5 – recorded on Form 022.

Humidifiers (where installed)

11.14 Humidification was originally required for some healthcare ventilation applications in order to control the risk associated with the use of flammable anaesthetic gases. The use of such gases has now ceased.

11.15 Where humidification is still required this must follow the requirements of SHTM 03-01 and this should be included in the *Legionella* risk assessment.

11.16 The steam supply connections to the humidifier should be provided with a dirt pocket and trap set installed as close as practicable to the humidifier. The water supply to the steam generating unit shall be designed as if potable supply right up to the device.

11.17 The humidifier chamber should be inspected on a six-monthly basis and specified in the plant PPM schedule. Particular attention should be given to any pooling of water. The chamber interior should be clean, and free from any scale or other build-up on the walls.

Heater batteries

11.18 Inspection of the heater batteries is needed in order to ensure free airflow and no build up of dirt, scale or other debris. Cooling coils should be examined regularly to ensure that correct drainage is being achieved, and that there is no pooling of water or development of slime, algae or other deposit. Drainage drip trays should be removed (if possible) and cleaned on a regular basis.

12. Hydrotherapy pools, whirlpool baths, whirlpool spas and birthing pools

General

12.1 Hydrotherapy pools, whirlpool baths, whirlpool spas, birthing pools and water features provide conditions which may favour the growth of *Legionella, Pseudomonas* Spp and other similar harmful bacteria. Whirlpool spas are particularly vulnerable because of the recirculation of a relatively small volume of water, and careful maintenance and chemical water treatment is needed in order to maintain water quality. A detailed log must be kept detailing the treatment method, filter cleaning, temperature, PH, chlorine residual, quantity and strength of chemicals applied and other key parameters.

12.2 Whirlpool baths and birthing pools normally employ a single fill for each user, and do not present the same level of risk as spas, provided that the guidance recommended for hot and cold water systems is followed.

Guidance

12.3 Hydrotherapy pools and spa pools should be operated to the guidance given in the following publications published by the Public Health Laboratory Service (PHLS):

- 'Hygiene for Hydrotherapy Pools';
- 'Hygiene for Spa Pools'.

12.4 Copies of these publications should be held in the Estates Department, and used as the primary source of guidance for the management of such pools.

12.5 All information on condition, cleanliness, servicing and monitoring to be recorded in a pool log book. Non-compliance or incidents to be identified to the Authorised Person (Water) immediately, and the Incident Report Record Form (004) completed and ensure the Responsible Person (Water) is notified as soon as possible.

13. Showers / unused outlets

13.1 Showers and other water outlets which are rarely used should preferably be removed or, if retained, flushed to waste at intervals for a 3 minute period. The interval should be at least twice-weekly. Where the outlet may be used by high risk patients, more frequent flushing will be needed and the increased frequency should be determined following risk assessment. In ICUs little-used outlets should be flushed daily at the start of each day.

13.2 The flushing must be carried out in such a way as to avoid the creation of aerosols. Full flow is not necessary.

13.3 A record must be kept of the flushing operation and should be retained for at least 5 years. The sample Record Form for Estates Department use is (026).

13.4 Risk Control Notice XXXXX was first issued on XXXXX to instruct all Duty Holders and Department Heads of this requirement. This has been updated to reflect SHTM 04-01 changes to allow Duty Holders to instruct ALL devolved management and local ward or departmental staff of the requirements. A sample record sheet for devolved mangers was included. The record sheet is audited as an integral part of Infection Control Audit (3 monthly using the HEI Inspection Audit Tool).

14. Monitoring requirements for other risk systems

Service	Task detailed Under Risk Assessment	Frequency
Ultrasonic humidifiers/ foggers and water misters	**Not** to be used in ***NHS Board***	
Spray humidifiers, air washers and wet scrubbers	**Not** to be used in ***NHS Board***	
Water Softeners and R.O. Systems	Clean and disinfect resin and brine tank - check with manufacturer what chemicals can be used to disinfect resin bed Duty Holders and their Local Managers to **note** their specific responsibilities for systems installed and used by functional departments (Renal etc.)	As recommended by specific manufacturer
CBRN, Deluge & Emergency Showers and Eye Wash Sprays	Flush through and purge to drain. Duty Holders and their local Managers to **note** their specific responsibilities for systems installed and used by functional departments	2 times per week following Risk Control Notice 11/04
Fire Sprinkler / Suppression and Hose Reel Systems	When witnessing tests of sprinkler / suppression system blow down and hose reels ensure that there is minimum risk of exposure to aerosols. *Any Hose Reels identified must be reported on Incident Report Record Form (004) for immediate removal including all dead-leg pipework*	As directed by specific manufacturers
Lathe and Machine Tool coolant systems	Coolant **not** to be used in ***NHS Board*** Systems	
Horticultural misting systems	**Not** to be used in ***NHS Board***	
Dental Equipment	Drain down and clean	At the end of each working day
Trolley Wash & Vehicle and Power Washing Plant	To be operated in line with manufacturer's instructions	See manufacturer's instructions
External Fountains and Water Features	Clean and disinfect ponds, spray heads and make-up tanks including all wetted surfaces, de-scaling as necessary. Risk Assessment to take account of proximity and likelihood of risk to healthcare buildings	Interval depending on condition
Internal Fountains and Water Features	**Not** to be used in ***NHS Board***	
Vending, Chilled Water and Ice-Making Machines	Follow the infection control precautions detailed in Scottish Health Facilities Note 30 Duty holders and their Local Managers to note Freestanding water dispensing machines using proprietary water containers *should not to be used in healthcare applications* (remove and return to supplier if found)	

15. Alterations to (including refurbishment or new) water systems guidance

15.1 Where alterations are planned to water systems and the Written Scheme, the Guidance for Alterations to Water Systems document must be followed. The document provides separate specific guidance and the details to be followed for controlling and avoiding the potential of *Legionellosis, Pseudomonas* Spp, other similar harmful bacteria and water safety risks. (specifically using Record Form 029 to record the acceptance of work to be conducted and conformation of work completed on a water system and all conditions involving Duty Holders and their staff, the Authorised Person (Water) of the written scheme of the system and the Authorised Person (Water) from the Project Team accepting responsibility for the work).

> **Note:** Record Form 029 shall e used to record the acceptance of **all** work to be conducted, confirmation of **all** work completed on a water system, **all** conditions involving Duty Holders and their staff, the Authorised Person (Water) of the Written Scheme of the system and the Authorised Person (Water) from the Project Team accepting responsibility for the work.

15.2 At the point of hand over **all** relevant information written on operating the system, system performance, together with accurate as-fitted drawings and design criteria of the domestic hot water systems and cold water services shall be submitted to ***NHS Board*** (i.e. an appropriate current Written Scheme, accepted in writing by the relevant Authorised Person [Water]).

15.3 Full operation of the system and occupancy of the building/property should be as soon after hand over as possible to reduce the potential of *Legionellosis, Pseudomonas* Spp, other similar harmful bacteria and avoid further costs being incurred due to any further necessary re-disinfection of the water systems.

16. Control of contractors

16.1 Contractors shall only be engaged in work on water systems or air conditioning plant under the control of the Authorised Person (Water) co-ordinated with any Estates persons.

16.2 The ***NHS Board*** Management and Control of Contractors – Health, Safety and Environment Policy & Procedural Arrangements along with the associated Guide for Contractors (and Consultants etc) will apply.

16.3 The Authorised Person (Water) shall ensure that the contractor is competent for the task(s) to be undertaken and shall ensure that the contractor is aware of and has made provision for all responsibilities under the various Environmental, Health and Safety Regulations, including CDM, COSHH, *Legionella*, water safety etc.

16.4 The Authorised Person (Water) shall ensure that the contractor:

- is suitably briefed in writing on the task(s) to be undertaken and is fully aware of the water safety implications and prescribed *Legionella* Procedures to be followed;
- demonstrates that all workforce to be engaged on the task(s) are suitably trained and experienced for the task and are properly managed and supervised;
- has provided appropriate equipment for the task including PPE;
- carries out the task(s) to the correct standards and in the correct manner all in accordance with ALL *NHS Board* and Estates policies and procedures.

16.5 The Authorised Person (Water) shall record the evidence provided by the contractor and store it for future reference and maintain hard copy records in the Water Safety Log Book.

16.6 The Authorised Person (Water) shall complete a review questionnaire upon completion of the work and shall forward it to the Environment & Safety Support team for recording.

17. Designer's responsibilities

Safety criteria

17.1 In order to avoid potentially costly remedial works, the design of new buildings or the installation or alterations to existing buildings and their water systems should be controlled in order to "get it right first time". The checklist provided in the "Control of Water Record Forms" document 025 (included in Appendix C for ease of reference), should be used by relevant Estates staff and/or supplied to design consultants in order that they may check their own design. The Designer (*i.e. the person identified to perform the design duties through clarifying assumptions, eliminating hazards and risks and providing the information about remaining risks – in compliance with the Construction (Design and Management) Regulations: 2007 which are part of the Health & Safety at Work regulatory framework*) shall ensure the Client and CDM Co-ordinator are aware.

17.2 This checklist is not a design brief and is not intended to deal with the potential design issues, but is a management checklist. If these issues are incorrect it is likely that other aspects of the design are also not compliant with regulatory and mandatory standards, or best practice. Also see Record Form 029.

The checklist should be used to record, take account and weigh up all relevant matters regarding the safety of the water system, the operating parameters, the assumptions and what is known (or importantly the level not known) or reasonably be expected to be known to eliminate or mitigate risk. ('*reasonably practicable*').

17.3 Water systems operate in premises across a wide range of settings - through a scale from suites of rooms within larger premises, to premises with single building blocks, to premises with multiple building blocks with multiple functions, up to large health campus containing multiple hospitals and complex specialist care services.

Additionally due to the age, construction type and nature of ***NHS Board*** premises there are a wide number of potential health hazards arising from care and support functions (such as infectiousness, hazardous, dangerous substances and radiation etc) and the nature of the physical environment (such as exposure to asbestos, confined spaces and access restriction etc). Where buildings owned or leased by ***NHS Board*** were built or refurbished prior to 2004 the use of asbestos-containing materials in their construction was common practice and it is possible that personnel could encounter asbestos material in difficult physical environments whilst undertaking work activities. It may also be very difficult to safely investigate intrusively, so considerations and assumptions on what is actually known must be recorded.

NHS Board takes a positive approach to controlling and reducing any potential risk exposure to those conducting work or exposing others to risk through the work activities. This will be achieved by staff and contractors co-operating, working together to the control measures and work methods outlined in Board

Policies and associated Procedural Arrangements.

17.4 Domestic Hot and Cold Water Systems should be designed to ensure safe operation at all time by avoiding, preventing or controlling conditions which permit the growth of *Legionella, Pseudomonas* Spp or any other similar harmful bacteria and which allow easy maintenance, cleaning and disinfection. In particular, the following must be considered:

- materials such as natural rubber, hemp, linseed oil based jointing compounds and fibre washers must **not** be used in domestic water systems. Materials and fittings for use in water systems, such as plastic pipework, plastic and rubber components in TMVs and flexible hose liners etc must **not** support microbial growth. The WRAS Water Fitting and Materials Directory should be consulted to identify approved products in keeping with regulatory requirements. Flexible hoses, WRAS approved or not, shall not be used in water systems except in exceptional (approved) circumstances;
- water storage tanks should be fitted with covers which comply with the Scottish Water Byelaws, also insect screens fitted to any pipework open to atmosphere, e.g. the overflow pipe and vent;
- tanks should be provided with a bottom drain outlet that allows the full contents to be safely drained to a suitable drainage point;
- multiple linked storage tanks or tanks with multiple ball valves should be avoided because of operational difficulties due to possible unequal flow rates and possible stagnation;
- accumulator vessels on pressure boosted hot and cold services should be fitted with diaphragms which are accessible for cleaning and that do **not** support microbial growth;
- point of use hot water generators, with minimal or no storage, taken with safe temperature guidance should be considered for remote low use outlets;
- thermostatic mixing valves (TMVs) where fitted, should be sited as close as possible to the point of use. A single TMV should serve a single shower outlet or a single tap outlet. A single TMV **must not** serve multiple tap or shower outlets. Where pipework contains blended water the maximum length of pipe is given in SHTM 04-01 Part A with the downstream leg not exceeding 2 metres and the complete length of the spur without circulation not exceeding 3 metres;
- duplicate or multiple circulation pumps should **not** be installed, as the pump on standby may harbour stagnant water. Instead, a single pump should be installed and a spare provided.
- for applications involving Neonatal Units and Adult & Paediatric Intensive Care Units there is particular guidance (which should be good practice elsewhere) to ensure:
  - engineering and cleaning protocols are achieved and manufacturers' instructions are followed;

- taps and thermostatic mixing valves (manual and automated) are commissioned (including programming auto flush cycles) and can be routinely validated, as per the manufacturer's instructions;
- for automated taps, ensure records of remote flushing can be achieved;
- flushing of all hand wash stations and sinks can be performed for 1 **minute** daily, at the maximum flow rate that this does not give rise to any splashing beyond the sink, e.g. on the floors;
- that water flowing from the taps cannot flow directly into the drain holes (to prevent splash back). Water flow must impact on the basin offset from the drain hole. Flushing (automated or manual) should not result in splashes beyond the wash hand station area;
- where outlets are planned to be flushed daily, there is no additional requirement for weekly (or automated) flushing;
- liaison with the user (Senior Charge Nurse) regarding the potential of infrequently used wash hand stations or sinks (used and / or flushed once a day) which will have to be subjected to a documented flushing regime, risk assessed and regularly reviewed for the need for the wash hand station or sink to be still there. (See: Guidance on the number of hand wash stations required);
- removal of any redundant branches from circulating mains and provide straight couplings on distribution pipework to eliminate residual dead-legs or blind stub-ends created by plugged tee-pieces (anywhere in the water system under alteration);
- the length of any dead-legs is checked and minimise where possible by taking the return leg pipework up to wash hand stations and sinks. (this should be included in the *Legionella* Risk Assessment for the water system);
- before undertaking any modifications to pipework, perform an impact risk assessment. Keep records of risk assessments and modifications made;
- considering whether thermostatic mixer valves can be located closer to the outlet;
- new taps, wherever considered necessary, have integral thermostatic control;
- the careful selection of taps to minimise the formation of aerosols. The water flow profile should be compatible with the shape of the wash hand station. Flow straighteners can capture biofilm, but their removal can create turbulent flow and increased pressure resulting in splashing of surrounding surfaces and flooring. Any policy for removal should result from risk assessments and / or restricting flow to the same as applied prior to the removal of the straighterners;
- to avoid positioning soap dispensers / alcohol based hand rubs such that any drips could fall on to the taps or into the basin of the hand wash station;

– as it is not possible to have taps, shower heads and hoses etc 'pre-disinfected' in the supply from manufacturers - disinfection will have to rely on normal flushing and disinfection protocols that would apply to any new installation before commissioning and putting into use. In large projects this process should be undertaken as close as possible to the system being handed over to avoid pipework being left unused filled with stagnant water. A daily flushing regime should be put in place until the system is handed over to the ***NHS Board.***

Domestic hot water systems

17.5 The storage capacity and recovery rate of the water heater should be selected to meet the normal daily functions in hot water use without any drop in the supply temperature.

17.6 Temperature is used as a means of control and each water heating device shall deliver water at a minimum of 60^{0}C at the flow point from the water heating device under normal water system demand draw-off. All storage water heating devices should have a suitably located drain valve.

The flow of water throughout the domestic hot water circuit shall be balanced by adjusting regulating valves to ensure that the target temperature is achieved throughout the system under all levels of water consumption.

Temperature is used as the means of controlling *Legionella* and other harmful bacteria. The domestic hot water circulating loop shall be designed to give a return temperature to the storage water heater of 55°C, but certainly no less than 50°C. The pipe branches to the individual hot taps shall be of sufficient size to enable the water in each of the hot taps ideally to reach 55°C, but certainly no less than 50°C, within one minute of turning on the tap.

In normal use, the system should be designed to achieve 55°C at the supply to the furthermost draw-off (sentinel) point in the circulating system. The set points for the water heating device should be adjusted to be at or above 60°C to ensure the water system achieves these criteria. Thermometer/immersion pockets shall be fitted on the flow and return to the storage water heating device and in the base of the storage water heater in addition to those required for control.

17.7 In larger domestic storage water heating devices, the fitting of time control shunt pumps (de-stratification pumps) shall be included to overcome temperature stratification of stored water.

Domestic hot water distribution pipes should be insulated with sufficient thermal performance to avoid affecting cold water pipes.

Whether a BEMS is fitted or not – a visible manual means of monitoring domestic hot water system storage, flow and return temperatures must be available at all time.

Cold water systems

17.8 The cold water storage tank should be sited in a cool place and protected from extremes of temperature by thermal insulation. Tanks and piping should be insulated with sufficient thermal performance and kept away from heat sources, hot ducting and other hot pipes to prevent excessive temperature rises in the cold water supply and distribution system.

Access hatches should be provided on cold water tanks for inlet valve maintenance, inspection and cleaning (more than one hatch may be needed on larger tanks). In new installations consideration should be given to locating hatches on the tanks sides to facilitate means of escape in an emergency for those inspecting the interior.

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 water flows through each of the tanks, to avoid stagnation in any one tank.

17.9 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.

17.10 Low-use outlets should be installed upstream of higher use outlets to maintain frequent flow; e.g. a safety shower can be installed upstream of a WC.

Whether a BEMS is fitted or not – a visible manual means of monitoring cold water system supply (at building block inlet or meter point), tank storage, flow (and return where appropriate) temperatures at **no more than 20^{0}C** must be available at all time

Temperature settings and Building Energy Management Systems (BEMS)

17.11 Domestic hot and cold water systems should be temperature monitored by the BEMS performing to SHTM 08-05 to ensure compliance with the temperature standards specified in the relevant regulations and guidance. System parameters must be detailed in the Written Scheme for the water system.

17.12 The minimum BEMS performance monitoring of the water system must be to ensure:

- Domestic Hot Water is continuously monitored and records the parameters highlighted in paragraph 17.6 above and described in detail in SHTM 04-01. i.e. 60^{o}C flow (minimum) from the water heating device to ensure 55°C at the supply to the furthermost draw-off (sentinel) point in the circulating system under normal use and no less than 50^{o}C return (lowest limit) to the water heating device;
- Cold Water is continuously monitored and recorded from the point it enters a building to the parameters highlighted in paragraph17.8 above and described in detail in SHTM 04-01. i.e. no more than 20^{o}C (highest limit);

- failures outwith the parameters are subject to alarms and service response messages;
- performance data requires to be secured and retained for at least 5 years, but must be easily available to the Authorised Person (Water), the other independent professional advisors, assessors and others with an interest in system performance.

Note: The definition of sentinel taps and information on TMV settings can be found in SHTM 04-01 Part A, Appendix 6

Other water systems connected or operating in close proximity

17.13 Designers must ensure there are no other water systems (such as for Fire Suppression, Fire Precautions or Fire Protection) connected or in close proximity to the water system. Reference should be made to the Water Safety Log Book and Written Scheme for the Building Block for information, changes or alterations.

18. Scottish water byelaws 2004

18.1 On 30 August 2004, the Scottish Water Byelaws 2004 replaced the previous Byelaws in governing the prevention of waste, misuse, undue consumption and contamination of public water supplies in domestic and commercial plumbing installations and represent important protection for public health and the environment. The Byelaws are based on performance standards, e.g. British Standards or those European Standards being mandated under the Construction Products Directive.

18.2 The Byelaws are enforced by Scottish Water, and further advice should be sought from them or from their website: www.scottishwater.co.uk

18.3 The Byelaws introduce a new specification to prevent the backflow of water. This brings the UK approach into line with the emerging harmonised European Standard. The system consists of five fluid categories, which reflect the potential toxicity of the downstream fluids. These categories relate to the risk posed to public health should fluids contaminate drinking water. The specification then equates each fluid category to the range of suitable backflow prevention devices. Particular reference should be made to the determination of fluid categories when considering alternative water treatment systems. The addition of a treatment chemical to potable water may result in it changing fluid categories to Category 3, with the resultant backflow prevention being required.

18.4 General issues of design, sizing, layout, construction and commissioning are discussed in BS EN 806-1-5: 2000-2012 and BS8558: 2011 following a transitional period. Material and fittings acceptable for use in the water system are listed in the directory published by the Water Regulations Advisory Scheme (WRAS). Low corrosion materials (copper, plastic, stainless steel etc) should be used where practicable. Non-metallic materials are deemed to be compliant provided they meet with the appropriate British Standard, BS6920: 'Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water'.

18.5 Certain aspects of the system will have to comply with the Building Regulations.

18.6 Water storage tanks should be fitted with covers which comply with Byelaws and insect screens fitted to any pipework open to the atmosphere, e.g. the overflow pipe.

18.7 The Scottish Water Byelaws 2004 introduced a scheme for 'Approved Contractors' (approved plumbers) who are approved to carry out work in compliance with the Water Byelaws. All approved plumbers undertake to work to the terms of the Plumbing Industry Licensing Scheme (PILS). Scottish Water has encouraged all professional plumbers to become members of a Licensing Scheme, showing a commitment to their industry, a willingness to raise quality standards and promote to customers a professional image of the industry. Scottish Water continues to support the "Plumbing Industry Licensing Scheme" (PILS) operated by the Scottish and Northern Ireland Plumbing Employers

Federation (SNIPEF) and recognises members of the Water Industry Approved Plumbers Scheme (WIAPS) operated by the Water Regulations Advisory Service (WRAS).

Note: Organisations seeking advice on the Scottish Water Byelaws should refer to their Licensed Provider (Business Scheme).in the first instance.

19. Risk assessments

Identification and assessment of risk

19.1 A suitable and sufficient assessment following the requirements of BS8580: 2010 Water Quality – Risk assessments for *Legionella* Control – Code of Practice is required to identify and assess the risk of exposure to *Legionella* bacteria from work activities and water systems on NHS Boards premises and any necessary precautionary measures.

19.2 The *Legionella* Risk Assessor shall be appointed as the Risk Assessor, shall be UKAS accredited and complete *Legionella* risk assessments to BS8580 criteria and the written terms of reference. The Risk Assessor will have access to competent assistance to assess the risks of exposure to *Legionella* bacteria in the water systems present in the premises and the required control measures.

19.3 The assessment will include

- identification and evaluation of potential sources of risk and the particular means by which exposure to *Legionella* bacteria is to be prevented, or
- the particular means by which the risk from exposure to *Legionella* bacteria is to be controlled, if prevention is not "reasonably practicable";
- identification of the use of flexible hoses in water supply and distribution systems following Safety Action Notice 886, for elimination of risk. Where flexible hoses are essential components to connect the water system to necessary equipment (or are part of equipment such as in hi-low baths) identification of action measures to test and prevent risk;
- identification of primary heat sources (such as steam systems and fixed temperature heating systems etc) that impact (directly, or indirectly, or seasonally) on the control and management of water systems and the operational criteria;
- a drinking water quality assessment.

19.4 Where the assessment demonstrates that there are no reasonably foreseeable or insignificant risks that are likely to increase, no further assessment or measures are necessary. The assessment needs to be reviewed and any necessary changes implemented should the situation change or whenever there is a reason to believe that the original assessment may no longer be valid.

19.5 The following types of records are kept.

Record	Retention Period
Policy & Procedure Documents.	Throughout the period for which they remain current and for at least two further years.
Risk Assessments.	
Risk minimisation scheme & details of its improvement.	
Monitoring, inspection, test & check results, including details of the state of operation of systems.	At least five years.

Record Retention Period

20. Training

20.1 ***NHS Board*** staff appointed to carry out the control measures and strategies shall be suitably informed, instructed & trained and their suitability assessed. Staff shall be trained to a standard, which ensures that tasks are carried out in a safe, technically competent manner.

20.2 The Authorising Engineer (Water) shall conduct a regular annual assessment review of competency and training requirements and shall make Training Programme recommendations to the Responsible Person (Water) for approved courses run by approved training organisations and where appropriate by the manufacturers of equipment.

20.3 The Authorised Person (Water) shall conduct and record induction and familiarisation with any new Competent Persons, Maintenance Technicians, Tradespersons, Installers, Contractors and Contract Supervising Officers being introduced to water systems. The Authorised Person shall also conduct a regular annual review of system familiarisation, operational maintenance, monitoring issues.

20.4 Recommendations shall be reported to the Responsible Person (Water).

20.5 Training will be appropriate to the post holders' duties, covering the following:

- Water Safety Policy, Procedures and the Written Scheme;
- SHTM 03-01 'Ventilation for healthcare premises';
- SHTM 04-01 'Water safety for healthcare premises';
- HSE Approved Code of Practice L8 – legislation and its part successor HSG 274;
- *Legionellosis* and other water safety risks – responsibilities;
- prevention or controlling the risk from exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria;
- hot & cold water systems;
- ventilation systems;
- water treatment;
- maintenance procedures;
- action in the event of a case of outbreak of Legionnaires' disease.

20.6 The training will be presented in the following formats

- annual 'In-house' awareness training;
- induction training;
- toolbox talks;

- training (update and refresher on changes).

20.7 Regular refresher training shall be given and records of all initial and refresher training and competency assessments provided to and received by all ***NHS Board*** personnel involved in water systems will be recorded in the individual's personal training file and the national NHS eKSF system.

20.8 ***NHS Board*** staff engaged in work which may have a direct or indirect effect on the control of *Legionella*, shall have adequate information, instruction & training to ensure that the Code of Practice and Written Scheme is applied at all times, and so ensure that ***NHS Board*** systems are not compromised.

21. Performance monitoring

21.1 The relevant Authorised Person (Water) will gather and maintain all the relevant information and records, including relevant *Legionella* Risk Assessments and Written Schemes.

21.2 Working with the Authorising Engineer (Water) and Responsible Person (Water), the relevant Authorised Person (Water) will review and analyse all records for compliance with *Legionella* and other water safety parameters.

21.3 The relevant Authorised Person (Water) will detail on these records any deviations from the *Legionella* and other water safety parameters giving a brief description as to the reason for this deviation.

21.4 The relevant Authorised Person (Water) will file locally all relevant information and maintain hard copy records in the Water Safety Log Book.

22. Audit / management review

Internal audit procedure

22.1 This procedure will be audited at agreed intervals.

22.2 Prepare an Audit Programme and ensure the entire procedure is audited.

22.3 The Audit Programme will consist of planned audits on the following elements of the procedure:

- this Procedure document;
- documentation associated with this Procedure;
- training review and records;
- risk Assessments;
- Written Schemes;
- schematic drawings;
- Water Safety Log Book(s).

22.4 A report will be produced on the audit.

External audit procedure

22.5 A duly appointed Authorising Engineer (Water) will audit the entire *Legionella* and Water Safety Systems within ***NHS Board*** annually.

22.6 A duly appointed Authorising Engineer for *Legionella* and Water Safety Systems will produce an annual report for management review.

22.7 A duly appointed *Legionella* Risk Assessor for *Legionella* and Water Safety Systems will update the *Legionella* risk assessment database annually, as appropriate.

Management review

22.8 The Responsible Person (Water) will hold regular review meetings to confirm:

- current compliance with *Legionella* and Water Safety System requirements;
- identification of any deficiencies and actions required to resolve;
- staff training needs.

22.9 The management review will be based on following:

- results of internal audits;
- results of external audits;

- staff suggestions;
- training records;
- operation of the system and procedures over the last six months.

23. The course of action for suspected Nosocomial Legionnaires' disease

Suspected or confirmed incident or outbreak

23.1 *NHS Board* will follow the guidance presented in the following regulatory and mandatory guidance documents:

- HSE ACOP L8 "The control of *Legionella* bacteria in water systems", see Appendix 2;
- SHTM 04-01 "Water safety for healthcare premises", Part B, Appendix 1;
- HPN2, "Guideline on management of *Legionella* incidents, outbreaks and clusters in the community";
- The *NHS Board* "Outbreak Plan".

Legionellosis is an atypical and potentially life-threatening form of pneumonia (Legionnaires' Disease). The majority of cases are isolated although outbreaks can occur (including large community outbreaks and hospital outbreaks).

In the event of a nosocomial case(s) of Legionnaires' disease ***NHS Board*** will follow the Health Protection Network's (HPN) – *'Guideline on Management of Legionella, Incidents, Outbreaks and Clusters in the Community'* (2009), SHTM 04-01 and *NHS Board's* Outbreak Plan.

23.2 An outbreak is defined in HSE ACOP L8 by the Public Health Laboratory Service (PHLS) as two or more confirmed cases of *Legionellosi*s occurring in the same locality within a six month period. However:

- HPN2 sets out and defines:

Incident	A (first) single case – presumptive or confirmed- where based on the evidence there are concerns about actual or suspected threats to the safety or quality of water systems that could require intervention to protect the public's interest.
Sporadic case	A single case not associated with any other case. No other case may be linked to probable source of exposure in last 2 years.
Outbreak	Two or more cases in the same locality for which there is strong epidemiological evidence of a common source of infection, with or without microbiological evidence, occurring within a 6 month period of the onset of illness from the first case confirmed.

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Linked case	Two or more cases associated with a single source with dates of onset more than 6 months apart but less than 2 years apart.
Probable Nosocomial	Legionnaires' disease in a person who was in hospital for between one and nine of the ten days before the onset of symptoms and either became ill in a hospital associated with one or more previous cases of Legionnaires' disease or yielded an isolate that was indistinguishable (by monoclonal antibody subgrouping [mAB] or by molecular typing methods) from isolates obtained from the hospital water system at about the same time.
Possible Nosocomial	Legionnaires' disease in a person who was in hospital for between one and nine of the ten days before the onset of illness in a hospital not previously known to be associated with any case of Legionnaires' disease and where no microbiological link has been established between the infection and the hospital.

- The ***NHS Board*** "Outbreak Plan" defines an outbreak and incident as:
  - "An outbreak is defined either as two or more linked cases of the same illness or when the observed number of cases exceeds the number expected;
  - An incident is defined as a case of communicable disease that has actual or potential serious implications for the public's health e.g. VHF or measles in a health care setting. An Incident Management Team (IMT) should be established using the approach described in this plan."

Actions

23.2 A nosocomial case(s) of Legionnaires' disease (definite/probable/possible) should be investigated immediately.

23.3 An Incident Management Team (IMT) or an Outbreak Control Team (OCT) will be convened for a single case or an outbreak of nosocomial Legionnaires' disease respectively;

The IMT/OCT will be convened by the Consultant in Public Health Medicine (CPHM) with responsibility for Health Protection (or the duty CPHM). The CPHM will lead and co-ordinate the investigation and control of the incident/outbreak in close collaboration with the Infection Prevention and Control Doctor. Further information on the roles and responsibilities of the different members of the IMT/OCT can be found in ***NHS Board's*** Outbreak Plan;

In the event of a case(s) of nosocomial Legionnaires' disease the following people/groups will be members of IMT/OCT and will be briefed by the CPHM:

- Consultant in Public Health Medicine (IMT/OCT Chair);
- Consultant Physician (involved with care of case);
- Consultant Medical Microbiologist/Infection Prevention and Control Doctor;
- Infection Prevention and Control Nurse;
- Health Protection Nurse Specialist;

- Facilities & Estates Department ;
- Environmental Health Officer;
- Health & Safety Executive;
- Health Protection Scotland;
- Reference Laboratory;
- Corporate Communications (***NHS Board***);
- Other members from partner agencies as decided by IMT/OCT Chair.

Guidance on the general response to a case(s) of nosocomial Legionnaires' disease can be found in the HPN Guidance, Section 3.1.1.2 and ***NHS Board's*** Outbreak Plan.

23.5 See Table 1 for the contacts to be used in the event of a confirmed or suspected incident:

***Legionella* Role**	**Name**	**Title**	**Phone**
Designated Person (Water)	See table 1		
Responsible Person (Water)	See table 1		
Responsible Person, Defined	See table 1		
Advisor Responsible Person, Defined	See table 1		
Infection Control	See table 1		
***Legionella* Role**	**Name**	**Title**	**Phone**
Laboratory Services	See table 1		
Authorising Engineer	See table 1		
Wastes & Water Services Manager – Water Specialist Advisor	See table 1		
Public Health	See table 1		
HSE	See table 1		
Health Protection Scotland	Duty Epidemiologist advised by Public Health		
Reference Laboratory Microbiologist	Duty Microbiologist advised by Public Health		

23.6 When it is unclear whether there is a threat to public health the CPHM may choose to convene a Problem Assessment Group (PAG) in order to undertake an initial assessment of the problem and determine if an IMT is required. Further information on the role of the PAG can be found in the Scottish Government guidance on the *Management of Public Health Incidents: Guidance on the Roles and Responsibilities of NHS led Incident Management Team: October 2011*.

23.7 The general response to an incident or outbreak may include:

- investigation of all potential sources of *Legionella* infection. This shall include checking recent maintenance work and project work that may have been carried out on water or air handling systems;
- identifying the location of any medical equipment used for dental care, respiratory therapy and within Haemodialysis units;

- identifying off-site information such as excavation or earth moving works, alterations to water supply and drainage;
- shutting down any processes which are capable of generating and disseminating airborne water droplets and keeping them shut down until sampling procedures and any remedial cleaning or other work has been done. Final clearance to restart the system may be required;
- taking water samples from the system before any emergency disinfection being undertaken. This will help the investigation of the cause of the illness. The investigating officers from the local authority may take samples or require them to be taken;
- co-operating fully in an investigation of any plant that may be suspected of being involved in the cause of the outbreak. This may involve, for example:
  - tracing of all pipework runs;
  - detailed scrutiny of all operational records;
  - statements from plant operatives and managers;
  - statements from water treatment contractors or consultants;
- any emergency cleaning and disinfection will be undertaken in accordance with ***NHS Board*** procedures;
- the Designated Person (Water) shall brief relevant Estates staff so that they are aware of the event and can respond to phone calls etc as instructed. The briefing shall include instructions that any comments to outside parties are agreed by Infection Prevention and Control;
- records shall be kept of all relevant information, including that provided by other departments.

General microbiological and Legionella sampling in hot & cold water systems

23.8 Circumstances under which samples are taken:

- prior alterations to an existing water system;
- as part of commissioning process, prior to handover of a new building or introduction of a (altered, refurbished or new) water system into use;
- one week following handover of a new building or new water system;
- as part of the tank cleaning and disinfection process;
- as part of an assessment programme;
- in response to taste, odour or sustained discoloured water complaints.

SHTM 04-01 Section C details Total Viable Counts (TVC) and *Legionella* water quality testing requirements (to BS EN ISO 5667-1, BS6068 and ISO 11731) to identify sampling for the following harmful bacteria:

Coliforms	*Legionella*
Escherichia coli	*Salmonella*
Pseudomonas aeruginosa	*Campylobacter*
Aerobic Colony Counts	*E.coli O157*
Environmental Mycobacteria	*Staphylococcus aureus*
The following may also be identified:	
Cryptosporidium	*Klebsiella*
Clostridia	*Enterococci*

There are also a variety of other organisms that can behave in a similar way to that of *Pseudomonas aeruginosa* that may also be identified. These organisms are less pathogenic and less frequently isolated than *Pseudomonas aeruginosa:*

Burkholderia cepacia	*Ralsotonia picketti*
Chrysebacterium spp	*Serratia marsecens*
Stenotrophomonas maltophilia	*Acinetobacter spp*
Sphingomonas spp	*Enterobacter spp*

The Consultant Microbiologist will provide interpretation on the isolation of particular bacteria, the results and confirm any necessary actions.

23.9 When such samples are taken, a mains supply sample should be taken as a control to verify whether the supply could be the source of the identified problems. Scottish Water should also be contacted for distribution zone water quality data.

23.10 Samples for *Legionella* testing may be taken:

- monthly from hot water systems treated with biocides where storage and distribution temperatures are reduced from those recommended in the HSE ACOP L8 / HSG 274. At the time of preparation of this procedure, there are no such testing regimes within ***NHS Board***;
- weekly from hot and cold water systems where control levels of the treatment regime, i.e. temperatures, are not consistently achieved – these samples should be taken until the system is brought back under control;
- when an outbreak is suspected or has been identified;
- regularly where a department specialises in services for “high risk” patients.

Note: Samples taken for *Legionella* must follow SHTM 04-01 in a 1 litre container as described, available from the Microbiology Laboratory.

23.11 Laboratory Compliance: Samples of *Legionella* should be tested by a UKAS accredited laboratory for the isolation of *Legionella* from water.

23.12 The Sampling and Leachate Testing to be undertaken is detailed in SHTM 04-01 Part E.

23.13 The TVC and *Legionella* Sampling and Test Protocol are detailed in SHTM 04-01 Part C. As described, sampling must follow that set out in BS7592: 2008 Code of Practice and BS EN ISO 5667-1: 2008 on Water Quality Sampling. Those organising sampling must make clear in advance which water quality technique is to be undertaken in order that systematic conclusion on risk can be drawn.

For initial water system sampling take a Post-Flush sample (as defined in BS 7592: 2008) at sentinel points without disinfection. Where there is an initial concern with a particular outlet location – say, a combined system and outlet problem – a BS Pre-Flush sample should be taken. If concerns persist with an outlet location (typically, a known dead-leg issue or lack of, or low, water use, a further BS Pre-Flush sample should be taken followed by disinfection before a BS Post-Flush with disinfection sample. Water should be allowed to run hot for 1 minute and cold for 2 minutes by which sampling would be temperature calibrated.

Where water quality sampling in a water system confirms (acceptable) *Legionella* results less than 100 CFUs/Litre – the Authorised Person (Water) would be informed and provided with copies of the samples in writing and record keeping. The Authorised Person (Water) would provide interpretation (with the Consultant Microbiologist when and where required) on the results and confirm if any actions are required.

Where water quality sampling in a water system confirmed *Legionella* results in excess of 100, but less than 1,000 CFUs/Litre – the Authorised Person (Water) and Consultant Microbiologist must be informed and provided with copies of the samples in writing. The Consultant Microbiologist would provide interpretation on the results and confirm the necessary actions prior to bringing the water system into use.

Where water quality sampling in a water system confirmed *Legionella* results in excess of 1,000 CFUs/Litre **immediate action must be taken** and the Consultant Microbiologist and Authorised Person (Water) must be informed and provided with copies of the samples in writing. They will immediately confirm the necessary actions prior to re-sampling and bringing the water system into use when (acceptable) *Legionella* results are reliably less than 100 CFUs/Litre.

Where continued water system sampling is required, this would be undertaken on a weekly frequency.

Where the results of 3 consecutive weekly water system samples remained below 100 CFUs/Litre, the Authorised Person (Water) and Consultant Microbiologist would be informed and sampling would revert to a monthly sampling frequency.

Where the results of 3 consecutive monthly Water System samples remained below 100 CFUs/Litre, the Authorised Person (Water) and Consultant Microbiologist would be informed and sampling would revert to a 3 monthly sampling frequency.

Appendix A: Understanding "*the Written Scheme**"

Extract replicated courtesy HSE - ACOP & GUIDANCE L8

"Preventing or controlling the risk from exposure to Legionella bacteria (Regulations Control of Substances Hazardous to Health Regulations 2002, Regulation 7 and 9 Health and Safety at Work etc. Act 1974, Sections 2, 3 and 4**)**

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

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

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

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

- controlling the release of water spray;
- avoidance of water temperatures and conditions that favour the proliferation of *Legionella* bacteria and other micro-organisms;
- avoidance of water stagnation;
- avoidance of the use of materials that harbour bacteria and other micro-organisms, or provide nutrients for microbial growth;
- maintenance of the cleanliness of the system and the water in it;
- use of water treatment techniques; and
- action to ensure the correct and safe operation and maintenance of the water system.

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

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

57 “In general, proliferation of *Legionella* bacteria may be prevented by:

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

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

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

- cleaning and disinfection procedures.

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

- commissioning and re-commissioning procedures;
- shutdown procedures;
- checks of warning systems and diagnostic systems in case of the system malfunctions;
- maintenance requirements and frequencies; and
- operating cycles - including when the system plant is in use or idle.

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

Review of control measures - monitoring and routine inspection

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

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

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

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

> **Note:** Although there are no cooling towers in use in the NHS Scotland, *NHS Boards* require to be alert to where there may be cooling towers operating in the local proximity.

64 “The routine monitoring of general bacterial numbers (total viable count) is also appropriate as an indication of whether microbiological control is being achieved. This is generally only carried out for cooling towers, rather than hot and cold water systems. Periodic sampling and testing for the presence of *Legionella* bacteria may also be relevant to show that adequate control is being

achieved. However, reliably detecting the presence of *Legionella* bacteria is technically difficult and requires specialist laboratory facilities. The interpretation of results is also difficult; a negative result is no guarantee that *Legionella* bacteria are not present. Conversely, a positive result may not indicate a failure of controls as *Legionella* are present in almost all natural water sources. Further guidance on bacteriological monitoring and interpretation of test results can be found in ACOP Part 2.

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

Appendix B: "*the Written Scheme*" template document

Water Safety – Facilities & Estates Sector

Note: Although the following pages set out a typical Written Scheme, it is stressed that account will require to be taken of issues that will not necessarily apply to all NHS facilities that could be influenced by configuration of accommodation (particularly plant spaces), varying NHS Board policies, type, age and complexity of accommodation.

The following pages detail *the Written Scheme** for controlling the risks of exposure to *Legionella* and other harmful bacteria at

Location: xxx

Building Block: Block zz, (xx Block)

System(s): Water System

Authorised Person (Water): xxx

Valid from:

Note 1: No work will be carried out on the water system without the knowledge and written consent of the Authorised Person (Water).

Note 2: The Written Scheme document is to be read in conjunction with the Operational Procedures for the Written Schemes document and should also be read in conjunction with the Control of Water Records document. For any alterations to the Water System this Written Scheme Document is to be read in conjunction with the Guidance for alterations to water systems document.

NHS Board____

Facilities & Estates Sector

The Written Scheme

Controlling the risk of exposure to *Legionella* and other harmful bacteria.

	Contents
1	Strategy for the correct and safe operation of the Water System……….……...
2	System Description……………………………………………….……………………
3	Drawings and Schedules of Plant / Equipment…..…………………………………
4	Risk Assessment and Annual Review .
5	System Monitoring / Information
6	Contractors
7	Temporary Closures
8	Risk Control Notices
9	Documentation and Records……………………………………………………..
10	Outbreaks – Actions…………………………………………………..………..
11	Operational Restrictions…………………………………………………………….
12	Alterations to Water Systems……………………………………………………….

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Strategy for the correct and safe operation of the water system

1. Safe management criteria

1.1 The Head of Maintenance (or appointed deputy) is the "Responsible Person (Water)" who is appointed in writing to manage the day–to–day risks of exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria and will be the estates lead in the event of an operational incident.

1.2 This water system is within the knowledge and control of an "Authorised Person (Water)" who is appointed in writing and has authority, competence, knowledge and control of the identified water system to ensure that all operational procedures and SHTM 04-01 requirements are carried out in a timely and effective manner to documented timescales. This strategy will involve "Competent Persons", "Maintenance Technicians", "Tradespersons", "Installers", "Contractors" and "Contract Supervising Officers" co-ordinated with Duty Holders in accordance with SHTM and HSE guidance.

2. Safe operational criteria

2.1 Water used in the Block will be controlled by means of the Temperature Control Regime (as outlined in HSE ACOP L8 / HSG 274) with full temperature control as advocated in SHTM 04-01 to temperatures in the various parts of the water system as follows:

Note: Water **will not** be stored or circulated at temperatures in the range – above 20°C or below 50°C

- Cold Water (CW) shall be stored or distributed to outlets at or below 20°C.
- Domestic Hot Water (DHW) shall be at or above 60°C (at the flow point from heat exchangers/vessels) as it enters the supply system and shall be circulated at no less than 50°C (at the return point to heat exchangers).
- Domestic Hot Water supplied to Thermostatic Mixing Valves (TMV) or other outlets shall be at no less than 55°C.
- Cold Water supplied to Thermostatic Mixing Valves (TMV) or other outlets shall be at or below 20°C.

Special attention and escalation in writing to the relevant Authorised Person (Water) and Responsible Person (Water) is required where and when any of these criteria cannot be met.

Remember that hot water (and hot surfaces) above 45°C presents a scalding (or burning) risk.

2.2 Point-of-Use Filters (P.O.U Filters) will only be installed and used where this is practical and there has been a written policy decision by the Water Safety

Group, along with a complimentary managed maintenance change filter process. This will be have to put in place for life – or until a further policy decision by the Water Safety Group are satisfied that the affected outlet and pipework has been removed or disinfected without compromising the rest of the water system.

2.3 Taps or other water outlets should **not** be installed if they will not be used regularly, that is, less than twice in a week.

2.4 Where taps or water outlets are not, or are unlikely to be, in regular daily use, Duty Holders have been alerted and reminded to flush these through and purge to drain, or purge to drain immediately before use, without release of aerosols. In Neonatal Units (NNUs), Adult and Paediatric Intensive Care Units (ICUs) infrequently used taps should be flushed daily at the start of each day. The Maintenance Department and Designers have responsibilities to be alert on Duty Holder requirements in Risk Control Notice 11/04 – and the record keeping on Sample Record Sheet) *or take steps to have the outlet removed* and the resultant dead-legs eliminated by taking out redundant branch pipework back to the circulating mains, removing the tee-piece and replacing with a straight coupling. The Instruction and Actions to Duty Holder's is detailed in Section 8 below.

2.5 Management Team Duty Holders have also been alerted on awareness and actions to minimise the risk of *Pseudomonas* Spp and other similar harmful bacteria in the use of equipment, transmission routes and requirements (such as in the use of hand wash stations and wash basins) in Risk Control Notice 12/04.

3. System description

XXXX, Block xx

3.1 The mains cold water supply which serves Block xx is fed directly from xxx and is located at the xxx end of the site at the corner of xxxx.

3.2 The point of entry is fed directly from the Scottish Water "xxx Pressure Line".

3.3 Scottish Water have introduced** Chloramine as the water treatment/disinfecting agent to the incoming water supply. As advised in writing by Scottish Water at introduction in 2004, *NHS Board* are not required to carry out any secondary water treatment of the reservoir supply feeding the site.

** Only incorporate paragraph 3.3 if applicable to the site.

3.4 A xxmm water supply makes its way underground into the basement area within the xxxx Blocks.

Domestic cold water system

3.5 A xxmm Mains Cold Water (MCW) supply rises from basement level through a pipe duct and feeds the LPHW Heating System and Block xx Cold Water Storage Tank. A xxmm MCW supply branches off before the tank and feeds down through the Block serving the following areas

- Ward xx;
- Ward xx;
- Ward xx.

3.6 The Cold Water Storage Tank has a capacity of approximately xx litres and serves the following:

- xxmm Cold Feed supply to the Domestic Hot Water Plate Heat Exchangers located in Plant Room xx (xx Block);
- xxmm Cold Downwater Service to Wards xx;
- A Cold Water Down Service serving the Block xx area is fed via a xxmm supply, water is drawn from the tank via the automated water booster pump set which is located within the roof plant room. This supplies cold water to all showers, washbasins, baths and WCs as per the reference drawings;
- Cold Feed to the Domestic Hot Water storage calorifiers is fed via a xxmm supply. Water is drawn from the tank via the automated water booster pump set located within the roof plant room. The xxmm cold feed runs within the DHW calorifier plant room at high level, the cold feed serving DHW calorifier No 1 (xx) drops and enters the lower section of the DHW calorifier. Prior to entering the DHW calorifier a xxmm branch goes to the system pressurisation vessel which serves DHWC No 1. The xxmm cold feed continues on to serve DHW calorifier No.2 (xx) in a similar manner.

Domestic hot water system

3.7 A xxmm Hot Water supply from each of the domestic hot water calorifiers, branches into a xxxmm Hot Water supply pipe at high level within the plant room. This pipe is routed around the xx Block dropping within the pipe duct, branching off at ceiling void level, feeding fitments *en route* and returning within the pipe duct to the DHW Calorifiers. Circulation is achieved by means of a single circulating pump located within the roof plant room.

Other water systems connected or operating in close proximity

3.8 There are no other water systems (such as for Fire Suppression, Fire Precautions or Fire Protection) connected or in close proximity. Regular reference should be made to the Water Safety Log Book for the Building Block for any changes or alterations.

Other water safety features

3.9 There are no Point-of-Use (P.O.U.) Filters fitted in the water system.

Details of any future policy decisions to fit, operate and maintain or remove Point of Use Filters to/from specific points in the system in specific locations to be held in the Water Safety Log Book.

4. Drawings, water safety log book and schedules of plant/equipment

- Schematic and detailed drawings of the main systems are kept within the Maintenance Section, Estates Department Offices, xxx.
- CAD Drawings, Schematic and detailed drawings of the system are also available at the Estates Department, xxxx, and viewable electronically > Shared on Yaren > *Legionella* > Site Drawings.
- Plans are to be kept up to date to include any alterations made to the water system. Notify xxx on tel 01xxx of any changes to be made to schematics or detailed drawings.
- All drawings of water distribution for xxx Block xx (xxx Block) are referenced with the Drawing Reference Number - Nxxx – Ox
- Each Building Block has a Water Safety Log Book held by the Competent Person (Water) Site Supervisor, located in the Estates Department Offices at xxxx containing details of the specific local water system(s).
- The Property Asset register reference number is as detailed per ***NHS Board*** Planet System. The Planet System produces Works Dockets for precautionary checks and maintenance routines for the water system.

5. Risk assessment and annual review

5.1 A current *Legionella* Risk Assessment by Water Hygiene Centre for the site is in place. Reference Number xxx.

By complying with the provisions of HSE ACOP L8 / HSG 274 and SHTM 04-01 the level of risk will be minimised. Any system modifications will be designed in accordance with the above standards and recorded.

The *Legionella* Risk Assessments are reviewed every two years or earlier when any changes are made to the operation or configuration of the system.

6. System monitoring / information

Water treatment

6.1 Primary water treatment is by Scottish Water (Chloramination/chlorination*).

* Delete as required

Sampling

6.2 Sampling will be carried out following SHTM 04-01Part B. Protocols for general microbiological and *Legionella* sampling in hot and cold water systems are detailed in the Operational Procedures for the Written Scheme Document Section 22 (22.7 – 22.12).

Temperature controls and checks

6.3 Water used in the Block will be controlled to the Temperature Control Regime (as outlined in HSE ACOP L8 / HSG 274) with full temperature control with a minimum flow temperature of 60°C from heat exchangers/vessels as advocated in SHTM 04-01. Water **will not** be stored or circulated at temperatures in the range above 20°C or below 50°C.

Regular temperature and maintenance checks on cold water tanks and hot and cold water distribution systems are carried out in accordance with operational procedures and with the detailed instructions on Planet Works Dockets, current guidance and the values logged in the Water Safety Log Book.

Daily - Temperature monitoring

6.4 This shall be carried out in accordance with the following:

Procedure	Description
P1C1 (with ALL incidents logged on Form 004 and BEMS alarms incidents on 021)	Incidents and Faults; BEMS monitoring & log of all alarms

Temperature is monitored by BEMS - to procedure P1C1

6.5 This system continually monitors the temperature of the following points

- BEMS Outstation No xxx
- Common Flow Temp Point No xx
- Common Return Temp Point No xx
- No 1 DHW Calorifier (xx) Flow Temp, Point No xx
- No 1 DHW Calorifier (xx) Return Temp, Point No xx
- No 2 DHW Calorifier (xx) Flow Temp, Point No xx
- No 2 DHW Calorifier (xx) Return Temp, Point No xx

6.6 The BEMS monitoring and control devices are set to give high priority alarms in the event of system failure and/or temperature variances outwith alarm set points. Temperature monitoring devices are physically tested annually and recalibrated in accordance with manufacturers' instructions.

System failures and/or temperature alarms are continually monitored 24 hours a day, with alarms being generated at Estate locations and by remote paging of Estates staff (i.e.controls engineer or duty engineer etc).

The Estates person carrying out the monitoring or being notified of an alarm condition is required to log all incidents in the Water Incident Report Record Form (004) and also where appropriate in the BEMS Water System Alarm/Fault Record Form (021).

All incidents require to be investigated by the Estates staff and appropriate actions implemented (see Water Safety Operational Procedures, SHTM 04-01 & *Legionella* ACOP L8 / HSG 274) Incidents are to be recorded in the Incident Report Record Form (004).

Temperature monitoring in the event where the BEMS is not operative

6.7 This shall be carried out in accordance with the following

Procedure	Description
P1C1A (logged on Form 005A)	Manual monitoring or where BEMS not installed or BEMS not operational

Check the flow and return temperatures on the domestic hot water calorifier system as defined in the local system plan, using the temperature gauges fitted or a suitable surface temperature probe.

The flow temperature to be at least 60°C and the return temperature has to be at least 50°C.

Record all temperatures on the Water Temperature Record Form (005A) DHW – daily; CW 6 monthly.

Inspect cold water tank and conduct temperature checks – P1C7 and record all inspection and temperatures on the Record Form (003).

Weekly – Water quality

6.8 The following procedures shall be carried out where chloramination treatment is provided by the water authority

Procedure	Description
P1C2 (logged on Form 027)	Chloramine checks (initially weekly)

Sampling results of *NHS Board* water systems shall be recorded in the Estates Chloramine Record Form (027). Sampling will be taken from a hot or cold water outlet point, representative of each secondary distribution pipework system. These will initially be conducted weekly and then subject to ongoing trend based frequency risk assessment, limited to no less than at once per month sampling test frequency. Frequency risk assessments to be held in the Water Safety Log Book.

Weekly – Manual change-over of DHW circulating pumps

6.9 Where applicable, the following procedures shall apply

Procedure	Description
P1C3 (logged on Form 028)	Manual change over and log of circulating pumps not on BEMS control

Not applicable on this system. The BEMS controls and logs the change-over of circulating pumps.

System failures and/or temperature alarms are continually monitored, with alarms being generated at Estate locations and by remote paging of Estates staff (i.e.controls engineer or duty engineer etc).

Monthly (and Annual) – Temperature monitoring

6.10 The extent of temperature monitoring is set out below

Procedure	Description
P1C4 (monthly logged on Form 005) P1C10 (annual logged on Form 005)	a) Sentinel hot water taps b) Sentinel cold water taps c) Sentinel TMV taps d) DHW calorifier/heat exchanger flow & return temperatures e) Chilled Water heat exchanger flow & return temperatures

6.11 Sentinel Hot and Cold Water Outlets in the water system are located

- 4th Floor, Ward xx;
- 3rd Floor, Ward xx;
- 2nd Floor, Ward xx;
- 1st Floor, Ward xx.

Sentinel hot and cold taps

6.12 Sentinel taps for hot water services (and any recirculating cold water systems) **are the first and last taps on a recirculating system**. For non-recirculating cold water systems (or non-circulating hot water systems) they would comprise the nearest and furthest taps from the storage tank.

Note: The choice of further sentinel taps may also include other taps that are considered to represent a particular risk. In normal use the system should achieve 55°C at the supply to the furthermost draw-off point in the circulating system.

6.13 Check the temperatures at the sentinel taps as defined

- using a calibrated temperature probe, check the temperature of water from the cold water tap does not rise above 20°C after running the tap for 2 minutes;
- using a calibrated temperature probe, check the temperature of water from the hot water tap does not fall below 50°C whilst running the tap for 1 minute;
- record all temperatures on Water Temperature Record Form (005).

Sentinel Thermostatic Mixing Valves (TMV)

6.14 Sentinel Thermostatic Mixing Valves (TMV) in the water system are located

- 4th Floor, Ward xx;
- 3rd Floor, Ward xx;
- 2nd Floor, Ward xx;
- 1st Floor, Ward xx.

Note: In normal use the system should achieve 55°C at the supply to the furthermost draw-off point in the circulating system.

6.15 Check the temperatures at the TMVs on a sentinel basis as defined

- using a calibrated temperature surface probe check that the temperature of water in the hot water pipework to the TMV does not fall below 50°C whilst running the tap for 1 minute;
- record all temperatures on Water Temperature Record Form (005).

Domestic hot water calorifier(s) and plate heat exchanger(s)

6.16 Check the flow and return temperatures on the domestic hot water system, using the temperature gauges fitted or a suitable surface temperature probe.

Note: The flow temperature to be at least 60ºC and the return temperature to be no less than 50ºC.

Record all temperatures on the Water Temperature Record Form (005).

Domestic cold / chilled water heat exchanger(s)

6.17 Not normally applicable.

Monthly – Air handling plant

6.18 *Complete the following where applicable:*

Procedure	Description
P1C5 (logged on Form 022)	Inspect, clean & log glass traps

Three-monthly – DHW Calorifier, DHW & CW storage/ buffer vessel flushing

6.19 The following procedures should be carried out:

Procedure	Description
P1C6 (logged on Form 006)	Flushing of DHW calorifier(s) and Storage/Buffer Vessel(s) associated with Hot /Cold/Chilled Water Heat Exchanger(s)

- flush each domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel through its drain valve by opening the drain valve 3 times, each time for a 3 minute period. The hose from the drain valve should be discharged to the nearest drain;

- record all actions on the top section of Record Form (006);
- where the domestic hot water system has a stratification pump(s) fitted to circulate the hot water from the top to the base of the calorifier or the storage/buffer vessel, and the history data shows no sludge deposits during flushing, then this procedure should be risk assessed to determine if the maintenance frequency can be changed. This assessment should be recorded on Form 023 as below.

Frequency risk based assessment

6.20 Systems that continually conform to and have a database history of temperature readings within the control parameters should have a risk-based assessment carried out annually to determine if the maintenance frequency can be changed. This assessment should be recorded on Form 023 by the Authorised Person (Water) ensuring that the Responsible Person (Water) is notified immediately in writing. Frequency risk assessments are to be held in the Water Safety Log Book.

Three-monthly for high risk areas and as required elsewhere, but at least once annually - Shower heads and hoses

6.21 The following procedures shall be carried out

Procedure	Description
P1C12 (logged on Form 005B)	Dismantle, clean and de-scale / or replace with new disinfected Shower Head and Hose

6.22 Showers in the water system are located

- 4th Floor, Ward xx;
- 3rd Floor, Ward xx;
- 2nd Floor, Ward xx;
- 1st Floor, Ward xx.

6.23 Planned Shower Head and Hose Replacement Programme shall be conducted 3-Monthly in identified High-Risk Areas and as required elsewhere, but undertaken at least once per Annum.

- remove the shower head and hose assembly. Place shower head and hose assembly into a plastic bag and seal;
- check that the new clean disinfected head and hose package is intact;
- open replacement new clean disinfected shower head and hose assembly sealed packaging, remove and fit following the manufacturer's instructions;
- run water and flush for 3 minutes in accordance with *Legionella* Risk

Assessment in such a way as to avoid the creation of aerosols;

- check and record final temperature for compliance and return shower appliance to use;
- return redundant sealed bag with shower head and hose assembly to workshop for disposal in accordance with Waste Procedures;
- record all actions on the Record Form (005B).

Six-monthly cold water summer / Winter temperature monitoring

6.24 These procedures shall be carried out as follows

Procedure	Description
P1C7 (logged on Form 003)	a) Cold Water at inlet to building block. Also to be continuously monitored by BEMS & log of all alarms
P1C7 (logged on Form 003)	a) Tank and temperature checks & log b) Tank inspection

- complete the Summer / Winter Inspection of water tank as per Record Form (003);
- where the system has no BEMS temperature sensors connected, the readings should be taken using a temperature sensor. The tank temperature should be below 20°C;
- record all inspection and temperatures including the mains water supply at the building/block inlet on the Record Form (003).

Six-monthly air handling plant

6.25 Where applicable these procedures shall be carried out as follows

Procedure	Description
P1C8 (logged on Form 007)	a) Humidity section inspection b) Cooling section inspection c) Disinfection

Annual - DHW Calorifiers, DHW & CW storage/ buffer vessels

6.26 The following procedures shall be carried out

Procedure	Description
P1C9 (logged on Form 006)	Drain & cleaning of DHW Calorifier(s) and Storage/Buffer Vessel(s) associated with Hot /Cold/Chilled Water Heat Exchanger(s)

- follow the manufacturers' maintenance instructions (in the Water Safety Log Book). Record all actions where applicable on the lower section of "Calorifier and Storage/Buffer Vessel Maintenance Record Form" (006) for each system;

- isolate domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel service valves;
- heat up any domestic hot water calorifier or hot water storage/buffer vessel until the contents have reached 60°C and hold at this temperature for a period of at least 1 hour;
- drain domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel and remove inspection hatch;
- hose out the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel to remove any debris, scale or other deposit. Care should be taken to keep aerosols to a minimum;
- if the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel does not have an inspection hatch, the pipework at the top of the vessel should be disconnected to allow the insertion of a water hose to allow debris to be washed down off internal surfaces;
- examine the internal and external condition of the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel and pipework. Any defects should be reported in writing to the relevant Authorised Person (Water). The safety valve should be checked, overhauled and reset as necessary. The temperature, altitude and pressure gauges to be checked for operation;
- on completion of examination and any repairs, the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel should be re-constructed;
- on completion of the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel assembly, the following sequence must be undertaken;
- refill with cold water;
- drain the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel;
- refill with cold water, leave cold feed valve open;
- run domestic hot water calorifier or hot water storage/buffer vessel at a temperature of 60°C for at least 1 hour. Test the operation of high-limit cut out system if fitted. Check the temperature of the calorifier/vessel top and bottom with a surface thermometer;
- adjust any controls as necessary;
- take bacteriological samples from the domestic hot water calorifier or hot, cold or chilled water storage/buffer vessel drainage trap (where possible) and nearest and furthest outlet;
- record all actions on the Record Form (006).

Flexible hoses

6.27 There are no flexible hoses in the water supply and distribution system.

(Amend statement to suit circumstances if required. Refer to paragraph 19.3 in "Operational Procedures" for detail as to likely occurrences).

Risk assessments for any future flexible hoses added to the system to be held in the Water Safety Log Book.

General comments – Hot water system

6.28 If conditions, e.g. temporary ward closure, leave a system unused for a period greater than 7 days, for a short term or limited closure typically not exceeding 30 days, then the Authorised Person (Water) must be notified.

Arrangements for the system must be made to ensure thorough flushing of all outlets weekly by opening all taps and allowing water temperatures to stabilise (see Section 7). If shutdown is longer than 30 days the Authorised Person (Water) will make arrangements for the system to be drained and left dry and sealed (see Section 7).

If and when the system is reinstated the Authorised Person (Water) will make arrangements for the system to be subject to a disinfecting regime. This will also include any de-stratification pumps.

The minimum number of DHW Calorifiers will be operated on line 24 hours per day, 7 days per week, with the domestic hot water circulation pump kept running to provide maximum turnover of water storage. Off-duty DHW Calorifiers will always be held in a drained, empty and dry condition until required for use. On return to service, DHW Calorifiers must be run through the pasteurising procedure.

Valves should be opened slowly to avoid disturbance of any sediment in the system.

Over-capacity of hot water storage must be identified and surplus equipment disconnected from the system.

Materials that sustain microbiological growth will not be used in connection with the waterside of domestic hot water systems (i.e. Water Byelaws, WRAS and SHTM 04-01 compliant).

Every DHW Calorifier shall be clearly marked with the following information

- Insurance Folio 'xx' Number;
- Areas supplied;
- DHW Calorifier capacity.

Hot Water circulating pumps

6.29 The *Legionella* risk is where duty and standby pumps are provided and there is no automatic changeover sequencer fitted to prevent stagnant water forming in the standby pump unit.

The circulation for secondary domestic hot water circuits from each calorifier are run on a simplex basis with one pump installed and operating 24 hours per day, 7 days per week.

Thermostatic Mixing Valves (TMVs)

6.30 Thermostatic mixing valves are installed to condition water for whole or partial body submersion to eliminate the risk of scalding.

These devices are fixed to showers, bidets, baths and wash basins. They are indicated on the Domestic Services Water Layout drawings for the site.

A maintenance programme of testing is ongoing throughout the year to ensure compliance with Safe Hot Water and Surface Temperatures requirements as set out below.

All temperature and maintenance checks are recorded on the Planet F.M. Pre-Planned Maintenance docket P.P.M. Completed Control of Water Record Sheets are to be returned to the Supervisor / Estates Officer for filing in the Water Safety Log Book. In normal use the system should achieve 55°C at the supply to the furthermost draw-off point in the circulating system.

Only Type 3 TMVs are used in the water system.

The maximum set domestic hot water temperature must not exceed the following temperatures

- 38°C Bidets;
- 41°C Showers;
- 41°C Wash basins;
- 43°C Bath (43°C fill);
- 46°C Bath (46°C fill).

Note: Bath fill temperatures of more than 43°C should only be considered in exceptional circumstances where there are particular difficulties in achieving an adequate bathing temperature. If a temperature of greater than 43°C is to be used then a safe means of preventing access to the hot water should be devised to protect vulnerable patients. Any valve delivering hot water exceeding this temperature should be isolated and removed from service immediately.

Materials and fittings

6.31 All materials for use on water systems shall comply with The Water Supply (Water Fittings) Regulations 1999 (WRc approved).

Tap washers, joint rings and compound shall be in accordance with the appropriate British Standard.

6.32 Materials in contact with water shall not

- impart any objectionable taste or colour;
- release any toxic substance;
- support microbiological growth;
- include traditional white products such as "Boss White" used with hemp contain linseed oil and shall **not be** used as they support microbiological growth.

6.33 However

- polytetrafluroethylene (PTFE) products can be used;
- lead-free solder fittings must be used on all potable water supplies.

6.34 All systems shall be designed and installed to ensure no back syphonage occurs and where applicable be passed to the Local Water Authority for comment and or information.

6.35 Also there is a combination of factors that may have facilitated *Pseudomonas* Spp becoming a clinical problem. These factors include any or all of the following:

- water system materials which may have facilitated biofilm formation (e.g. plastic pipework, plastic and rubber components in TMVs and flexible hose liners etc);
- water outlets with thermostatic mixer valves (TMVs) designed to regulate water temperature and minimise the risk of scalding, which may also have increased the risk of other waterborne pathogens;
- the increased number of wash hand basins / sinks in clinical areas, combined with the increased use of alcohol based hand rubs (ABHRs) which may have resulted in a decreased use of water at individual wash hand basins / sinks;
- the use of non touch (sensor) water fittings, resulting in low water volumes flowing through outlets. This combined with a column of standing water left in the pipework provides an ideal condition for bacterial growth;
- some recent cold water storage tanks incorporate 100mm dia. PVC-U piping to support the lids. These supporting pipes are not sealed to the tank base or lids resulting in creation of a column of stagnant water following filling with incoming cold water. This has been the source of high TVCs and seeding of bacterial contamination that has circulated through the piping network distribution.

Planned maintenance programme

Legionella and water safety risk reduction

6.36 *Legionellosis* and other water safety risks can be controlled by actively pursuing a policy of good housekeeping.

This requires the following maintenance actions:

- yearly tank inspection and monitoring/recording of tank temperatures;
- quarterly inspection and annual cleaning of DHW Calorifiers;
- daily monitoring and recording of DHW Calorifier temperatures;
- twice-weekly flushing, of all little used water outlets except in ICUs where daily flushing is required at the start of each day;
- monthly monitoring and recording of sentinel water outlet temperatures;
- annual monitoring and recording of representative water outlet temperatures;
- annual cleaning of humidity chambers on air movement systems;
- satisfactory operation of thermostatic mixer valves (3 monthly for high risk areas and as required elsewhere, but at least once annually).

Water Safety Log Books and maintenance records are kept in the Maintenance Managers office

Daily BMS Record Forms are printed out, for all critical system temperatures and plant status, and are held in the Maintenance Managers Office.

6.37 The procedures set out below shall be followed

Service	Task	Frequency
Cold Water Services	Check tank water temperature remote from ball valve and mains temperature at ball valve. Note maximum temperatures recorded by fixed maximum thermometers where fitted. (on Procedure P1C7 – recorded on 003)	Six monthly
	Check that temperature is below 20°C after running the water for up to two minutes in the sentinel taps. (on Procedure P1C4 – recorded on 005)	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. (on Procedure P1C7 – recorded on 003)	Annually
Shower Heads	Dismantle, clean and de-scale shower heads and hoses / or replace with new disinfected Shower Head and Hose. (on Procedure P1C12 – recorded on 005B)	3 Monthly for high risk areas and as required elsewhere, but at least once annually
Little Used Outlets	Flush through and purge to drain, or purge to drain immediately before use, without release of aerosols. (on Risk Control Notice 11/04 – recorded on Sample Record Sheet by Duty Holder)	Twice weekly

Cold water services routine inspection and frequency table

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6.38 The procedures set out below shall be followed

Service	Task	Frequency
	Arrange for samples to be taken from hot water calorifiers, in order to note condition of drain water. (on Procedure P1C9 – recorded on 006)	Annually
	Visual check on internal surfaces of calorifiers for scale and sludge. Clean and disinfect. Check representative taps for temperature as above on a rotational basis. (on Procedure P1C9 – recorded on 006)	Annually
	Each calorifier and any associated storage/buffer vessels should be flushed quarterly through its drain valve by opening the drain valve 3 times, each time for a 3 minute period. Calorifier and any associated storage/buffer vessels flushing should be carried out after temperature checks on the calorifier and system have been completed. Record form (006) should be completed.	Quarterly
	Check temperatures in flow and return at calorifiers. (on Procedure P1C4 – recorded on 005)	Monthly
	Check water temperature up to one minute to see if it has reached 50°C in the sentinel taps. (on Procedure P1C4 – recorded on 005)	Monthly

Hot water services routine inspection and frequency table

Maintenance instructions

6.39 The Planet System produces Works Dockets for the precautionary checks and maintenance routines for the water system. Copies of the maintenance instructions for each of the above tasks are included in the Water Safety Log Book.

Disinfection

6.40 Where not an integral part of the Planet precautionary checks and maintenance routines, water systems should also be cleaned and disinfected under the circumstances in the following table:

System/ Service	Circumstance Requiring Cleaning and Disinfection* (* for disinfection check current Risk Assessment)	Frequency
Domestic Cold Water Tank	New installations. Re-commissioning empty/unused tanks. Tank temperature exceeds 25°C. Tank contains moderate sediment, i.e. a complete covering of the tank base. Evidence of tank corrosion (check with current Risk Assessment). Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Regular programme for high-risk healthcare category, with disinfection* (check with current Risk Assessment). Regular programme for medium risk healthcare category, with disinfection* (check with current Risk Assessment). Regular programme for non-healthcare premises, with disinfection* (check with current Risk Assessment).	As required As required As required As required As required As required As required Annually 2 Yearly 5 Yearly
Domestic Cold Water Distribution System	New installations and modifications or additions. Temperature exceeds 25°C. Any contamination of tank (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc.	As required As required As required As required
Domestic Hot Water Calorifier and Storage/ Buffer Vessels	New installations and modifications or additions. Temperature has fallen below 45°C. Re-commissioning of empty/unused plant. Any contamination of header tank (by organic, by vermin or vermin faeces or similar). Regular programme.	As required As required As required As required Annually
Domestic Hot Water Distribution System	New installations and modifications or additions. Temperature has fallen below 45°C. Any contamination of header tank (by organic, by vermin or vermin faeces or similar).	As required As required As required
Air Handling Units	Any contamination (by organic, by vermin or vermin faeces or similar). Gross organic contamination e.g. large number of dead insects, feathers, animal or bird bodies etc. Chiller battery, drip trays and drainage pipework.	As required As required 6 monthly

Domestic cold water tanks and distribution systems table

6.41 The procedures set out below shall be followed

Procedure	Description
(logged on Form 004)	for Cold Water Tanks and Distribution Systems following the identification of water temperature greater than 20°C

Drinking water, to a relevant water quality under Regulations, is provided to *NHS Board* by Business Stream, a Licensed Provider (LP) who works with Scottish Water to make sure that the water supply is connected properly, and the water is clean and ready to use.

These obligations cover the supply network up to the boundary point (normally the meter point), thereafter obligations rest with *NHS Board*.

Note: Currently there is no legal maximum water supply temperature from the Licensed Provider. In practice the water supply temperature to boundary point will be subject to seasonal variation. In winter this would normally be expected to be in the 5 – 10 °C range and in summer up to 20°C.

6.42 The following staged risk assessment escalation procedure should be employed where the water temperature in Cold Water Storage Tanks is greater than 20ºC. (i.e. the water storage tanks for Domestic Cold Water Systems and for Domestic Hot Water Systems).

Stage 1 - Verification

- where tepid cold water occurrence (i.e. more than 20 °C) is reported from any number of cold water outlets, from maintenance procedures, from BEMS monitoring, or from the manual monitoring of storage tanks, the person identifying, or making a report must notify the relevant Authorised Person (Water) as soon as the problem is identified and confirm this in writing within 24 hours;
- the Authorised Person (Water) should liaise with the person identifying the problem and verify the problem by independently rechecking by taking the water temperature of the appropriate cold water storage tank, the temperature of the incoming mains cold water at the site boundary point (and building entry point if there are multiple buildings served by the mains cold water system) and the outflow distribution temperature;
- if the cold water storage temperature is confirmed greater than 20°C, then the Authorised Person (Water) should record this in writing as well as conducting continuous monitoring of the incoming cold water mains, the cold water storage and the outflow temperatures to establish the temperature profiles and in more detail over at least a one week period to determine the level of risk;
- the Authorised Person (Water) should also review the Water Safety Log Book and take into account the recent water system history to specifically include - the primary water treatment levels, any water sampling carried out following SHTM 04-01; system monitoring data, including temperature monitoring and water quality chloramine checks; recent maintenance history; recent alterations, changes or additions to the water system; and any other changes made by Duty Holders or users of the water system;
- on reviewing continuous monitoring temperature profiles, in conjunction with Water Safety Log Book and recent history, action as Stage 2 or Stage 3 or Stage 4 as appropriate. The Authorised Person (Water) will ensure the Responsible Person (Water) is notified immediately in writing at each Stage and also recorded in the Water Safety Log Book.

Stage 2 - Initial Action – high incoming mains cold water temperature

- where the incoming mains cold water is 18°C or greater for more than a 48

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hour period the Responsible Person (Water) should contact Business Stream, the Licensed Provider, who will work with Scottish Water to establish the reasons and determine a resolution. Continuous monitoring should continue and recorded in the risk assessment.

Stage 3 - Water temperatures fluctuating above and below 20°C (but no greater than 25°C)

- where water temperatures are fluctuating above and below 20°C in a regular cyclic manner over 72 hour periods in response to regular user water demand (but no greater than 25°C) and are more than 2°C higher than the incoming cold water mains supply temperature at the building entry point, then continuous monitoring should be continued by the Authorised Person (Water), the reason(s) for failure(s) identified and rectified as soon as possible. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there may be increased risk and appropriate actions may be required to mitigate exposure).

Considerations for failures include

- accuracy of temperature sensors (requiring recalibration);
- temperature sensors being located in water (requiring reposition where tank storage levels have been reduced and sensor no longer sensing stored water);
- inappropriate standby tank configuration;
- temperature sensor in standby system;
- temperature sensor measuring stagnation (requiring reposition);
- inappropriate siting (not in a cool location);
- heat gain to the tank and pipework (due to lack of appropriate insulation or located close to heat gain from other heat sources);
- storage capacity not minimised to match daily use (changes in user water demand);
- ingress of hot water through cross connection or mixing valve failure (i.e. from DHW system or Steam systems).

Stage 4 - Water temperatures fluctuating above and below 25°C (and rarely below 20°C)

- in this situation continuous monitoring should be continued by the Authorised Person (Water), the reason(s) for failure(s) (as Stage 3) identified and rectified on an urgent basis. This should be recorded by updated risk assessment (specifically in relation to the patient risk rating – where there will be an increased risk and appropriate actions will be required to mitigate exposure);
- in this situation a permanent solution, such as ventilation for the plant room, or changing the water storage arrangements, or forming a circulating distribution system (with or without chilling depending on the circumstances)

must be implemented;

- the Authorised Person (Water) should, unless instructed in writing to the contrary by Responsible Person (Water)
  – arrange to drain the tank contents and clean if necessary;
  – inform the users of the failed system that they must not draw off any cold water (and hot water if a single domestic hot water header) from the affected system until further notice;
  – chlorine (or other suitable) disinfection of the tank and distribution system shall be carried out;
  – thereafter the tank shall be brought back into service;
  – then the users shall be informed that the system is back in operation.

The Authorised Person (Water) shall complete an Incident Report Record Form (004). An entry should also be made in the Water Safety Log Book and ensure the Responsible Person (Water) is notified in writing as soon as possible.

Domestic hot water plant and distribution systems

6.43 The following procedure should be employed if the Calorifier or Plate Heat Exchanger outflow temperature falls below 45°C.

Procedure	Description
(logged on Form 004)	Domestic Hot Water Systems following plant failure, allowing system water temperature to drop below critical control levels

Decision table for hot water system breakdown

6.44 The Table overleaf should be used to decide on the actions necessary in the event of a plant breakdown such as power failure or steam supply failure.

Breakdown leading to temperature <45°C, lasting for:	Risk Category	Action
<12 hrs	High	Verify[1]
	Significant	Verify[1]
	Moderate	Verify[1]
>12 hrs	High	Thermally pasteurise[2]
	Significant	Verify[1]
	Moderate	Verify[1]
>24 hrs	High	Thermally pasteurise[2]
	Significant	Thermally pasteurise[2]
	Moderate	Verify[1]
Breakdown leading to temperature <45°C, lasting for:	**Risk Category**	**Action**
>72 hrs	High	Thermally pasteurise[2]
	Significant	Thermally pasteurise[2]
	Moderate	Thermally pasteurise[2]

[1]Ensure that normal temperature performance has been resumed, i.e.60°C

[2]Calorifier or plate heat exchanger and complete distribution system

6.45 In the event of a reduction in domestic hot water temperature the Authorised Person (Water) should be notified in writing as soon as possible. The reason for failure must be identified and rectified as soon as possible.

6.46 The Authorised Person (Water) shall notify the Duty Holder and users on the failed system that they must not draw off any hot water from the affected services until further notice.

6.47 The relevant Duty Holder shall ensure that their staff are aware of the situation, and that they in turn shall prevent patients from using affected services.

6.48 Where thermal pasteurisation is to be carried out, the temperature of the calorifier or plate heat exchanger shall be raised to 70°C, and the water shall be circulated throughout the affected distribution system for at least one 1 hour. Each tap or appliance should be run in sequence until full temperature is achieved (this should be measured). To be effective the temperature in the calorifier or plate heat exchanger should be high enough to ensure that all distribution outlets receive water at a temperature of greater than 60°C. Ensure the return flow to the calorifier or plate heat exchanger is no less than 50°C.

6.49 The Authorised Person (Water) shall inform users that the system is back in operation.

6.50 Bacteriological samples should be taken in consultation with the Infection Prevention and Control team.

6.51 The Authorised Person (Water) shall complete an Incident Report Record (004) and ensure the Responsible Person (Water) is notified in writing as soon as possible. Maintain hard copy records in the Water Safety Log Book.

Air handling plant

6.52 If applicable the following procedures shall be carried out

Procedure	Description
P1C8 (logged on Form 007)	a) Humidity section inspection b) Cooling section inspection c) Disinfection

Aerosol generation

Note: The disease caused by the *Legionella* bacteria is a type of pneumonia, affecting the lungs and other organs of the body. The basic cause of infection is the inhalation of droplets of water infected with the *Legionella* bacteria, the highest risk being aerosols.

6.53 Aerosols may be generated from a number of sources, such as showers, aerated taps, air conditioning units, water disturbances in tanks and calorifiers and by the use of hoses for flushing and cleaning. All maintenance tasks are therefore conducted in a manner that minimises the production of potentially dangerous aerosols. Some examples are as follows: -

- calorifiers are pasteurised, fully drained, prior to opening for examination;
- sediment and sludge should be carefully cleared before hosing.

6.54 Risk Assessment has been used to identify the possible producers of aerosols, the hazards associated when they are produced, and the control measures in place to reduce the risks to a manageable level.

7. Contractors

7.1 Only Competent Contractors may be used to supplement the in-house labour force in carrying out the following operations

- water storage tank cleaning and disinfection;
- thermostatic Mixer Valve (TMV) maintenance;
- system disinfection;
- BEMS Maintenance.

Note: Contractors are appointed in accordance with the *NHS Board* Control of Contractors Policy. Contractors shall only be engaged in work on water systems or air conditioning plant under the control of the Authorised Person (Water) co-ordinated with any Estates persons.

7.2 The *NHS Board* Management and Control of Contractors – Health, Safety and

Environment Policy & Procedural Arrangements along with the associated Guide for Contractors will apply.

7.3 The Authorised Person (Water) shall ensure that the Contractor is competent for the task(s) to be undertaken and shall ensure that the Contractor is aware of and has made provision for all responsibilities under the various Environmental, Health and Safety Regulations, including CDM, COSHH, *Legionella*, water safety etc.

7.4 The Authorised Person (Water) shall ensure that the Contractor:-

- is suitably briefed in writing on the task(s) to be undertaken and is fully aware of the water safety implications and prescribed Water Safety Procedures to be followed;
- demonstrates that all workforce to be engaged on the task(s) are suitably trained and experienced for the task and are properly managed and supervised;
- has provided appropriate equipment for the task including PPE;
- carries out the task(s) to the correct standards and in the correct manner all in accordance with all *NHS Board* and Estates policies and procedures.

7.5 The Authorised Person (Water) shall record the evidence provided by the contractor and store it for future reference and maintain hard copy records in the Water Safety Log Book.

7.6 The Authorised Person (Water) shall complete a review questionnaire upon completion of the work and shall forward it to the Environment & Safety Support team for recording.

8. Temporary closures

8.1 The Duty Holder requires to ensure that Ward/Departmental Managers notify the Authorised Person (Water) and Estates Maintenance Department in advance to assess the risks of exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria when closures are planned.

8.2 When wards or departments are closed temporarily (for short terms or limited periods not exceeding 30 days), a procedure for the regular flushing of all domestic water outlets will be implemented immediately. The flushing operation should be conducted on a twice weekly flushing cycle basis and details recorded and transferred to the Water Safety Log Book and the Planet system. The procedure will involve running every water outlet for 3 minutes and flush each toilet.

8.3 Domestic Services Supervisors and Managers will also notify the Maintenance Department if they identify any unused areas or outlets.

8.4 Where wards or departments are to be closed indefinitely or mothballed with no planned re-opening date, or where the closure period typically exceeds 30 days, the Estates Department must be consulted and provided with funding in order to assess the risks of exposure to *Legionella, Pseudomonas* Spp and other similar harmful bacteria with a view to alter or disconnect and drain the relevant water services.

9. Risk control notices

9.1 *NHS Board* Clinical Governance and Risk Management Unit have issued Risk Control Notice 11/04 dated 20th June 2011 **to Duty Holders** on the Management and Control of *Legionella*. This instructs actions by devolved management and local ward or department staff to eliminate or manage the risk as follows:

Use of water system outlets

9.2 The manager responsible for the ward or department must put systems in place to undertake a weekly review of the use of water systems outlets.

Where water outlets are

- Unused or Redundant – follow Action 9.3 below;
- Little Used – follow Action 9.4 below.

9.3 **Unused or Redundant System Outlets** – outlets deemed unused or redundant (and associated supply pipework at showers, taps in basins & baths, etc) must be reported by the manager responsible for the ward or department to the Estates Department on ext: xxxxx to be taken out of service and for removal, to eliminate the risk.

Alternatively, if the outlet has to be retained (such as for emergency or irregular use) the manager responsible for the ward or department must put systems in place for the outlet to be flushed to waste for 3 minutes, at least **twice weekly**, by ward or department staff, following Actions 9.5 – 9.8 below.

9.4 **Little Used System Outlets** - (i.e. outlets that are not used at least twice weekly). The manager responsible for the ward or department must put systems in place for the outlet to be flushed to waste for 3 minutes, at least twice weekly, by ward or department staff, following Actions 9.5 – 9.8 below. Where the outlet may be used by high-risk patients, more frequent flushing may be needed and the frequency should be determined following a risk assessment.

9.5 The flushing must be carried out in such a way as to avoid (or protect from) the creation of any aerosols. If the flushing has been *regular and in accordance with this notice,* the risk posed by aerosols is very low.

9.6 Shower heads which are dirty and are to be retained should be reported to domestic services so that these may be thoroughly cleaned or replaced.

9.7 A record must be kept of the weekly flushing operation. A template record sheet is attached. This must be retained in the ward or department for at least 5 years.

9.8 Local flushing regimes must be ongoing and continuous at all times, in order to prevent critical increases in *Legionella* growth and to demonstrate auditable management control of *Legionella* in local workplaces.

9.9 The Record Sheet is audited as an integral part of Infection Control Audit (3-monthly using the HEI Inspection Audit Tool).

9.10 Management Team Duty Holders have also been alerted on awareness and actions to minimise the risk of *Pseudomonas* Spp and other similar harmful bacteria in the use of equipment, transmission routes and requirements (such as in the use of hand wash stations and wash basins) in Risk Control Notice 12/04.

10. Documentation and records

10.1 The documentation and records of all work undertaken to prevent the growth and spread of *Legionella* require to be maintained and performance reviewed by the Authorised Person. These records include:

- Risk Assessments;
- the *Legionella* operational maintenance site plan;
- records of maintenance actually carried out, contained within Water Safety Log Books and Planet;
- records of procedural audit and review, contained within the Water Safety Log Book;
- other Procedures are set out below:

Other Procedures	Record	Description
Short / Limited Closure Record Form	Logged on Form 001	For a period typically not exceeding 30 days
Indefinite Closure / Re–occupation Record Form	Logged on Form 002	For periods typically exceeding 30 days
Incident Report Record Form	Logged on Form 004	For all incidents and resulting actions
Water Maintenance Frequencies Risk Based Assessment Form	Logged on Form 023	For review and change of any maintenance frequency
Water Disinfection Risk Based Assessment Form	Logged on Form 024	For assessment for disinfection of systems after work or alterations
Checklist for New Water System Designs	Logged on Form 025	Checklist for designers
Other Procedures	Record	Description
Flushing Water Outlets Record Form	Logged on Form 026	Record sheet for Estates Department use
Estates Chloramine Record Form *(where applicable)*	Logged on Form 027	Record sheet for Estates Department use

Other Procedures	Record	Description
Water Safety Control Log – Record Form	Logged on Form 028	For plant status, maintenance tasks and resulting actions
Risk Control Notice 11/04	Logged on Sample Record Sheet	For Duty Holders
Risk Control Notice 12/04	Actions to Estates Helpdesk	For Duty Holders

11. Outbreaks – Actions

Note: Any incidents or deviance from the controls for the Temperature Control Regime must be reported to the Authorised Person (Water) immediately, the Incident Report Record Form (004) is completed and ensure the Responsible Person (Water) is notified as soon as possible.

11.1 In the event of an Outbreak, an Incident Management Team (IMT) or an Outbreak Control Team (OCT) will be convened for a single case or an outbreak of nosocomial Legionnaires' disease respectively.

11.2 The IMT/OCT will be convened by the Consultant in Public Health Medicine (CPHM) with responsibility for Health Protection (or the duty CPHM). The CPHM will lead and co-ordinate the investigation and control of the incident/outbreak in close collaboration with the Infection Prevention and Control Doctor. Further information on the roles and responsibilities of the different members of the IMT/OCT can be found in *NHS Board's* Outbreak Plan. Refer to Section 22 and *NHS Board* Control of Infection Manual for full information.

11.3 The general response to an incident or outbreak may include:

- investigation of all potential sources of *Legionella* infection. This shall include checking recent maintenance work and project work that may have been carried out on water or air handling systems;
- identifying the location of any medical equipment used for dental care, respiratory therapy and within Haemodialysis units;
- identifying off-site information such as excavation or earth moving works, alterations to water supply and drainage;
- shutting down any processes which are capable of generating and disseminating airborne water droplets and keep them shut down until sampling procedures and any remedial cleaning or other work has been done. Final clearance to restart the system may be required;
- taking water samples from the system before any emergency disinfection being undertaken. This will help the investigation of the cause of the illness. The investigating officers from the local authority may take samples or require them to be taken;
- co-operating fully in an investigation of any plant that may be suspected of being involved in the cause of the outbreak. This may involve, for example

  - tracing of all pipework runs;
  - detailed scrutiny of all operational records;
  - statements from plant operatives and managers;
  - statements from water treatment contractors or consultants;
- any emergency cleaning and disinfection will be undertaken in accordance with *NHS Board* procedures;
- the Designated Person (Water) shall brief relevant Estates staff so that they are aware of the event and can respond to phone calls etc as instructed. The briefing shall include instructions that any comments to outside parties are agreed by Infection Prevention and Control;
- records shall be kept of all relevant information, including that provided by other departments.

12. Operational restrictions

12.1 These will be recorded within the Water Safety Log book, in consultation with the users (if any) of the facility.

13. Alterations to water systems

13.1 Where alterations are planned to water systems and the Written Scheme, the Guidance for Alterations to Water Systems document must be followed. The document provides separate specific guidance and the details to be followed for controlling and avoiding the risk of *Legionellosis* and other water safety risks. (specifically using Record Form 029 to record the acceptance of work to be conducted and conformation of work completed on a water system and all conditions involving Duty Holders, the Authorised Person (Water) of the written scheme of the system and the Authorised Person (Water) from the Project Team accepting responsibility for the work).

13.2 Record Form 029 shall be used to record the acceptance of ALL work to be conducted and confirmation of ALL work completed on a water system and ALL conditions involving Duty Holders, the Authorised Person (Water) of the Written Scheme of the systems and the Authorised Person (Water**)** from the Project Team accepting responsibility for the work.

13.3 At the point of hand over **all** relevant information written on operating the system, system performance, together with accurate ‘as-fitted’ drawings and design criteria of the domestic hot water systems and cold water services shall be submitted to *NHS Board* (i.e. an appropriate current Written Scheme, accepted in writing by the relevant Authorised Person [Water]).

13.4 Full operation of the system and occupancy of the building/property should be progressed as soon after hand over as possible to reduce the potential of *Legionellosis* and other water safety risks and avoid further costs being incurred due to of any further re-disinfection of the water systems.

Appendix C: Typical report forms

Contents:

Note: This Control of Water Record Forms document is to be read in conjunction with the Written Scheme and the Guidance for Alterations to Water Systems documents

Temporary ward / Department closure record form (001)

NHS Board			
Estates Department			
Site/Premises		Closure date	
Ward/Department		Closure period (typically not exceeding 30 days)	
Equipment and outlets affected by closure:			
Compiled by (signature)		Print name	
Supervisor (signature)		Print name	

Approval by Authorised Person (Water) to operate on a twice weekly flushing cycle basis (to run every water outlet for 3 minutes and to flush each toilet)

To operate the water system listed above in accordance with the procedure for short/limited closure

Approved by (signature)		Print name	
Date			
Remarks			

Completed record forms to be held in Water Safety Log Book

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Indefinite ward / Department / Site closure record form (002)

NHS Board			
Estates Department			
Site/Premises		Closure date	
Ward/Department		Closure period	
Work carried out to disconnect and close down water services:			
Closure declaration by Authorised Person (Water)			
Compiled by (signature)		Print name	
Date			
Reoccupation of the area above		Date	
Work carried out and details of modifications:			
Work done by (signature)		Print name	
Clean and disinfect (carried out by)		Print name	
Re-occupation declaration approved by Authorised Person (Water)			
Approved by (signature)		Print name	
Date			

Completed record forms to be held in Water Safety Log Book

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Annual tank inspection record form (003a)

NHS Board			
Estates department			
Site/Premises		Tank Location	
Date		Tank Reference	
Annual tank inspection			

Question	Compliance Yes / No	Comments / Action
Tank Clean – (does tank require draining and chlorinating?)		
Tank Access Locked? (if applicable)		
Adequate Covers?		
Water Regulations Compliant?		
Insect Screens Fitted?		
External Condition?		
Internal Condition?		
Water Level?		
Operation of Ball Valve?		
Cleaning Method Used? (if used)		
Paint/Coating? (if used)		
Bacteriological Results? (if applicable)		

Work done by (Print name)		Signature	
Supervisor accepted by (Print name)		Signature	
Date			

Completed record forms to be held in Water Safety Log Book

6-Monthly (Summer/Winter) Temperature recordings (003b)

NHS Board			
Estates department			
Site/Premises		Tank Location	
Date		Tank Reference	
6-Monthly Temperature Readings:			
Reading at	Temp °C	Comments / Action	
Ambient Outside Air			
Tank Room			
Water within Tank			
Mains Supply Water at inlet to Building/Block			
Ambient Outside Air			
Work done by (Print name)		Signature	
Supervisor accepted by (Print name)		Signature	
Date			

Completed record forms to be held in Water Safety Log Book

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Incident report record form (004)

NHS Board			
Estates department			
Site/Premises		Date	
Ward/Department		Time	
Nature and details of incident/fault			
Identified by (Print name)		Signature	
Actions taken			
Work done by (Print name)		Signature	
Time completed		Date completed	
Supervisor accepted by (Print name)		Signature	

Completed record forms to be held in Water Safety Log Book

Water temperature record form (005)

NHS Board			
Estates department			
Site/Premises		Date	
Ward/Department		Time	

Storage Temperatures (°C)

Detail	Cal/Heat Exchanger No 1 Plant Ref No:	Cal/Heat Exchanger No 2 Plant Ref No:	Cal/Heat Exchanger No 3 Plant Ref No:
Storage Temp			
Outflow Temp			
Return Temp			
Cold Feed Temp			

Outlet Temperatures (°C)

Ward/Department	Room	Temperature		Okay Yes/No	Comments
		Hot	Cold		

Additional Comments/Actions

Reading taken by (Print name)		Signature	
Supervisor accepted by (Print name)		Signature	
Date completed		Time completed	

Completed record forms to be held in Water Safety Log Book

Daily DHW Calorifier / Water temperature record form (005a) or where a BEMS is not installed or where BEMS is not Operational

NHS Board			
Estates department			
Site/Premises		Month/Year	
Block/System		Calorifier No.	
Temperatures			

Day	Temperature (°C)			Comments	Time of Recording	Name & Signature
	Storage	Flow	Return			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

(continued overleaf)

Day	Temperature (°C)			Comments	Time of Recording	Name & Signature
	Storage	Flow	Return			
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
Additional Comments / Actions						
Supervisor accepted by (Print name)					Signature	

Completed record forms to be held in Water Safety Log Book

Disinfected shower head and Hose replacement record form (005b)

NHS Board			
Estates department			
Site/Premises		Date	
Block/System(s)		Time	

Replacement details

Ward / Dept	Room	Shower Ref. or Item No.	Replaced by		Attach Disinfection ID and LOT Number (sticker from pack)
			Print name	Signed	

Additional Comments/Actions

Supervisor accepted by (Print name)		Signature	

Completed record forms to be held in Water Safety Log Book

Calorifier and storage / Buffer vessel maintenance record form (006)

NHS Board				
Estates department				
Site/Premises		System ref		
System (Domestic Hot water calorifier(s) and Storage /Buffer vessel(s) associated with Hot/Cold/Chilled water heat exchanger(s)		Plant ref no		
Quarterly flushing				
Period	Date Undertaken	By (Name)	Signature	Comments
1st Quarter				
2nd Quarter				
3rd Quarter				
4th Quarter				
Annual Plant Cleaning (Plant Ref No as above):				
Plant taken out of service for annual cleaning	Date		Time	
Drain and clean done by (Print name)		Signature		
Drain and clean done by (Second man print name)		Signature		
Start up procedure done by (Print name)		Signature		
Where domestic hot water calorifier or Storage/buffer vessel – held at 60°C for (hours)				
Date Plant back in service		Time Plant back in service		
Supervisor accepted by (Print name)		Signature		
Additional Comments / Actions – forward to **Authorised Person (Water)**				

Completed record forms to be held in Water Safety Log Book

Air handling unit disinfection record form (007) (Please refer to water operational procedure at all times)

NHS Board						
Estates department						
Site/Premises				Plant Location		
Date		Plant Reference		**NB: Use Sodium Hypochlorite Solution 5ppm within 2 hours of issue**		
Sodium Hypochlorite Solution 5ppm	Batch Number			Expiry Date		
Safety Checks						
Ref	Details	Yes/No	Comments			
1	Have you read and understood the data COSHH sheet?					
2	Have you read and understood the risk assessment sheet?					
3	Have you put appropriate signage in place?					
4	Are you wearing the appropriate PPE?					
Pre-Disinfection Checks						
1	Was there water present in ductwork?					
2	Was drain glass trap clean? (i.e. transparent)					
3	Any sign of biological growth?					
4	Drainage trays clean and corrosive free?					
How long was 5ppm chlorine applied for before being washed off?			Hours			
Completion Checks						
1	All wetted areas dry?					
2	Was sample taken for analysis?					
3	All panels replaced and plant switched on?					
4	Entry made in local maintenance log?					
Comments						
Signed (Craftsperson)				Date		
Accepted by (Supervisor)				Date		

Completed record forms to be held in Water Safety Log Book

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Building energy management system water system alarm/Fault record form (021)

NHS Board					
Estates department					
Site/Premises				Plant Location	
Date		Time		Plant Reference	
Details of alarm condition					
Details of actual Fault/Alarm					
Action taken					
System back in operation at (date & time):					
Craftsperson who reported (signature)				Date	
Craftsperson who repaired (Signature)				Date	
Accepted by (Signature of Authorised Person (Water))				Date	

Completed record forms to be held in Water Safety Log Book

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Monthly checks of water drain traps on ventilation plant form (022)

NHS Board					
Estate department					
a) Visually inspect condition of drain trap assembly. b) Top up any drain trap that is below minimum level. c) Remove and clean any dirty glass drain traps.					
Checked by				Date	
Location (Site/Block/Plant Room)	Drain Ref No	Plant drain trap fitted to (or Plant Ref No)	Water level Yes / No	Trap clean/dirty	Remarks
Accepted by Authorised Person (Water) (Signature)				Date	

Completed record forms to be held in Water Safety Log Book

A47392376

Water maintenance frequencies risk based assessment form (023)

<table>
<tr><td>NHS Board</td><td colspan="4"></td></tr>
<tr><td>Estates department</td><td colspan="4"></td></tr>
<tr><td>Site/Premises</td><td></td><td>Plant Location</td><td colspan="2"></td></tr>
<tr><td>Date / Time</td><td></td><td>Plant Reference</td><td colspan="2"></td></tr>
<tr><td>Maintenance Task being Accessed</td><td></td><td>Existing Frequency</td><td colspan="2"></td></tr>
<tr><td colspan="5">Brief description for change of maintenance frequency:</td></tr>
<tr><td colspan="5">Assessment</td></tr>
<tr><td colspan="2">Patients/Staff Risk Rating (A) (tick). See Appendix A, Patient Risk Rating - “Guidance for Alterations to Water Systems)</td><td>5 (high)</td><td>4.5 (med)</td><td>4 (low)</td></tr>
<tr><td colspan="2">Water System Risk Rating (B) (tick). Range 5 (high) – 1 (low)</td><td colspan="3">1 | 2 | 3 | 4 | 5</td></tr>
<tr><td colspan="2">Patients/Staff Risk Rating (A) x Water System Risk rating (B) = (C)</td><td>5 or less</td><td>5 to 15</td><td>15 or more</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Check risk register database for all outstanding work required to the system</td><td>Database checked Yes / No</td><td></td><td>Amount of outstanding Items</td><td></td></tr>
<tr><td>Existing paperwork, logs, forms and graphs checked and show consistent level of control against Legionella and any other harmful bacteria</td><td>Yes / No</td><td></td><td>Paperwork starting (date)</td><td></td></tr>
<tr><td>Details of changes to frequency of task</td><td>Date changed</td><td></td><td>New frequency</td><td></td></tr>
<tr><td colspan="5">Comments</td></tr>
<tr><td>Assessment carried out by (Signature of Authorised Person (Water))</td><td colspan="2"></td><td>Date</td><td></td></tr>
<tr><td>Agreed by Head of Maintenance (Signature of Responsible Person (Water))</td><td colspan="2"></td><td>Date</td><td></td></tr>
</table>

Completed record forms to be held in Water Safety Log Book

A47392376

Water disinfection risk based assessment form (024)

NHS Board			
Estates department			
Site/Premises:		Location of Work:	
Date:		Project Ref:	
Person Making Assessment: (Print Name)			
Brief description of work / upgrade:			

Assessment for Disinfection of System after Upgrade Completed (refer to “Guidance for Alterations to Water Systems” Section 3 and Disinfection Assessment Risk Table on page 10) Circle appropriate level of risk.					
A. Patients risk rating (see tables in Appendix A): 5, 4.5 or 4	4		4.5	5	
B. Water system risk rating (see tables in Appendix A):	1	2	3	4	5
C. Level of work being carried out (delete as required):	1 Minimal (non intrusive or work at outlet)	2 Moderate (intrusive work)		3 Extensive (intrusive work taking more than 7 days)	
Risk Score = A. x B. x C. =					

Disinfection assessment (delete as required):	No action	Immersion or spray of fittings	Full disinfection
Comments			

Assessed by (Signature)		Authorised Person (Water) (Project/Estates Officer)	Date	
Approved by (Signature)		Deputy Responsible Person (Water) (Head of Projects)	Date	
Accepted by (Signature)		Authorised Person (Water) (For the Written Scheme to accept the System back in use)	Date	

Completed record forms to be held in Water Safety Log Book

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Design checklist for alterations to or new work to water systems (025)

<table>
<tr><td>NHS Board</td><td colspan="4"></td></tr>
<tr><td>Estates department</td><td colspan="4"></td></tr>
<tr><td>Site premises</td><td colspan="2"></td><td>Location of works</td><td></td></tr>
<tr><td>Project reference</td><td colspan="2"></td><td>Date</td><td></td></tr>
<tr><td>Person Making Assessment
(Print name)</td><td colspan="2"></td><td colspan="2">‘Designer’
in compliance with the Construction (Design and Management) Regulations: 2007.</td></tr>
<tr><td colspan="5">Brief description of alteration/upgrade/project:</td></tr>
</table>

Completed record forms to be held in Water Safety Log Book

Design Checklist

Ref	Design, Planning and Construction	Yes	No
	General		
1	If you are altering an existing system, are all outstanding and retrospective issues in the *Legionella* Risk Assessment or Written Scheme accounted for in the project work to ensure the Temperature Regime works?		
2	If you are fitting a new system or new components to any existing system, do any of the materials or fittings to be used support the growth of micro-organisms?		
3	Are low corrosion materials used?		
4	Have arrangements been made to follow the requirements of SHTM 04-01 Part E (materials and filtration) and include the leachate flushing and disinfection regime?		
5	If fitted, are thermostatic mixing valves (TMVs) sited as close as possible to the point of use?		
6	Has the inclusion of flexible hoses been avoided (and any existing removed) in the project?		
7	Are all showers fitted with fixed heads to prevent backflow?		
8	Are all dead-legs and blind stub-ends/plugged-tees been removed from the system?		
9	At hand wash stations – has an assessment been made to ensure that the tap outlet is appropriate and suits the basin? i.e. is without requiring water straighteners to avoid splashing? – and water from the tap outlet does not flow directly into basin drain hole, whilst avoiding splashing?		
10	At hand wash stations, are soap dispensers/ alcohol hand rubs placed to avoid drips on taps or into the basin?		
11	Has the Written Scheme for the water system been *Legionella* risk assessed?		
12	Have arrangements for updating the Written Scheme for the water system been planned to take account of this project, including written operating instructions, accurate schematic and detailed as fitted drawings at handover?		
13	Is the water system connected to BEMS with the required performance parameters?		
14	Have arrangements been made prior to work commencing for water sampling and testing to follow the requirements of SHTM 04-01 Part C?		
15	Have arrangements been made for Palintest Chlorometer readings of the water system(s) prior to the project? (027)		
16	Have arrangements been made for Palintest Chlorometer readings of the water system(s) to be included in the commissioning details for the project on completion? (027)		

(continued overleaf)

Ref	Design, Planning and Construction	Yes	No
	Cold Water Systems		
17	Whether a BEMS is fitted or not – is a visible and accessible manual means of monitoring cold water system supply (at building block inlet or meter point), tank storage, flow (and return where appropriate) temperatures available?		
18	Is cold water stored and distributed to outlets at below 20^{0}C?		
19	Is the cold water circulated?		
20	If cold water is circulated will it require to be chilled to ensure distribution below 20^{0}C?		
21	Are low use outlets installed upstream of higher use outlets?		
22	Has cold water storage been assessed and minimised, i.e. holds enough for one days use?		
23	Is supply and distribution piping insulated and kept away from all heat sources?		
24	Is the cold water tank:		
a)	Fitted with a cover and insect screen(s) on any pipework open to the atmosphere?		
b)	Located in a cool place and protected from external temperature?		
c)	Accessible?		
	Domestic Hot Water Systems		
25	Whether a BEMS is fitted or not – is a visible and accessible manual means of monitoring domestic hot water system storage, flow and return temperatures available?		
26	Is domestic hot water stored and distributed above 60^{0}C as it enters the supply system and circulated at no less than 50^{0}C at the return into the calorifier?		
27	Does the calorifier storage capacity meet normal daily fluctuations in hot water use while maintaining a supply temperature of at least 55^{0}C to the furthermost draw-off (sentinel) point in the circulating system?		
28	Are the hot water distribution pipes insulated?		
29	If more than one calorifier is used, are they connected in parallel?		
30	Does the calorifier have the following fitted:		
a)	A drain valve?		
b)	A temperature gauge on the calorifier and on inlet and outlet pipework?		
c)	An accessible access panel?		

(continued overleaf)

Ref	Design, Planning and Construction	Yes	No
	Domestic Hot Water Systems		
25	Whether a BEMS is fitted or not – is a visible and accessible manual means of monitoring domestic hot water system storage, flow and return temperatures available?		
26	Is domestic hot water stored and distributed above 60^{0}C as it enters the supply system and circulated at no less than 50^{0}C at the return into the calorifier?		
27	Does the calorifier storage capacity meet normal daily fluctuations in hot water use while maintaining a supply temperature of at least 55^{0}C to the furthermost draw-off (sentinel) point in the circulating system?		
28	Are the hot water distribution pipes insulated?		
29	If more than one calorifier is used, are they connected in parallel?		
30	Does the calorifier have the following fitted:		
a)	A drain valve?		
b)	A temperature gauge on the calorifier and on inlet and outlet pipework?		
c)	An accessible access panel?		

Assessment and any Comments *(to clarify assumptions, eliminate hazards and risks and provide information about any remaining risks):*

Assessed by: Designer (Print name)		Signature		Date	
Co-ordinated by Authorised Person (Water) (Project / Estates Officer) (Print name)		Signature		Date	
Approved by Deputy Responsible Person (Water) (Head of Projects) (Print name)		Signature		Date	
Accepted by Authorised Person (Water) (For the Written Scheme holder accepting Pre-Start) (Print name)		Signature		Date	

Completed record forms to be held in Water Safety Log Book

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Flushing water outlets record form (026)

NHS Board	
Site / Premises :	
Ward / Dept :	

Outlet being flushed	Date flushed	Initials

Supervisor Accepted by (Signature)	
Print name	

NB: This record to be retained for 5 years, to comply with regulations.

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Estates chloramines record form (027) *(Use where applicable)*

NHS Board			
Estates department			
Site/Premises		Thermometer and Calibration No's.	
System(s)		Chlorometer No.	

Instructions for Palintest DPD Test Chlorometer PTH 045D:

1. Select an appropriate hot or cold water outlet, representative of secondary distribution pipework system. Run hot water for 1 minute and cold water for 2 minutes before commencing sampling in Test A.
2. **Test A Free Chlorine** – rinse test tube with sample leaving 2 or 3 drops in the tube. Add one DPD No 1 tablet, crush table, then fill to the 10ml mark. Mix dissolved tablet and ensure particles have settled. Take reading immediately and record.
3. **Test B Total Chlorine** – Using solution from Test A – Add one DPD No 3 Table, crush and mix to dissolve. Stand for 2 minutes. Take reading immediately thereafter and record.
4. **Calculate Combined Chlorine** – Subject A from B and record. Readings should normally be just less than 1.0 mg/litre down to 0.4 mg/litre. If the reading is less than 0.4 mg/litre – inform the Authorised Person, who will investige.

Data recorded

Ward / Dept	Room No.	Date and Time	Outlet Details				Palintest Readings			Comments Okay - Yes / No (tick / cross)
			WHB/SINK/ BATH/SHWR	HOT (tick)	COLD (tick)	Temp (°C)	Free Chlorine (Tablet No 1) (A) (mg/litre)	Total Chlorine (Tablet No 3) (B) (mg/litre)	Combined Chlorine (B – A) (mg/litre)	

(continued overleaf)

Additional comments/Actions			
Reading taken by (Print name)		Signature	
Supervisor accepted by (Print name)		Signature	
Assessor (Authorised Person (Water))	Print name		
Signature		Date	
Manager (Responsible Person (Water))	Print name		
Signature		Date	

Completed record forms to be held in Water Safety Log Book

Safety control log (including plant and maintenance) record form (028)

NHS Board					
Estates department					
Site/Premises					
Block/System			Plant Room		
Date (day/month/ year)	Description / Comments	Actions to		Time of Record	Name & Signature
Accepted by (Signature of Supervisor)			Print name		

Completed record forms to be held in Water Safety Log Book

Record form for acceptance of work to be conducted and confirmation of work completed on a water system (029)

<table>
<tr><td>NHS Board</td><td colspan="3"></td></tr>
<tr><td>Estates department</td><td colspan="3"></td></tr>
<tr><td colspan="4">Pre-start</td></tr>
<tr><td>Project Number:</td><td></td><td>Project Manager:</td><td></td></tr>
<tr><td>Site / Block / Premises:</td><td></td><td>Location of Work (Ward/Department):</td><td></td></tr>
<tr><td>Written Scheme Ref. No.:</td><td></td><td>Authorised Person (Water) The holder of the Written Scheme:</td><td></td></tr>
<tr><td>Expected Start Date:</td><td></td><td>Project Designer:</td><td></td></tr>
<tr><td>Anticipated Duration:</td><td></td><td>Project Contractor:</td><td></td></tr>
<tr><td>Expected Completion Date:</td><td></td><td>Contractor(s) Working on the Water System:</td><td></td></tr>
<tr><td>Reference Specification No.:</td><td></td><td>Reference Drawing No(s):</td><td></td></tr>
<tr><td>Form 024 Completed and attached:</td><td></td><td>Form 025 Completed and attached:</td><td></td></tr>
<tr><td>Water Quality Sampling Certificate and Palintest Results completed and attached:</td><td></td><td>Where required are -Leachate / Disinfection Test Results completed and attached:</td><td></td></tr>
<tr><td colspan="3">Confirmation that those working on the water system are Approved Plumbers (PILS):</td><td></td></tr>
<tr><td colspan="3">The Water System remains operational in part? or whole? or not operational?</td><td></td></tr>
<tr><td>Date Form Compiled:</td><td></td><td>Water Quality acceptable prior to work commencing:</td><td></td></tr>
<tr><td colspan="3">Authorised Person (Water) From the Project Team compiling this Form and taking responsibility for the work:</td><td></td></tr>
</table>

(continued overleaf)

Summary Description of the Work / Project and the Area / Rooms affected:				
Duty Holder(s) or their devolved Local Manager(s) informed and affected by the work / project are:				
Approval and acceptance of work and conditions				
Duty Holder(s) or their devolved Local Manager(s)		Accepted by (Print name)		
Signature			Date	
Authorised Person (Water) (Holder of the written scheme)		Approved by (Print name)		
Signature			Date	
Authorised Person (Water) (From the project team accepting responsibility for the work, working with the holder of the Written Scheme – who remains responsible for the water system		Accepted by (Print name)		
Signature			Date	

Completed record forms to be held in Water Safety Log Book

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Post completion – Confirmation of work completed and acceptance:

Post Completion Checklist:

Ref	Design, Planning and Construction	Yes	No
	General		
1	Has **all** the work as described in the PRE-START Section been completed?		
2	Comments:	-	-
3	Where an existing system has been altered, are all outstanding and retrospective issues in the *Legionella* Risk Assessment or Written Scheme accounted for in the completed work to ensure the Temperature Regime works?		
4	Where a new system or where new components have been fitted to an existing system, do any of the materials or fittings to be used support the growth of micro-organisms?		
5	Have low corrosion materials been used?		
6	Have arrangements followed the requirements of SHTM 04-01 Part E (materials and filtration) and include the leachate flushing and disinfection regime?		
7	Where fitted, are thermostatic mixing valves (TMVs) sited as close as possible to the point of use?		
8	Has the inclusion of flexible hoses been avoided (and any existing removed) in the project?		
9	Have all showers been fitted with fixed heads to prevent backflow?		
10	Have all dead-legs and blind stub-ends/plugged-tees been removed from the system?		
11	At hand wash stations – has an assessment been completed to ensure that the tap outlet is appropriate and suits the basin? i.e. is without requiring water straighteners to avoid splashing? – and water from the tap outlet does not flow directly into basin drain hole, whilst avoiding splashing?		
12	At hand wash stations, have soap dispensers/ alcohol hand rubs been placed to avoid drips on taps or into the basin?		
13	Has the Written Scheme for the water system been updated to take account of this project, with written operating instructions, accurate schematic and detailed as fitted drawings provided at handover?		
14	Has the updated Written Scheme for the water system been *Legionella* risk assessed?		

(continued overleaf)

15	Has the water system been connected to BEMS with the required performance parameters?		
16	Have arrangements been made after the work has been completed for water quality sampling and testing to follow the requirements of SHTM 04-01 Part C?		
17	Have arrangements been made for Palintest Chlorometer readings of the water system(s) after completion of the project? **(027)**		
18	Have the Palintest Chlorometer readings of the water system(s) been included in the commissioning details for the project at completion? **(027)**		
19	Has a certificate of disinfection to BS6700 (or BS EN 806) been provided?		
20	Whether a BEMS has been fitted or not – is a visible and accessible manual means of monitoring cold water system supply (at building block inlet or meter point), tank storage, flow (and return where appropriate) temperatures available?		
21	Is cold water stored and distributed to outlets at below 20^0C?		
22	Is the cold water circulated?		
23	If cold water is circulated – is it (or require to be) chilled to ensure distribution below 20^0C?		
24	Are low use outlets installed upstream of higher use outlets?		
25	Has cold water storage been assessed and minimised, i.e. holds enough for one days use?		
26	Has all supply and distribution piping been insulated and kept away from all heat sources?		
27	Is the cold water tank:		
a)	Fitted with a cover and insect screen(s) on any pipework open to the atmosphere?		
b)	Located in a cool place and protected from external temperature?		
c)	Accessible?		
	Domestic Hot Water Systems		
28	Whether a BEMS has been fitted or not – is a visible and accessible manual means of monitoring domestic hot water system storage, flow and return temperatures available?		
29	Is domestic hot water stored and distributed above 60^0C as it enters the supply system and circulated at no less than 50^0C at the return into the calorifier?		
30	Does the calorifier storage capacity meet normal daily fluctuations in hot water use while maintaining a supply temperature of at least 55^0C to the furthermost draw-off (sentinel) point in the circulating system?		

(continued overleaf)

31	Have the hot water distribution pipes been insulated?		
32	If more than one calorifier is used, have they been connected in parallel?		
33	Does the calorifier have the following fitted:		
a)	A drain valve?		
b)	A temperature gauge on the calorifier and on inlet and outlet pipework?		
c)	An accessible access panel?		
34	Leachate / Disinfection Test Results completed and attached:		
35	Water Quality Sampling Certificate and Palintest Resulted completed and attached:		
36	Water Quality acceptable prior to returning the water system into use?		
Any other comments			
Confirmation of work completed and acceptance:			

Completed record forms to be held in Water Safety Log Book

A47392376

Confirmation of work completed and acceptance:

This confirms compliance of all work described in the Post completion checklist, in accordance with the NHS Board - Management and Control of Water Safety Policy and associated Procedures. No other work has been carried out under this notification other than that described previously.

Confirmed all Work Completed by:		
(signed) (Designer)	Date:	
(print name)		
and:		
(signed)	Date:	
(print name)		
Authorised Person (Water) (From the Project Team accepting responsibility for the work, completing work with an updated Written Scheme)		
Approved and Accepted by:		
(signed)	Date:	
(print name)		
Authorised Person (Water) (Holder of the updated Written Scheme)		
Accepted by **Duty Holder(s)** or their devolved Local Manager(s)		
(signed)	Date:	
(print name)		
(for those that were affected by the work / project)		

Completed record forms to be held in Water Safety Log Book

NHS National Services Scotland

Scottish Health Technical Memorandum 04-01:

The control of *Legionella*, hygiene, 'safe' hot water, cold water and drinking water systems Part E: Alternative materials and filtration

Health Facilities Scotland
Engineering and Environment

August 2015

Contents

A47392376

Acknowledgements

SHTM 04-01 Part E has been developed, updated and amended by Health Facilities Scotland based on the second edition of former Scottish Hospital Technical Note (SHTN) 2 published in December 1999 by the Property & Environment Form Executive (PEFEx). The significant participation of the National Water Services Advisory Group and Alistair Waddell of Zander Services is gratefully acknowledged.

Preface

About Scottish Health Technical Memoranda

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

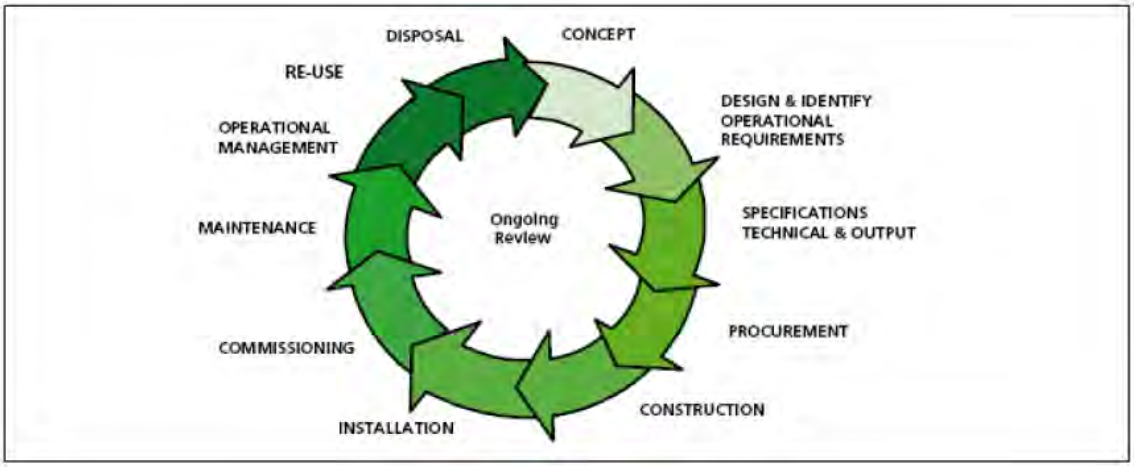
The focus of SHTM guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle: Healthcare providers have a duty of care to ensure that appropriate engineering governance arrangements are in place and are managed effectively. The Engineering Scottish Health Technical Memorandum series provides best practice engineering standards and policy to enable management of this duty of care.

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

Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities. Scottish Health Technical Memorandum guidance is the main source of specific healthcare-related guidance for estates and facilities professionals.

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

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



Healthcare building life-cycle

Technical Memorandum suite

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

Scottish Health Technical Memorandum 00: Policies and principles (applicable to all Scottish Health Technical Memoranda in this series)

Scottish Health Technical Memorandum 01: Decontamination

Scottish Health Technical Memorandum 02: Medical gases

Scottish Health Technical Memorandum 03: Heating and ventilation systems

Scottish Health Technical Memorandum 04: Water systems

Scottish Health Technical Memorandum 05: Reserved for future use

Scottish Health Technical Memorandum 06: Electrical services

Scottish Health Technical Memorandum 07: Environment and sustainability

Scottish Health Technical Memorandum 08: Specialist services Some subject areas may be further developed into topics shown as -01, -02 etc and further referenced into Parts A, B etc.

Example: Scottish Health Technical Memorandum 06-02 Part A will represent: Electrical safety guidance for low voltage systems

In a similar way Scottish Health Technical Memorandum 07-02 will simply represent: Environment and Sustainability – EnCO$_2$de.

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

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

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

Engineering guidance structure

Executive Summary

This part of Scottish Hospital Technical Memorandum (SHTM) 04-01originates partly from investigations which had been carried out in consequence of the widespread corrosion of copper piping in the domestic hot and cold water (DHCW) services systems in NHSScotland premises, and gives guidance on the selection of alternative materials for the piping, fittings, associated water filtration equipment requirements, and installation and commissioning procedures.

The section dealing with filtration includes operational experience to assist designers and purchasers. Filtration should no longer be regarded as a desirable optional extra as its inclusion brings many benefits that offset the capital and revenue costs in the longer term. SHTM 04-01 Part A, Section 5 also refers.

Introduction

Background information

The original Scottish Hospital Technical Note 2 was one of a series of Scottish Hospital Estate technical guidance notes, intended to assist Chief Executives, General Managers, Facilities Managers and Estates Managers in achieving appropriate technical standards in new and refurbishment projects.

SHTN 2 addressed the problems experienced by the NHS in Scotland in consequence of the corrosion of copper pipework systems. Despite extensive research, the absolute cause of the corrosion has never been precisely determined, but enough was understood to conclude that copper pipework in Domestic Hot and Cold Water (DHCW) services in hospitals and other healthcare premises in many areas of Scotland (and elsewhere), with soft water, and / or where high levels of sediment were found, had a high propensity to failure.

Guidance on approved alternatives to copper pipework is provided in this SHTM. Over time, more alternatives may be developed and tested, and these will be included in future revisions as and when required.

The original research involved significant 'on site' work in Scottish hospitals over an extended period. Many hundreds of copper pipework systems, ranging in age from 18 months to 50 years, were opened up for inspection and the levels of detritus found have led to the conclusion that it is essential for healthcare premises pipework systems to be filtered to maintain hygienic conditions. Filtration advice, therefore, is also included in this SHTM.

1. Management Overview

General

1.1 This SHTM covers the policy, design, commissioning, operation and maintenance requirements for the installation of domestic hot and cold water (DHCW) services systems throughout NHSScotland premises.

Note: The water (hot and cold) in these systems is considered potable.

1.2 For NHSScotland this SHTM supersedes the specification of domestic hot and cold water systems outlined in the NHS Health Technical Specification CO1 – Common Services, Mechanical, except where specifically noted.

1.3 This particular section of this SHTM addresses the selection of materials for distribution pipework and fittings and gives guidance on water consumption data required to size water filtration equipment to be used in DHCW services systems.

1.4 Since 1983 it has become evident that corrosion of copper piping within DHCW services in many Scottish hospitals and other Healthcare Premises was a serious problem.

1.5 This corrosion, which took the form of localised pitting or 'pinhole' attack to the wall of the piping, may be unique to institutional buildings, and with slight variations, has been found to be predominant in soft water regions throughout Scotland. Other countries in mainland Europe have experienced similar problems, with Northern Ireland and Wales also identifying corrosion within healthcare premises.

1.6 The 'pinholes' can form singly or in groups, but do not appear to connect one with another to form cracks leading to catastrophic failure of the pipe. Nevertheless, serious leakage has occurred.

1.7 The propagation rate of this 'pinhole' corrosion through the pipe wall was such that the copper pipework could leak in as little as 6 years from the introduction of water into the system. However no definitive time scale was able to be accurately assessed.

1.8 Although this form of attack has not so far as is known resulted in a catastrophic form of failure, it does lead nevertheless to a severe shortening of a system's useful life, with a noticeably growing incidence of repair work and disruption to the operation of healthcare premises as the extent of pipe failure and water leakage increases.

1.9 Several Scottish healthcare premises which suffered serious pipework corrosion had to be totally re-piped using alternative materials for the pipework system.

1.10 It was also found that when only partial re-piping was carried out using copper tube within an already corroded system, the renewed pipework inevitably suffered similar corrosion. Such remedial treatment, therefore, could only defer eventual full scale re-plumbing for a period of time.

1.11 To date the cause of this form of copper corrosion has not been fully identified, but sufficient evidence was gathered to confirm its widespread existence to varying degrees throughout Scottish hospitals and other Healthcare Premises.

1.12 As well as investigating possible causes of this corrosion, the NHS has investigated the use of alternative materials to replace copper. The approved alternative materials have emerged as:

- austenitic stainless steels;
- polyvinyl-chloride (PVC) plastics;
- polybutylene;
- cross-linked polyethylene (PE-X).

Guidance on the requirements for the specific use of these materials is given in Sections 3, 4, 5, 6 and 7 of this section of this SHTM.

Policy and strategy

1.13 It is accepted that some areas in NHSScotland suffer less from corrosion of copper pipework than others. However, as a result of the intensive research into the corrosion of copper piping, the implications of the use of copper as a piping material should be very carefully considered prior to the material being proposed for use for DHCW services pipework in new or refurbishment projects. The strongest recommendation remains that it should be employed only for small, localised repairs. See also Section 11 of SHTM 04-01 Part A.

Note: This statement applies only to copper *pipe*. It does not apply to copper alloy fittings which, as indicated in other parts of this SHTM, may be used in conjunction with stainless steel and plastic piping.

1.14 This SHTM supersedes all previous recommendations and/or specifications relating to the selection of materials and the design, installation and maintenance of pipework and associated equipment for DHCW services systems in NHSScotland premises.

1.15 Copper pipe, however, may still be usefully used for on-going maintenance purposes in the DHCW services systems of existing accommodation.

Note: Such use shall not be construed to infer that the use of copper pipe for sizeable extensions or major re-piping of existing water distribution systems is recommended.

1.16 Legionnaires' disease is considered preventable. Consequently, designers, installers, operators and maintainers are recommended to adopt the practices stated in this SHTM for achieving and maintaining a high standard of cleanliness in all DHCW services systems in addition to the measures stipulated in the relevant codes of practice of NHSScotland and the Health and Safety Executive (HSE), namely:

- Scottish Health Technical Memorandum (SHTM) 04-01: The control of *Legionella,* hygiene, 'safe' hot water, cold water and drinking water systems
  - Part A: Design, installation and testing
  - Part B: Operational management
  - Part C: TVC testing protocol
  - Part D: Disinfection of domestic water services
  - Part E: Alternative materials and filtration HSE: Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8). Approved code of practice and guidance (2000)

1.17 In keeping with this, appropriate water filtration equipment should also be introduced to assist in maintaining hygiene and reducing detritus in pipework systems. Guidance on requirements specific to the use of such equipment is given in Section 8 of this part of this SHTM.

1.18 Some of the alternative materials, when used in the pipework of DHCW services systems, may leach substances potentially harmful to patients, staff and visitors. The use of such materials must not give rise to levels of such contaminants in excess of acceptable toxicity and health standards (e.g. those specified by the World Health Organisation (WHO).

Note: This is an important stipulation. This requirement is in addition to the requirement to meet the United Kingdom Water Byelaws Scheme (UK WBS) – managed by WRc plc – which in essence is designed only to satisfy the requirements of BS6920-2.1: 2000.

1.19 Compliance with paragraph 1.18 means that system designers, manufacturers and suppliers must use materials which meet acceptable criteria with respect to leaching contaminants into water and potential toxic effects.

Related standards and codes of practice

1.20 In addition to the requirements specified in this SHTM, the design, installation, disinfection, commissioning and maintenance of DHCW services pipework and filtration equipment must also comply with the following standards and codes of practice:

- BS6700: 2006+A1: 2009 sections as applicable;
- Health and Safety at Work etc. Act 1974;
- Water Authority Byelaws of the relevant Councils in Scotland;
- Water Fittings and Materials Directory;
- Control of Substances Hazardous to Health Regulations 2002.

1.21 Further details of these documents are given in References. It is the responsibility of anyone using any of these reference documents to ensure that it is the latest edition, including any amendments, and to pay due attention to the effect of any changes it may have on this SHTM.

Management responsibilities

1.22 It is recommended that Chief Executives, General Managers, Facilities Managers and Estates Managers within NHSScotland ensure that the guidance given in this SHTM is implemented within their respective areas of responsibility.

1.23 It is also recommended that management ensure that:

- all concerned with the procurement and supply of material and equipment for the DHCW services systems in NHSScotland premises are aware of and are contributing (at a level appropriate to their duties and responsibilities in the procurement and/or supply processes) to the Post Commissioning Documentation (PCD) requirements set out in SHTN 1;
- on delivery, all material and equipment fully complies with the prescribed specifications and contract requirements; and
- careful consideration is given to assessing levels of 'on site' supervision to ensure continuing compliance.

2. Design and Operational Considerations

General

2.1 The general requirements for the installation and maintenance of DHCW systems are outlined in this section. Specific requirements for materials are laid out in Sections 3, 4, 5, 6 and 7.

2.2 The onset of widespread corrosion in copper piping led to extensive investigations of DHCW services systems in NHSScotland premises. These investigations highlighted many design and operational difficulties. For example, test results showed that there were a number of areas where it was difficult to comply with the maintenance of 'safe' water temperatures, as stipulated in SHTM 04-01, Part A. Test results also showed that the monitoring of hot and cold water temperature profiles was of paramount importance because of their influence on bacterial growth. A recent deficiency has highlighted a lack of facilities for measuring or monitoring incoming water mains temperatures prior to the entry to storage tanks.

2.3 It has been demonstrated that, when the DHCW services are not circulating, hot and cold water temperatures reach ambient temperature. Cold water circuits, therefore, can readily attain temperatures above 25°C, whilst hot water temperatures can drop to below 50°C in a very short time. Consequently, it is important that care be taken to ensure that appropriate water temperatures are maintained and that means are provided whereby any potential *Legionella* hazards are minimised.

2.4 To assist in maintaining appropriate cold water temperatures within the system, due consideration should be given at the design stage to the overall layout to ensure that the pipework is so arranged as to minimise stagnation/heat gain in the system. Stagnation is always a risk and efforts to reduce this may incur the use of additional pipework, to ensure that legs of the system terminate at frequently used appliances.

2.5 Where practicable pipework should not be installed adjacent to a known heat source. However, it is accepted that this is not always possible particularly during re-piping activities, whilst maintaining the existing system in operation.

2.6 All pipework and fittings should therefore be insulated to a standard to minimise heat gain and maintain the cold water temperature at an acceptable level.

2.7 Furthermore it is important that attention is given to the location and capacity of cold water storage cisterns to avoid undue heat gain from heat sources, such as heat emitting plant and pipework or the sun in summer months.

2.8 To combat the effect of heat gain cold water storage cisterns should be provided with a standard of insulation relative to the highest ambient temperature which may be achieved within the tank room to prevent the contents of the cistern exceeding the maximum cold water temperatures allowable.

2.9 Insulation/cistern manufacturers and/or suppliers should therefore be advised as to the temperature requirements prior to the designers finalising the specification to ensure that the requirements can be achieved.

2.10 Most hot water systems are already provided with return circuitry or, in some cases, trace heating elements. Nevertheless, problems in maintaining temperatures do occur. Inevitably it is the smaller installations, such as health centres or clinics, where these problems occur, possibly due in the main to the shutting-down of the water circulating pumps when the centre is closed at night and during weekends. In these circumstances, consideration should be given to maintaining systems in use at all times or else to adopting alternative methods such as single pipe systems using cold water and local 'point of use' heaters. Further advice is given in SHTM 04-01, Part A, paragraph 9.59.

Materials

2.11 The alternative materials investigated and deemed acceptable to replace copper piping in DHCW services systems in NHSScotland premises are as follows:

- 316 S16 austenitic stainless steel to the following specifications:
  - BS4127: 1994
  - DIN 1988;
  - DIN 2463;
  - BS EN 10088-2.
- Unplasticised polyvinyl chloride (PVC-U) to the following specification:
  - BS EN 1452: 1999 (for cold water systems only).

Note: PVC-U has now generally been superseded in use by PVC-C.

- Chlorinated polyvinyl chloride (PVC-C) to the following specifications:
  - BS7291, Part 4: 2001 (for hot and cold water systems);
  - DIN 8079 & DIN 8080.
- Polybutylene to the following specification:
  - BS7291, Parts 1 and 2: 2001;
- PE-X to the following specification:
  - BS7291, Parts 1 & 3: 2001,DIN 16892.

Note:

1. PVC-U, PVC-C, PB or PE-X should not be used for a fire hose-reel system.

2. It should be noted by designers and installers that the approved range of thermoplastic materials has a much greater coefficient of thermal movement than metallic pipework. Thermal movement of the pipework system must be allowed for in both design and installation and must comply with manufacturer's requirements.

2.12 The selection of these materials has involved considerable research to prove their worthiness. One consequence of this work is that great importance is now placed on the toxicity of leachates emanating from pipework material.

2.13 In this respect, it is now apparent that many materials previously considered acceptable can release undesirable leachates during the early life of a new or partially re-piped system. A typical example is the use of copper alloy fittings, such as gunmetal, which can contain up to 6% lead. During the early commissioning stages, when first immersed in water and the oxide films are forming on the wetted surface of the fittings, a significant release of lead and zinc can take place. This rapidly decays during the first months of operation, after which the traces of lead and zinc may be within acceptable levels. It is therefore advantageous, where possible, to 'pre-soak' these fittings prior to installation by immersion in water.

2.14 This release or leaching occurs in all pipework systems where copper alloy fittings are used. Monitoring tests have only recently highlighted this problem, which has gone unnoticed in the past.

Note: The attention of designers and management of all NHSScotland premises (and in particular maternity and infant care units) is drawn to the need to examine carefully the design and commissioning of DHCW services systems to ensure that appropriate flushing regimes are carried out and that subsequent post-commissioning monitoring programmes are implemented.

2.15 In the case of the PVC plastics, initial concerns with regard to the use or ‘organo-tin’ and lead plasticisers have been largely resolved. Leachate tests have shown that, for the PVC-C materials subjected to tests, only the solvent remains a problem.

2.16 It is important, therefore, that every endeavour should be made, during installation, to minimise the carry-over of solvent material to the internal surfaces of the piping or fittings.

2.17 In addition to the pipework systems discussed above, all materials associated with auxiliary equipment in contact with the water must conform to the requirements of the UK WBS, managed by WRc plc.

Leachate flushing

2.18 It has been determined that the use of stainless steel, PVC-U, PVC-C, PB or PE-X piping requires a leachate flushing regime to reduce the level of contaminants leaching from the piping material into the water. As indicated in the Introduction, further pipework materials may emerge in future as suitable for conveying domestic hot & cold water services and it should be assumed that all pipework materials must undergo a flushing procedure prior to being brought into use.

2.19 Details of this regime are given in paragraph 2.58 and its timing within the construction and commissioning of a new or refurbishment project is shown in Figure 2.2.

Pipe fittings and valves

2.20 All pipe fittings (i.e. couplings and flanges) and valves should be made of materials compatible with the material of the pipe to which they are to be fitted, and all parts in contact with the water must be non-dezincifiable.

Note: Cast iron must not be used in the construction of any pipes, fittings, valves, pumps or part thereof which may come into contact with the water.

2.21 All valves should be of the ¼-turn ball or butterfly type and have either compression coupling ends, screwed ends, flanged ends, solvent cement jointing ends or fusion jointing ends as appropriate to the size and type of pipe to which they are to be fitted. The use of disconnecting unions at valves and plant will simplify maintenance while keeping systems in operation.

2.22 Where practicable, only one manufacturer of fittings and only one manufacturer of valves should be used in any single NHSScotland premises.

Pumps

2.23 All pumps should be made to BS5257: 1975. Construction and dimensions and should be supplied with isolating valves on the inlets and non return valves and isolating valves on the discharge. Pump casings should be made of gunmetal or stainless steel depending upon the type of construction used and the shafts and rotating elements should be made from stainless steel. The isolating and non return valves should be made from compatible materials and have ends appropriate to the material and size of pipe to which they are to be fitted.

Note: In general, all pumps and their associated valves should comply with the relevant requirements of BS6920: 2000 (where applicable) and the UK WBS. In particular, all parts of the pumps and valves that are in contact with the water must be of stainless steel or non-dezincifiable material.

Cold water storage cisterns

2.24 All cold water storage cisterns should meet the requirements of U.K. WBS Byelaw 30, SHTM 04-01 and BS6700: 2006 and be constructed of single piece or sectional glass-reinforced plastic. All internal components of the cisterns (i.e. nuts, bolts, washers, stays, spacers, bracings, etc.) should be of 316L stainless steel. All external components should be zinc plated.

2.25 Where multi-compartment type cisterns are to be provided, these should be so designed and assembled to ensure no leakage occurs when any of the compartments are subjected to unequal forces due to one or more of the compartments being drained for routine maintenance. Cisterns shall have a smooth internal finish with a free draining base. Incoming and outlet pipework shall be so arranged to achieve a balanced flow and prevent stagnation within the cistern. Cisterns shall be fully factory insulated.

Pipework system

2.26 Stainless steel, PVC-C, PB and PE-X piping may be used in hot water systems and in cold water systems. If PVC-U piping is to be used at all, it should be confined to cold water systems only.

Note: Where PVC-C, PB or PE-X pipework is used for hot water distribution, temperature operated actuated valves should be installed on the flow pipework within 300mm of the connection to the calorifier. The valve should be set to operate should the calorifier temperature exceed 75°C. This is to protect the pipework from irreversible distortion due to high temperatures. By implication alternatives to pasteurisation involving higher temperatures will be required for plastic pipework installations. Further guidance is provided in Part D of this SHTM. Paragraphs 2.9 – 2.11 and Appendix 1 (Heat and Flush).

Excessive temperatures may also occur should there be a failure within the calorifier control system.

The installation of non-return valves on both the Cold Water Feed and Hot Water Service Return should protect this pipework in the event of calorifier overheating. However, it is possible that the non-return valves could be subject to malfunction.

It is therefore recommended that temperature operated actuated valves are installed on both **cold water feed** and **hot water service return** pipework within 300mm of the connection to the calorifier.

As no valve is allowed on an open vent, consideration should be given to the use of stainless steel for the open vent pipework in a vented system.

The circulating pump must be located on the flow pipework after the open vent. This will allow the vent to be taken through the lid of the cold water storage tank and sealed in place to maintain integrity and avoid particulates entering the system.

2.27 Irrespective of which pipe material is used, the design of DHCW pipework systems should meet the following requirements:

- in general, the pipework should follow the design guidelines laid down in Chartered Institution of Building Services Engineers (CIBSE) Guide G: Public Health Engineering (2004) and BS6700: 2006;
- due allowance should be made for differences in the thermal expansion characteristics of the pipe material and the material of associated fittings, pipe clips and support brackets, and the system should be designed in such a way as to minimise stress;
- thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system;
- the manufacturer's guidance and recommendations must be adopted at both stages of the work;
- there are various methods of containing the effects of thermal movement within the pipework system;
- the widely used method within NHSScotland premises is the use of expansion loops/offsets with fixed points/anchors all arranged in accordance with the manufacturer's data and guidance;
- where space is limited consideration may be given to the use of expansion devices such as bellows or flexible braided sections. However, alternatives to ethylene propylene diene monomer (EPDM) for bellows or lining must be used. Safety Action Notice SAN (SC) 09/03 dated 30th November 2009 refers.

The high co-efficient of linear expansion for thermoplastic pipework, compared to metallic pipework, results in considerable movement of the pipework due to changes in temperature. This thermal movement is a function of the change in average temperature of the pipe wall. This temperature depends on internal and external environment temperatures. (See Figure. 2.1)

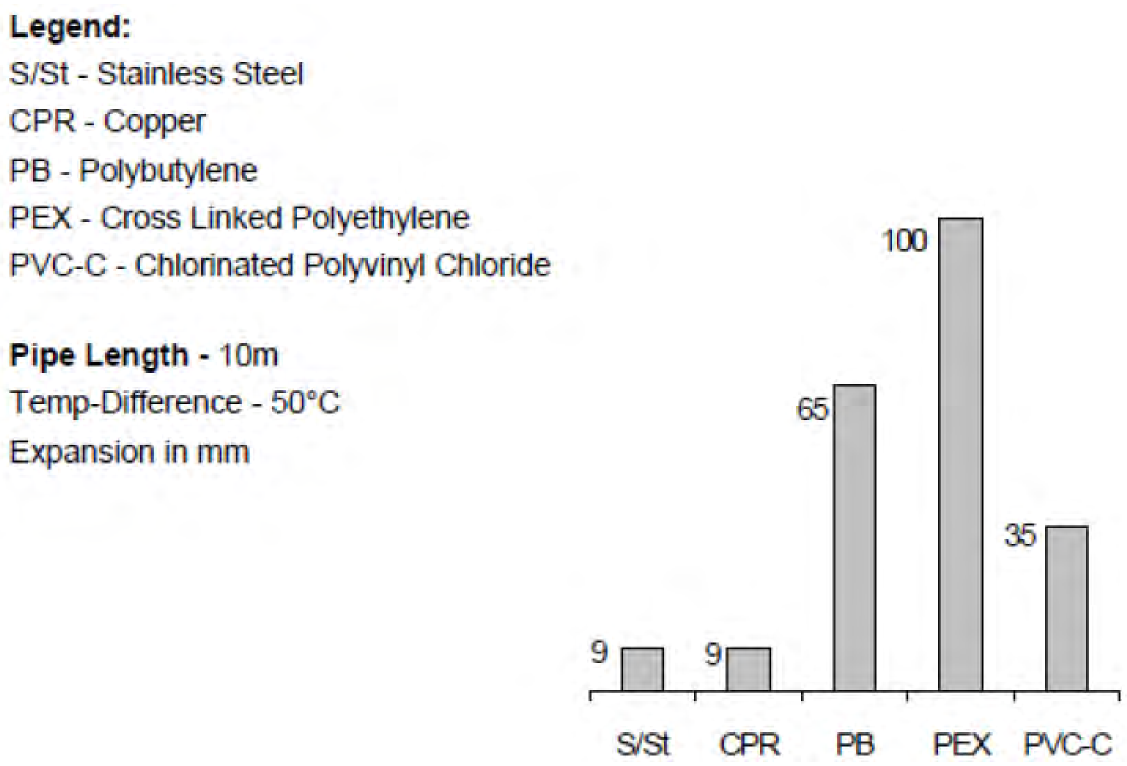


Figure 2.1

To accommodate thermal movement, loops/offsets are included within the pipework system, sized in accordance with the manufacturer's data and the relevant temperature differentials.

The pipework is constrained laterally by fixed points/anchors to induce the thermal movement to the loops/offsets.

Where fixed points/anchors are indicated, they must securely fix the pipework at that point.

Fixed points/anchors may be of either a proprietary brand or fabricated to meet specific site conditions.

Should fabrication of fixed points/anchors be adopted, the support arrangement should be offered for manufacturer's approval prior to overall adoption. Similar comments apply to the provision of pipe guides to direct movement towards loops, expansion bellows, etc.

Note: Manufacturer's literature indicates that a fixed point may be achieved with a tightened pipe clip with oversized pipe shells either side.

Installation experience has shown that the dimension from the building fabric face to the centre-line of the pipe is critical. The nippling rod between back-plate and pipe ring can flex under the force exerted by movement of the pipework. To eliminate this movement at a fixed point / anchor it is recommended that the distance between back-plate fixing to the building and the centre line of the pipe does not exceed that confirmed by the pipework or pipework support manufacturer.

Particular attention should be given to fixed points/anchors on vertical pipework due to the additional force of the weight of the column of pipe and its contents.

Note: Where PVC-C, PB or PE-X is utilised on the cold water distribution system allowance should be made in the design of the cold water system for the possible introduction of high temperature hot water (70 °C) for control of *Legionella* within the system (see paragraph 2.64). The cold water system and its associated expansion units, anchors and guides should therefore be designed to accommodate expansion of the same order as the hot water system.

- All fixed points and supports should comply with respective manufacturer's requirements.
- All pipe clips and support brackets should allow for thermal movement of the pipework in a controlled manner with minimum abrasive action. No clip or bracket should be sited so close to a direction change as to act as an unintentional anchor.
- Drain cocks should be provided as necessary at all low points to allow the system to be completely emptied of water when required. These drain cocks should be fitted parallel to the pipework where practical and should not provide projections. They should be finished with ends appropriate to the size of pipe to which they are to be fitted. Similarly, full-bore scour points will be required to aid removal of any detritus following chemical cleaning of the system.
- Unless specified otherwise, servicing isolating valves should be provided on each water draw-off connection to a fitment.
- all other valves should be fitted as and where necessary to:
  - balance the DHWS system;
  - allow isolation of individual circuits; and
  - comply with the Byelaws of the appropriate national and the water authority.
- Where quick-closing solenoid valves are fitted, or where due to pressure characteristics, water hammer may develop within the system. The pipework manufacturer should be consulted and the proposed method of containing/absorbing the resultant kinetic energy generated within the pipework system should be endorsed and approved by the manufacturer. It is preferable where possible to eliminate strong pressure surges within the system by carefully designing out any potential problems. Where this is impracticable careful selection of flexible links and surge dampers in conjunction with the pipework manufacturer should be undertaken, to ensure that the surge pressure/velocities generated do not have a detrimental effect on the integrity of the pipework system, or lead to excessive noise. Comments regarding the use of EPDM linings set out in paragraph 2.27 also apply here.
- The sizes of pipework should be as small as possible, consistent with current design practices, whilst ensuring that noise levels arising from the water flow remain satisfactory under maximum and minimum usage conditions.

- All pipe runs should be graded to ensure adequate venting and draining.
- Pipe runs should not be excessively long and dead legs should be kept to an absolute minimum to avoid stagnant flow conditions.

Note: This is particularly applicable to hot water systems, for which compliance with SHTM 04-01 Part A is necessary.

- Where there is risk of minimal flow or stagnant dead legs consideration should be given to re-routing pipework to ensure that the final connection is made to a frequently used fitment.
- Where a reduction of bore is accomplished at a pipe joint by the use of a reducer, these should be eccentric when installed in horizontal pipework and concentric when vertical.
- Thermal insulation should comply with BS5970: 2001 and should preferably not be applied to any pipework until after the pipework has been pressure tested. (See Note at end of paragraphs 2.28 and 2.49). Depending on the extent, size and complexity of a system, it may be expedient, to allow sectional programming to progress, to have thermal insulation applied in advance of pressure testing provided all joints are left fully exposed. This would require prior agreement confirmed in writing with the client's representative.

Sleeves

2.28 Tubular pipe sleeves should be fitted to all pipes which pass through external walls and internal divisions in the building fabric (i.e. walls, floors, ceilings, etc.) These sleeves should have internal diameters of sufficient size as to permit the free passage of the pipes through the building fabric and also ensure that the pipes do not touch either the sleeve or the building fabric.

Note: Pipes should **not** be insulated over the length within the sleeves.

2.29 At an external wall and where the internal division in the building fabric is **not** constructed as a fire barrier:

1. the sleeve should be:
   - constructed from a pipe cut-off of the same material as the pipe;
   - be set in position in the building fabric prior to the completion of finishing works, such as plasterwork, laying of screeds, etc;
   - extend the full thickness of the building fabric *and* finishing works in which it is set;
   - be cut back carefully to avoid protrusion beyond the finished surface of the wall, floor or ceiling.

Note: For requirements specific to wet floors see NHS Health Technical Specification C01, Element 02, Item 09.

2. at an external wall:

- the space between the sleeve and the pipe and the space between the sleeve and the wall should be sealed with mastic compound.

3. at an internal division:

   - the space between the sleeve and the pipe should be packed with inert, vermin proof, non-combustible fibrous material, and the sleeve ends should be sealed with non-combustible, non-hardening, non-cracking, intumescent mastic;

   - the space between the sleeve and the building fabric should be packed with inert, vermin proof, non-combustible fibrous material.

Note: Filler rings should be fitted to facilitate 2 and 3. The sleeve infill should extend along the full length of the sleeve.

Fire sleeves

2.30 Where pipes pass through internal divisions in the building fabric which are constructed as fire barriers, the sleeves fitted should be fire sleeves where required by Building Standards (Scotland) Regulations and NHS in Scotland Firecode.

2.31 In general, these fire sleeves should comply with the following:

- They should be specifically manufactured to suit the outside diameter of the pipe to which they are to be applied.
- They should be cylindrical in shape and closely, neatly and uniformly fit the pipe to which they are applied.
- They should be of robust construction.
- They should have a fire resistance rating of not less than the fire division through which the pipework is penetrating.
- Casings should not distort during the specified period of fire resistance.

2.32 In particular, they should comply, as appropriate, with the requirements given in Sections 3, 4, 5, 6 and 7 for stainless steel, PVC-U, PVC-C, PB & PE-X pipework systems respectively.

Installing the pipework system

2.33 Site supervision should be such as to ensure that a high standard of cleanliness is attained and maintained throughout all stages of installation.

2.34 All pipes, pipe fittings, valves, pumps and any other associated equipment should be inspected by site supervisory staff on delivery to site, to verify that they meet specification and contract requirements. All these items should also be checked to verify that they have been supplied properly protected, undamaged and free from surface abrasions or defects, in a clean condition (internally and externally) and with all pipe ends cut square and capped.

Note: Any item which, on delivery, does not meet the specification and contract requirements should be rejected and replaced.

2.35 The pipes should then be stored carefully in racks and kept protected in a clean dry condition until used in the pipework system. All other items should be stored in appropriate protected, clean dry conditions until used.

2.36 Each item should be examined carefully by the installer prior to installation to ensure that it has not suffered accidental damage whilst being transported about the site and is clean and free from dirt or contamination.

2.37 The pipes should be handled carefully and supported during the installation stages to ensure that the roundness of the pipe is maintained within the specified limits. Proper support is of particular importance when a pipe is clamped in a vice to ensure that its roundness is not affected by over-clamping.

Note: The vice jaws should be of a construction and material that does *not* mark or damage the surface of the pipe or impregnate the pipe.

2.38 When a pipe is cut on site it is imperative that proper methods of cutting are employed. The cut should be square with the pipe's length, and the cut-off portion and the remainder of the pipe should both be properly dressed, reamed and cleaned to ensure all debris from the cutting is removed. Purpose made tools should be used whenever possible.

Note: The use of hacksaws is not permitted due to their generating burrs and allowing swarf to enter the pipe bore.

2.39 All cuttings of pipe should be capped immediately after they have been cut from a length of pipe and so also should the remainder of the length. If not, site supervisory staff should reject them from use on the system.

2.40 Temporary caps should be fitted to all open pipe ends of the pipework during installation, to protect it from ingress of dirt when it is not being worked on.

2.41 All fittings, valves, pumps and other items should be installed in accordance with the manufacturer's detailed instructions.

Note: This is of particular importance for compression couplings. Over-tightening can impair the integrity of the joint and also, in stainless steel systems, lead to stress corrosion in the pipe in the vicinity of the compression ring if over-tightening has excessively deformed the pipe.

2.42 Samples of pipework may be removed from the installation during construction for examination and analysis to ensure appropriate levels of workmanship are being maintained.

2.43 The pipework should be installed so it is consistent with maintaining prescribed minimum clearances between pipes and adjacent surfaces after the installation of wall, floor and ceiling finishing works and any thermal insulation to the pipework.

2.44 For prescribed minimum clearances with respect to:

- walls;
- ceilings;
- finished floors;
- adjacent pipes, both insulated;
- adjacent pipes, both uninsulated;
- adjacent pipes, only one insulated;
- insulated pipes, adjacent to conduit or trunking;
- uninsulated pipes adjacent to conduit or trunking;
- insulated pipes adjacent to electrical cables not in conduit or trunking;
- uninsulated pipes adjacent to electrical cables not in conduit or trunking.

See NHS Health Technical Specification C01, Element 02, Item 08 and BSRIA Technical Note 10/92: Space allowances for building services distribution systems.

2.45 Notwithstanding the minimum clearances, the contractor should allow sufficient space to facilitate easy application of the pipework insulation.

2.46 When fitting sleeves and fire sleeves, the contractor should ensure that no damage is caused to the pipework and building fabric during the operation.

Testing the pipework system

2.47 The testing procedure should be in compliance with BS6700: 2006 and the manufacturer's recommendations. The contractor should carry out a programme of testing the pipework system and its associated fittings and equipment, in individual sections and as a whole, as appropriate to the complexity of the system and maintaining progress with the construction project.

2.48 This programme includes testing the integrity of the system pipework together with its joints and preparing the complete system or section thereof, for final commissioning. The constituent parts of this programme are to be implemented as indicated in Figure 2.2.

Pressure testing

2.49 If, contrary to paragraph 2.27, and where a concession to allow thermal insulation to proceed in advance of pressure testing has *not* been agreed, thermal insulation has been applied to untested pipework, it should be removed and the pipework re-insulated after pressure testing.

2.50 Water is an accepted means for carrying out pressure tests. However, on large installations where there could be a delay or lapse of time between hydraulic pressure testing and use, the residual water could become contaminated unless turned over regularly. In these situations, pneumatic testing would be preferred, allowing follow-on and finishing trades to proceed, culminating with hydraulic testing immediately prior to use.

2.51 All pipework and fittings within the system should be pressure tested. The pressure applied should normally be 1½ times the actual working pressure imposed upon the system when in use, the test pressure being held for a period of 1 hour or as agreed with the pipework manufacturer.

Note: The test pressure applied should not exceed the nominal pressure rating of the lowest rated item in the pipeline system by more than 50%.

(For PB and PE-X pipework and fittings the system should be pressure tested in accordance with BS6700: 2006 test procedures for elastomeric pipes at a pressure indicated by BS6700 or by the manufacturer.)

2.52 During this time the system or section thereof should be examined for leaks.

2.53 If during this period leaks are evident or the test pressure falls the test shall fail. The system or section thereof shall be drained, repairs carried out and further testing undertaken until the test is satisfactory.

2.54 On completion of satisfactory pressure testing, the pipework should be drained in readiness to complete the commissioning procedure shown in Figure 2.2. Re-filling should take place as soon as possible, however, in order to avoid the installation sitting with a large wetted surface area. The Figure 2.2 algorithm illustrates a simple application but the comments set out here and in paragraph 2.50 must be taken into account.

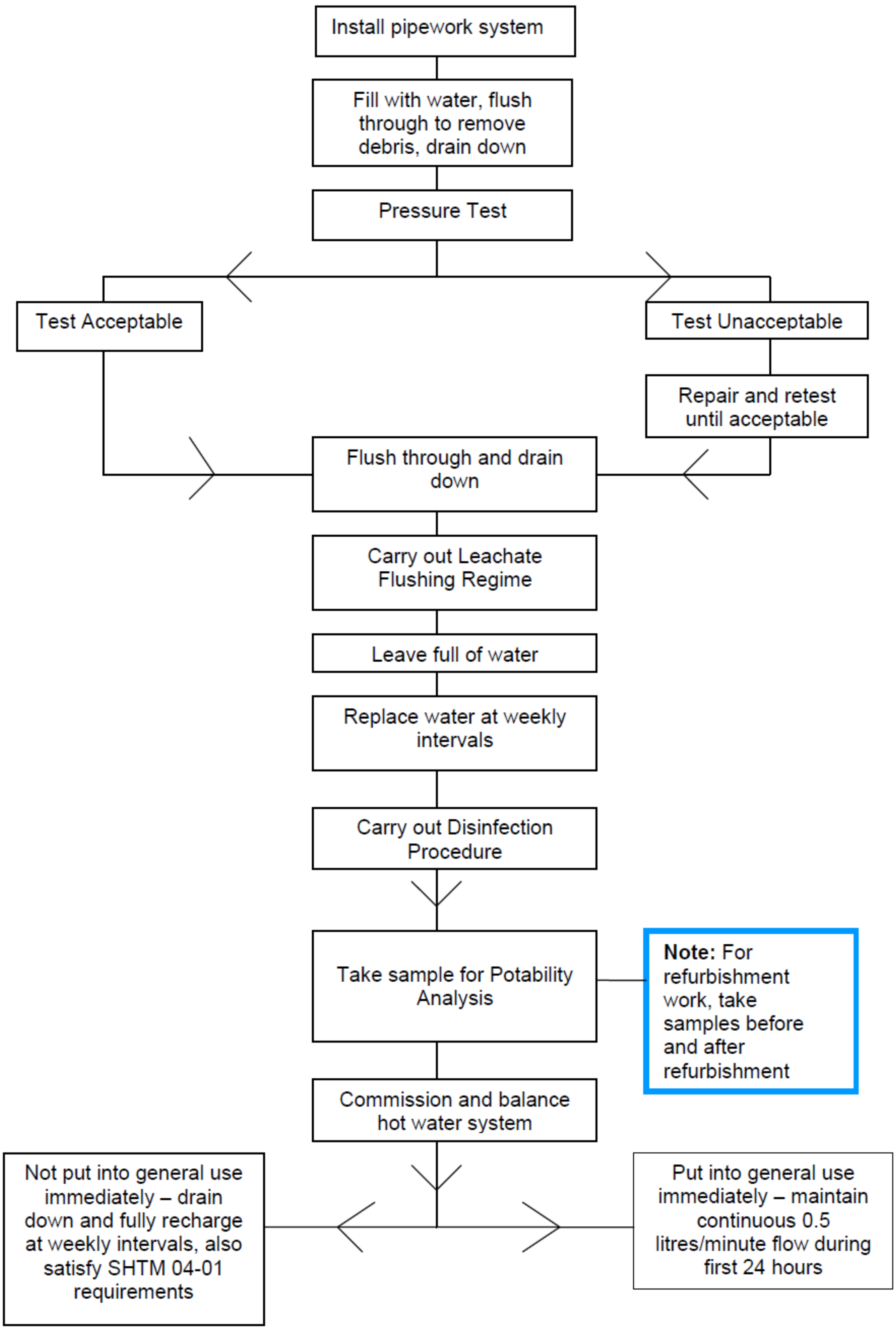


Figure 2.2: Sequence of events

Note: The potability sampling analysis referred to in Figure 2.2 must not be taken within the 'active' period following sterilisation. A period of at least three days – and preferably five – should be allowed for the system to settle prior to sampling activities commencing.

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2.55 Pressure test certification should be signed by both the installer and the client's supervising officer.

2.56 These certificates should clearly indicate the section of pipework under test, the test pressure and test period and should be handed over for inclusion within the Post Commissioning Documentation (see paragraph 2.84).

Flushing

2.57 As and when appropriate after pressure testing, the system (in sections and finally as a whole) should be filled with water, thoroughly flushed through to remove debris, and then drained down, followed by immediate re-filling.

Leachate flushing regime

2.58 The leachate flushing regime, which should be used with all currently approved metals and plastics, is as follows:

- after the final connections have been made, the pipework should be filled with water, thoroughly flushed out, and fully recharged with fresh water by the use of temporary full bore outlets using cold water at maximum mains pressure;
- the system should then be left to stand fully charged for successive periods of 1 day, 7 days, and finally, 1 day;
- after each of these periods, the water in the system should be fully discharged and the system fully recharged with fresh water;
- upon completion of the final 1 day period, the site supervisor's approval of the leachate flushing should be obtained;
- if disinfection is to follow immediately, the system should first be drained down;
- if disinfection is not to follow immediately, the system should be left full of water and thereafter, until disinfection is carried out, the system should be fully drained down and replenished with fresh water at weekly intervals.

Disinfection

2.59 It is recommended that specialist firms are engaged for the disinfecting and water sampling process.

No section of a pipework system should be connected to a 'live' system prior to disinfection, nor should it be connected to a 'live' system while the disinfection process is in process. A full physical break must be provided between it and any 'live' system.

Note: A closed isolating valve is not acceptable as a physical break. All outlets shall be clearly marked with **Disinfection in Progress. Do Not Use.**

2.60 The disinfection procedure should generally be in compliance with BS6700: 2006, taking into account the information contained in SHTM 04-01 Part D, but with the exception that chlorine should **not** be used for the disinfection of:

- stainless steel piping; or membrane filters manufactured from polypropylene.

2.61 Part D of this SHTM provides guidance on the various options for disinfection, their applications, advantages and disadvantages.

Note: The contractor's attention should be drawn to the necessity to comply with the requirements of the Control of Substances Hazardous to Health Regulations 2002 and that these requirements must be fully adhered to when handling disinfectants.

2.62 It is important to note that high concentrations of peracetic acid can have a detrimental effect on copper and that this, conversely, can reduce the disinfecting potential of the peracetic acid. It is necessary, therefore, to evaluate the percentage of copper and/or copper alloy (fittings, valves, alloy, calorifiers, etc.) in the system and to derive, in conjunction with the manufacturer of the disinfectant, appropriate concentration levels for adequate disinfection of the system. The concentration to be used, thus, depends upon individual systems, but a concentration of 50ppm (that is, 50 parts peracetic acid to 1 million parts of water) should be considered.

2.63 It is also necessary for system designers, installers and specialists to ensure that all materials forming part of system components are compatible with the disinfecting agents used in any particular system.

2.64 The design of hot water systems and cold water systems should both cater for shock dosing to control *Legionella* outbreaks, either by the use of disinfectants or by flushing out with high temperature hot water (70°C). Suitable means should be installed to cope with pipework expansion during the hot water pasteurisation process. Caution is advised, however, and further guidance can be found in Part A of this SHTM, paragraphs 17.11 and 17.12.

Note: PVC-U piping should **not** be subjected to temperatures exceeding 60°C.

Commissioning and using the system

2.65 When all disinfection work has been completed the whole system should be drained down, thoroughly flushed out and fully recharged with fresh water in preparation for commissioning and 'balancing' the hot water system.

Note: Disinfection and this subsequent flushing should be carried out preferably as continuous and consecutive operations without any intermediate delays.

2.66 Water samples should be obtained from appropriate points in the system after each recharging. Potability analysis of these samples of water should be carried out by the Public Analyst, or an approved independent body, and the contractor should supply a full set of the analysis to the site supervisor for approval before the system is put into use.

2.67 In the event of the system not being in general use for periods of 24 hours or more during the first month after commissioning, the system should be fully drained down and recharged with fresh water prior to general use.

2.68 If the system is not immediately put into use after commissioning, partial re-plumbing or maintenance work, the system should be fully drained down and recharged with fresh water at weekly intervals until it is put into use.

2.69 If the system requires to be left unused for any appreciable period, pneumatic pressure testing would be employed rather than hydraulic. This would avoid large residual wetted surface areas remaining after draining down that would form a breeding area for bacteria. Paragraph 2.50 also refers.

Note: The system should be disinfected and flushed out before being put back into use.

2.70 Local disinfection should be carried out on those parts of a system affected by partial re-plumbing and maintenance work.

Water consumption

2.71 The corrosion research programmes mentioned earlier helped to provide a better understanding of current water consumption rates of a district general hospital. This arose as a result of the investigations into filtration, and gave a useful indicator for the prediction of water consumption for new hospitals.

2.72 Water consumption design estimates are based upon data generated by The Hospital Engineering Research Unit in the early 1960s and the results published in a series of data sheets by DHSS in 1973. In Data Sheet DY1.1 it is suggested that an increase on about 3% per annum should be allowed for as an ongoing correction factor. On that basis a present-day estimate of water consumption for a similar unit would be of the order of 2 times the 1963 value, which would appear to be excessive.

2.73 There is a need therefore, for the original data and the basis of calculation to be re-assessed.

2.74 Some interim guidelines to assist designers, particularly with regard to the sizing of filtration equipment, are given in Appendix 1 of Part A of this SHTM. *In many situations, however, the best estimates of water consumption will be provided by the user or from NHS Board records.*

Water storage

2.75 The quantity of cold water storage requires careful consideration. There is a need to satisfy the requirements of the minimum storage requirement of the Water Authority, HSE ACOP L8 and the hospital.

2.76 Further guidance is contained in Part A of this SHTM, paragraphs 7.3 - 7.9.

Water filtration

2.77 As stated earlier, Section 5 of Part A of this SHTM seeks to reduce the propagation of Legionellae in DHCW services systems by temperature control and maintaining high standards of cleanliness, both during the installation of pipework systems and throughout their subsequent operation. This can be achieved by the introduction of modified work practices and high standards of filtration of water, air vents and water overflows.

2.78 It is emphasised, however, that extremely high degrees of filtration, such as might be achieved by, say, nano-filtration or osmosis, are not required for use in normal potable water services in hospitals (dialysis units, etc. are special cases).

2.79 To help achieve the above and minimise the formation of bio-films in pipework, the following guidelines should be followed in selecting appropriate levels of filtration:

- for the range of approved thermoplastics pipework covered by this SHTM a maximum cut off of 5 microns should be specified.
- for stainless steel pipework covered by this SHTN a maximum cut off of 0.5 micron should be specified. This can be relaxed to 5 microns on receipt of written guarantees from the pipework and fittings manufacturers that the system should have a life-span not less than that provided by a plastic pipework installation.
- in a situation where the recommendation of this SHTM is not adhered to and copper pipework is installed it is strongly recommended that a filtration level of 0.5 micron absolute is specified.

2.80 Further guidance is given in Section 8 of this SHTM.

2.81 In addition, the filtered water cistern's air inlets and water overflow connections should be protected to afford similar levels of protection against the ingress of bacteria and debris.

Spares

2.82 The contractor should supply an approved and agreed set of spare parts and replacements for the pipework system and all items of plant installed. These should be handed over not less than two weeks prior to the contractor's completion date.

Record documentation

2.83 The installing contractor should supply such documents and drawings as are specified in the contract for inclusion in the Post Commissioning Documentation. These documents and drawings should be compiled, supplied and updated as and when necessary to meet the ongoing requirements of PCD, as stated in SHTN 1.

2.84 As a minimum, for a new installation or major refurbishment, and in addition to the stipulations of SHTN 1, the contract should require the following documents and drawings to be supplied:

- full manufacturing details, including batch numbers of all pipes and fittings;
- full records and certificates of pressure tests for all sections of pipework;
- results of any tests undertaken on any stainless steel welding;
- full records and certificates confirming disinfection carried out as per
- specification, complete with readings;
- full records and certificates confirming leachate and other flushing regimes, complete with final water quality analysis results;
- settings of all balancing valves, with readings of flow rates and
- temperatures of domestic flow and return, where applicable;
- settings and temperatures recorded at all mixing valves, where applicable;
- full details of each item of plant, including detail and arrangement drawings
- and manufacturer's test certificates and engineers' test certificates where applicable;
- 'As Fitted' drawings covering the complete DHCW services system;

Note: These drawings must be fully detailed with positions of:

1. balancing valves, indicating flow and setting;

2. isolation valves;

3. drain valves;

all clearly and precisely detailed.

- for each item of plant, manufacturer's recommended maintenance and list of spare parts and replacements.

2.85 The documentation at handover should also include a clear description of the design intent and proposed operation of the system, along with full details of routine monthly, biannual and annual maintenance requirements.

Statutory requirements

2.86 In addition to the requirements previously specified, the design, installation, disinfection, commissioning and maintenance of DHCW services systems must also comply with the following standards and codes of practice:

- Health and Safety at Work, etc. Act 1974;
- Ionising Radiation (Sealed Sources) Regulations 1961;

- Radioactive Substances Act 1993;
- Scottish Water Byelaws, 2004;
- The Building (Scotland) Regulations 2004;
- The Building (Scotland) Regulations : Technical handbooks and guidance, 2004;
- Water Fittings and Materials Directory Published by WRc plc for the UK Water Byelaws Scheme.

3. Stainless Steel Pipework Specification

General

3.1 Requirements specific to the design and installation of stainless steel pipework systems are contained within this Section. These are in addition to the general requirements outlined within Section 2.

3.2 Stainless steel pipework and fittings intended for the conveyance of potable cold water and hot water service for uses within NHSScotland Premises should comply with the requirements of the following:

- BS EN 10088-2: 2005;
- BS1452: 1999;
- BS EN 1254 1 & 2: 1998;
- DIN 2463;
- BS4127: 1994;
- DIN 1988.

Note: All materials in contact with stainless steel must not have a chloride content exceeding 0.05%. (This applies in particular to insulation.)

3.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

Pressures and temperatures

3.4 The working pressures and operating temperatures of press fitting, stainless steel pipework and fittings are listed for guidance in Table 3.1, below.

Pressure ratings – Pipe, fittings and valves press fitting system at 80°C		
Product	**Size**	**Pressure rating at 80°C**
Fittings	15mm – 100mm	16 Bar
Valves	15mm – 100mm	16 Bar
Pipe	15mm – 100mm	16 Bar

Table 3.1: Stainless steel pipework – working pressures/operating temperatures

NB: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.

Normal operating temperatures will be in the range of 10°C - 60°C.

Note: Maximum operating temperature must not exceed 110°C continuous or 130°C for a period of not exceeding one hour.

3.5 The whole of the stainless steel pipework installation shall be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

- BS6700: 2006+A1: 2009;
- SHTM 04-01 Parts A,B,C & D;
- HSE: Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8). Approved code of practice and guidance (2000).

and the relevant manufacturer's instructions.

3.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings.

3.7 The use of stainless steel does not impose any additional requirements in respect of hot and cold water systems providing all materials within the system are fully compatible for use with stainless steel. However it should be noted that sacrificial anodes should not be used.

3.8 Insulation for stainless steel pipework systems should preferably be chloride - free, however it is acceptable to use material where the content by weight of water soluble chloride ions does not exceed 0.05%.

3.9 A protective aluminium foil should be applied to the pipework system under all circumstances prior to insulation.

Pipes

3.10 All stainless steel piping used in the hot and cold water services system should comply with the following:

- BS EN 10216-5: 2004;
- BS EN 10217-7: 2005;
- BS4127: 1994 LWHT 316S16;
- DIN 1988 Part 2 LWHT 316S16;
- DIN 2463;
- BS EN 10088-2: 2005.

Pipe fittings and valves

3.11 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be supplied/or approved by the pipework manufacturer for use with the pipework system.

Note: Pipework normally selected for use within NHSScotland Premises is generally for use with press-fitting fittings or in some cases on smaller diameters for use with compression fittings.

Pipework complying with BS4127 is unsuitable for use with press fitting joints.

Pipework exceeding 100mm diameter will require to be flanged.

3.12 Non-manipulative type 'A' compression joints may be used on pipework not exceeding 54mm diameter. The joints shall be constructed from a non-dezincifiable alloy.

Note: Experience has indicated that where compression fittings are used, the compression cone should be suitable for use with stainless steel pipework. Prior to specification the proposed fittings manufacturer must be consulted to verify their requirements for their range of fittings for use with stainless steel.

3.13 Stainless steel compression fittings to BS4368-1: 1998 and DIN 2353 are available but are generally not considered for widespread use.

Note: Should BS4127 pipework be specified, joints on pipework exceeding 54mm diameter will require to be flanged, with the flanges welded to the pipework.

Flanges should comply with BS EN 1092-3: 2003.

Sealing rings and gaskets used in flanged joints should comply with BS7874: 1998.

3.14 Consideration should be given to the benefits of specifying valves with extended handles. This would allow thermal insulation to be run straight through, straight over the valve body. This would minimise of eliminate the problems associated with condensation on the surface of the valve body. Valves for stainless steel pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

- The use of gunmetal gate valves complying with BS EN 12288: 2010, complete with flanged bush connectors for pipes over 63mm outside diameter or with threaded connectors for pipe up to and including 63mm outside diameter is discouraged but may be supplied by the pipe or fittings manufacturer provided they are manufactured entirely from nondezincifiable materials. Maintenance will be reduced and simplified, however, with the adoption of ¼ turn ball or butterfly valves;
- also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

3.15 Where servicing ball valves are required at fitments, these shall be of non dezincifiable construction with compression ends suitable for direct connection to stainless steel pipework. Removal will be simplified by the incorporation of disconnection unions.

Cleanliness requirements

3.16 As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in all NHS Scotland premises pipework installations. To satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplied to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

3.17 The finished tube shall be smooth, free of internal and external mechanical imperfections, and shall have a clean bright appearance.

Packaging and transportation

3.18 The pipes should be delivered in straight lengths with each end securely capped against ingress of dirt. The capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, metal or alloy designation, size, total length or piece count and name of supplier.

Note: Any pipes delivered unprotected or with open ends should be rejected.

3.19 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that 'heat' identification is required, the purchaser shall specify the details desired.

Pipework systems

3.20 It may be appropriate to use 'pulled' bends in parts of a pipework system. When used these bends should conform to the bore of the pipe and the centre to end radius of the bend should be not less than three times the pipe bore.

3.21 The bend should be smoothly formed. Wrinkled or flattened bends should not be accepted.

3.22 Where expansion loops are used, they should be formed using fittings and pipe of the same material and specification as the pipework system.

3.23 Where expansion bellows are utilised, they should be:

- of stainless steel construction 316S16;
- of a design incorporating internal sleeving (to minimise the accumulation of debris in crevices); and
- be finished with compressing coupling or flanged ends which meet the materials requirements stated in paragraph 3.13 (Note) and are appropriate to the size of pipe to which they are to be fitted.

Note: All parts of the expansion bellows in contact with water must be of stainless steel 316S16 construction.

3.24 Bellows should be equipped and installed with stainless steel-lined guides as required by the expansion bellows manufacturer.

3.25 All pipes should be supported by pipe clips and/or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 3.2, below, or as advised and confirmed by the pipe manufacturer.

Pipe outside diameter (mm)	Maximum interval	
	Horizontal (metres)	Vertical (metres)
15	1.2	1.8
20	1.2	1.8
25	1.5	2.4
32	1.8	3.0
40	1.8	3.0
50	1.8	3.0
65	2.4	3.0
80	2.4	3.7
100	2.4	3.7

Table 3.2: Support bracket spacing; 60°C

3.26 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such clips and brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

3.27 Pipe clips and support brackets in contact with the surface of stainless steel pipework should be compatible with the pipework system.

Fire sleeves

3.28 Fire sleeves for stainless steel pipework should generally comply with the requirements of paragraph 2.31 and should be made of stainless steel and be sealed with a Class @o@ fire resistant infill which is chloride free.

Installing the pipework

3.29 Any welding of stainless steel pipe should be carried out by the tungsten inert gas (TIG) welding process, using an argon shield gas, in accordance with BS EN 1011-3: 2000. When this method of jointing is employed it is of great importance that the faces of the pipe and fitting to be butted together are cut square and have no malformation and the ovality is maintained at a minimum to ensure proper fusion of the weld.

3.30 All welders employed should have been approved in accordance with BS EN 287: Part 1 and have current certificates for argon arc welding, and should be required to demonstrate their skills by providing sample welds prior to carrying out welding on the system.

3.31 While the thermal expansion/contraction of stainless steel is considerably less than thermoplastic pipework nevertheless it must be taken into account during both the design stage and the installation stage of the work. It is incumbent on the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

Note: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

4. PVC-U Pipework Specification

General

4.1 Requirements specific to the design and installation of PVC-U pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

4.2 PVC-U pipework and fittings intended for the conveyance of potable cold water for use in all domestic cold water services within NHSScotland premises should comply with the requirements of BS EN 1452: 1999.

4.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

Note: Whilst the operating temperature of PVC-U is rated to a maximum of 60ºC at a pressure of 2 Bar it should not however be specified for other than domestic cold water systems.

4.4 The working pressures and operating temperatures of PVC-U pipework and fittings are listed for guidance in Table 4.1.

4.5 The whole of the PVC-U pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

- BS CP 312;
- BS6700: 2006+A1: 2009;
- SHTM 04-01 Parts A,B,C & D;
- HSE: Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice and guidance (2000).

4.6 Care should be exercised whilst off-loading, storing, transporting about the site, and installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

4.7 Great care should also be exercised in the storage and use of pipe cleaning materials and solvent cements. The requirements of the HSE and rules and regulations for working with materials hazardous to health should be adhered to at all times. It is essential that materials containing solvents should be stored in a secure lockfast store when not in use.

Pipes

4.8 All PVC-U piping used in the **cold water systems** of DHCW services systems in NHSScotland premises should be to BS EN 1452: 1999.

Pipe fittings and valves

4.9 All associated pipe fittings (i.e. unions and flanges) should be manufactured to the composition, properties and conditions specified in:

- BS EN 1452 1&2: 2009 (for unions);
- BS EN 1092-3: 2003 (for flanges).

4.10 Valves in PVC-U pipework should generally be PVC-U ball valves incorporating, double socket disconnecting ends, removable seating seals and direction of flow arrow. They should be as supplied for the application by the piping manufacturer and be of the double-union ball valve pattern - Class E for sizes up to 54mm (2 inch nominal size) and Class C for 75mm (3 inch for nominal size) and above - all to BS EN 1452: 2009. Where space is limited, butterfly type valves may be considered for use.

Metric – Imperial equivalence

4.11 At the date of compiling this SHTM, the information given in BS EN 1452 is still based on the Imperial Unit system.

4.12 Therefore, to enable compatibility with other metric dimensioned pipework and fittings indicated upon contract drawings and included within the contract documents, it is suggested:

- that metric terminology be adopted when PVC-U pipes and fittings are being specified; and
- that a table, such as Table 4.2, relating the indicated metric dimensions to the equivalent Imperial dimensions be included on the contract drawings.

Note: Attention is drawn to the fact that plastic pipes are identified by their outside diameters as opposed to the nominal bores by which metallic pipes are designated.

Pressure ratings – Pipe, fittings and valves		
Product	**Size**	**Pressure rating at 20°C**
Fittings (Solvent cement)	½" – 6"	15 Bar
Fittings (threaded)	½" – 4"	10 Bar
Ball valves	½" – 2"	16 Bar
All other valves	½" – 6"	10 Bar & 6 Bar
All actuated valves	½" – 6"	10 Bar & 6 Bar
Pipe	½" – 6"	15 Bar

Table 4.1: PVC-U pipework (inch) – working pressures/operating temperatures

NB: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.

Normal operating temperatures will be in the range 10°C - 20°C.

Note: Maximum temperature must not exceed 60°C at a maximum pressure of 2 Bar.

Indicated metric diameter (mm)	Equivalent normal size (inch)
15mm	0.5”
22mm	0.75”
28mm	1.0”
35mm	1.25”
42Mm	1.5”
54mm	2.0”
75mm	3.0”
100mm	4.0”

Table 4.2: PVC-U pipes and fittings (BS EN 1452)

Cleanliness requirements

4.13 As stated in Section 2 of this SHTM it is imperative that a high standard of cleanliness is maintained in pipework installations in all NHSScotland premises, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplied, to pass the 'cleanliness test' described in ASTM: B280-86 clause 12.

Workmanship, finish and appearance

4.14 The finished tube shall be smooth, free from internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

4.15 The pipes should be delivered in straight lengths with each and every end securely capped against ingress of dirt, and the capped tubes shall be bundled by size, in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier.

Note: Any pipes delivered unprotected or with open ends shall be rejected.

4.16 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

4.17 The pipes and fitting should be entirely compatible with each other, should be jointed by means of the manufacturer's approved cleaner and solvent cement and the jointing should be carried out in strict accordance with the manufacturer's printed instructions. PVC-U solvents should comply with BS EN 1452: 2009 and the solvent cement should be based on methyl ethyl ketone (MEK) with a minimum contamination of other solvents.

Note: The use of solvents which contain n-hexane and propylene oxide should **not** be permitted.

4.18 Unless indicated otherwise, the pipe joints in PVC-U pipework should be made by socket and spigot solvent cemented joints. To enable disconnections to be effected, demountable socket unions to BS EN 1452: 2009. Class E should be fitted on pipes not exceeding 54mm outside diameter (2 inch nominal size). On 75mm (3 inch nominal size) and 100mm (4 inch nominal size) outside diameter pipes, unions to BS EN 1452: 2009 Class C or PVC-U flanges to BS EN 1092-3: 2003 should be used.

Note: Locations for demountable unions and flanges should be selected by the site supervisor.

4.19 Screwed adaptor fittings should be used at screwed joints to appliances and the like. PVC-U flanges, having dimensions in accordance with BS EN 1092-3: 2003, should be provided for connections to cisterns or pumps.

Pipework system

4.20 Samples of the following should be submitted to the site supervisor for approval:

- PVC-U piping;
- PVC-U pipework regulation and isolation valves;
- PVC-U pipework bends, tees and tap connectors;
- PVC-U cleaner and solvent cement.

4.21 The installation contractor should not confirm orders for the system pipework, nor should the construction of the installation of the system proceed until these samples have been approved in writing.

4.22 The approved samples should be retained on site for comparison with the work as actually installed.

4.23 At connections to taps on sinks, worktops, etc. the final connector should be a 0.5 metre (approximate) length of stainless steel pipe and arrangements should be made to ensure that it and the PVC-U pipe to which it is joined are guarded and secured in such a way as to be protected from impact damage or undue torque.

Fire sleeves

4.24 Fire sleeves should be used where PVC-U pipes of 54mm outside diameter (2 inch nominal size) and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

- they should be constructed with an outer galvanised steel casing and intumescent lining;
- each sleeve should be manufactured in two longitudinal half sections. The sections should be joined together, around the pipe, utilising galvanised steel slide-on clamping strips;
- casing should accommodate the expansion of intumescent linings during fire conditions;
- intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accord with pipe manufacturer's requirements;
- individual sleeves mounted on vertical pipework should:
  - be of construction suitable for surface mounting;
  - not exceed 200mm in length;
  - be fitted with a flanged, galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
  - be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position).
- Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

4.25 The contractor should:

- check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;
- check that all the piping and fittings supplied are uniform in colour density; and
- exercise particular care in storing, handling and installing to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

4.26 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

4.27 It is incumbent upon the contractor to ensure that all pipe cleaners and solvent cements being used are within their designated shelf life. Any materials found to be beyond their shelf life should be removed from site.

4.28 The cleaners should be applied in strict accordance with the manufacturer's printed instructions and should not be detrimental to long term joint performance and should have no toxicological implications.

4.29 It is essential that cleaners are correctly applied to the pipe ends and sockets prior to the application of solvent cements, with cleaning pads changed regularly in accordance with manufacturer's instructions. After swabbing the ends of pipes and surface of moulded fittings, a bead of solvent cement on the outside will provide evidence of complete solvent cementing.

Note: When preparing pipework and fittings for jointing in ambient temperatures less than 5°C, the manufacturer's advice should be sought to establish appropriate jointing procedures.

4.30 Great care should be taken to ensure that only the manufacturer's installation procedures are followed and, in particular, that the full curing period is maintained before any joint is considered to be complete.

4.31 Care should be exercised to ensure that, wherever practical, the PVC-U pipework does not suffer from the effects of heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

4.32 On no account should ladders, scaffold or other building items be propped against the PVC-U pipework installation.

4.33 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PVC-U piping any offsetting required should be formed using fittings. No thermally induced bending of PVC-U pipes, through the application of local heating, should be permitted.

4.34 All PVC-U pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 4.3, or as advised and confirmed by the pipe manufacturer.

Pipe outside diameter		Maximum interval	
Mm	Inch	Horizontal metres	Vertical metres
15	0.5	0.8	1.2
22	0.75	0.8	1.2
28	1.0	0.9	1.5
35	1.25	1.0	1.5
42	1.5	1.1	1.5
54	2.0	1.2	1.8
75	3.0	1.5	1.8
100	4.0	1.7	1.8

Table 4.3: Support bracket spacing; 20°C

4.35 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

4.36 PVC-U pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

4.37 Where PVC-U piping is supported using other than standard PVC-U pipe clips, the supports should comprise steel split pipe rings with rubber insert, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

4.38 Thermal expansion/contraction of the material must be taken into account during both the design stage and installation stage. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

> **Note:** The manufacturer's guidance and recommendations should be adopted at both stages of work.

5. PVC-C Pipework Specification

General

5.1 Requirements specific to the design and installation of PVC-C pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

5.2 PVC-C pipework and fittings intended for the conveyance of potable cold water and hot water service for use in all domestic hot and cold water services within NHSScotland premises should comply with the requirements of the following:

- DIN 8079;
- DIN 8080;
- DIN 1988;
- BS7291: 2010 (Parts 1 & 4) ;
- BS5955-8: 2001.

5.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

5.4 The working pressures and operating temperatures of PVC-C pipework and fittings are listed for guidance in Table 5.1, below.

Pressure ratings – pipe, fittings and valves		
Product	**Size**	**Pressure rating at 80°C**
Fittings (solvent cement)	16mm – 50mm	6 Bar
Fittings	63mm- 160mm	4 Bar
Valves	16mm – 63mm	6 Bar
Valves	63mm – 160mm	4 Bar
Pipe	16mm – 50mm	6 Bar
Pipe	63mm – 160mm	4 Bar

Table 5.1: PVC-C pipework (metric) – working pressures/operating temperatures

NB: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the material.

Normal operating temperatures will be generally be in the range 10°C – 60°C.

Note: Maximum temperature must not exceed 95°C at a maximum pressure of 3.5 Bar.

5.5 The whole of the PVC-C pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

- BS5955-8: 2001;
- BS6700: 2006;
- SHTM 04-01 Parts A,B,C & D;
- HSE: Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8). Approved code of practice and guidance (2000).

and the relevant manufacturer's instructions.

5.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

5.7 Great care should also be exercised in the storage and use of pipe cleaning materials and solvent cements. The requirements of the HSE and rules and regulations for working with materials hazardous to health should be adhered to at all times. It is essential that materials containing solvents should be stored in a secure lockfast store when not in use.

Pipes

5.8 All PVC-C piping used in DHCW services pipework systems in NHSScotland premises should be to BS7291, Parts 1 and 4: 2010 or DIN 8079/DIN 8080/DIN 1988.

Pipe fittings and valves

5.9 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be PVC-C manufactured to the composition, properties and conditions specified in BS7291, Parts 1 and 4: 2010.

5.10 Valves for PVC-C pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

- PVC-C ball valves, for pipe sizes up to and including 110mm outside diameter, meeting the resistance to pressure requirement of DIN 3441, allowing bi-directional flow with floating ball, and complete with double socket disconnecting ends, removable seals and direction of flow arrow.
- PVC-C flanged butterfly valves for pipe sizes 63mm outside diameter and above, allowing bi-directional flow, of overall dimensions complying with DIN 3441: Part 5 or ISO 7508 and having valve body holes to allow connection to flanges drilled in accordance with DIN 8063: Part 4, ISO 2536 or BS 10: 2009 Tables D or E. Specifying double-lugged valves or single-lugged valves with spool pieces will allow pipe disconnection to be undertaken without the valve falling off.
- ¼-turn ball or butterfly valves complete with flanged bush connectors for pipes over 63mm outside diameter or with threaded connectors for pipe up to and including 63mm outside diameter may be supplied by the pipe or fittings

manufacturer provided they are manufactured entirely from nondezincifiable materials.

- Also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

5.11 Where servicing ball valves are required at fitments, these shall be of non dezincifiable construction with compression ends suitable for direct connection to PVC-C pipework.

Cleanliness requirements

5.12 As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in pipework installations within all NHSScotland premises, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplies, to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

5.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

5.14 The pipes should be delivered in straight lengths with each and every end securely capped against the ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier.

Note: Any pipes delivered unprotected or with open ends should be rejected.

5.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

5.16 The pipes and fittings should be entirely compatible with each other, should be jointed by means of the manufacturer's approved cleaner and solvent cement and the jointing should be carried out in strict accordance with the manufacturer's printed instructions. PVC-C solvents should comply with BS 7291, Part 4: 2010.

Note: The use of solvents which contain n-hexane and propylene oxide should **not** be permitted.

5.17 Unless indicated otherwise, the pipe joints in PVC-C pipework should be made by socket and spigot solvent cemented joints. The specification for these should be

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dependent on the manufacturer of the PVC-C piping and the joints should in all respects be compatible with the installed pipework. They should comprise either:

- push-fit conical self-centering pattern spigot and socket joints with raised marking arrows to allow correct lining up with pipe markings and ensure that all branches in a pipe length are in the correct plane; or
- parallel sided spigot socket joints with internal stop heads or shoulders to prevent over penetration of the pipe into the fitting.

5.18 Where directed, to enable disconnections to be undertaken, demountable socket unions should be fitted on pipes not exceeding 63mm outside diameter. Above 63mm outside diameter, flanged joints should be used.

Note: Locations for demountable unions and flanges should be selected by the designer in conjunction with the site supervisor.

5.19 Screwed adaptor fittings should be used at screwed joints to appliances and the like. PVC-C flanges, having dimensions in accordance with BS EN 1092-3: 2003, should be provided for connections to pumps or cisterns.

Pipework system

5.20 The piping contractor should provide samples of the following for approval:

- PVC-C piping;
- PVC-C pipework valves, or (if applicable) gunmetal gate valves and connectors;
- PVC-C pipework bends, tees and tap connectors;
- PVC-C cleaner and solvent cement, or (if applicable) gunmetal or stainless steel compression fittings for use with PVC-C.

5.21 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system be proceeded with until these samples have been approved in writing.

5.22 The approved samples should be retained on site for comparison with the work as actually installed.

5.23 At connections to taps on sinks, worktops, etc. the final connector should be a 0.5metre (approximate) length of stainless steel pipe and arrangements should be made to ensure that it and the PVC-C pipe to which it is joined are guarded and secured in such a way as to be protected from impact damage or undue torque.

5.24 No PVC-C pipework should be connected directly to any heat source (for example, a secondary domestic hot water heater). Final connections up to a length of 1.0metre, or as advised by the manufacturer of the PVC-C pipework, should be made with stainless steel pipe and clearance between PVC-C piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5metre.

Fire sleeves

5.25 Fire sleeves should be used where PVC-C pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

- they should be constructed with an outer galvanised steel casing and intumescent lining;
- each sleeve should be manufactured in two longitudinal half sections. The sections should be jointed together, around the pipe, utilising galvanised steel slide on clamping strips;
- casings should accommodate the expansion of intumescent linings during fire conditions;
- intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accordance with the pipe manufacturer's requirements;
- individual sleeves mounted on vertical pipework should:
  - be of construction suitable for surface mounting;
  - not exceed 200mm in length;
  - be fitted with a flanged galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
  - be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position);
- individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

5.26 The contractor should:

- check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;
- check that all the piping and fittings supplied are uniform in colour density; and
- exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

5.27 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

5.28 It is incumbent on the contractor to ensure that all pipe cleaners (where required) and solvent cements are within their designated shelf life. Any materials found to be beyond their stated shelf life should be removed from site.

5.29 The cleaners (where required) and the solvent cement should be fully compatible with the pipework system. Only cleaners/solvents approved and supplied by the manufacturer should be used:

- they should not be detrimental to long-term joint performance, and
- they should have no toxicological implications.

5.30 It is essential that cleaners, where required, are correctly applied to the pipe ends and sockets prior to the application of solvent cements, with cleaning pads changed regularly in accordance with manufacturer's instructions. After swabbing the ends of pipes and surface of moulded fittings, a bead of solvent cement on the outside will provide evidence of complete solvent welding.

Note: When preparing pipework and fittings for jointing in ambient temperatures less than 5°C, the manufacturer's advice should be sought to establish appropriate jointing procedures.

5.31 Great care should be taken to ensure that only the manufacturer's installation procedures are followed and, in particular, that the full curing period is maintained before any joint is considered to be complete. Comments regarding the use of hacksaws as set out in paragraph 2.38 apply here.

5.32 No pipework, or section thereof, shall have pressure applied until the manufacturer's stipulated curing period has elapsed.

Note: This may vary according to the manufacturer and should be confirmed by the manufacturer of the system being installed.

5.33 Great care should be exercised to ensure that, where practical, the PVC-C pipework does not suffer from the effects of undue heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

5.34 On no account should ladders, scaffold or other building items be propped up against the PVC-C pipework installation.

5.35 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PVC-C piping any offsetting required should be formed using fittings. No thermally induced bending of PVC-C pipes, through the application of local heating, should be permitted.

5.36 All PVC-C pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer) the spacing of which should not exceed the maximum intervals given in Table 5.2, below, or as advised and confirmed by the pipe manufacturer.

Note: Some manufacturers supply a profiled snap-on metal support tray system for use with pipework up to and including 32mm diameter.

The use of this support system increases the distance between supports and therefore reduces number of support brackets required.

Pipe outside diameter (mm)	Maximum interval	
	Horizontal (metres)	Vertical (metres)
16	0.65	0.85
20	0.75	0.90
25	0.75	0.98
32	0.85	1.10
40	0.95	1.25
50	1.05	1.35
63	1.20	1.55
75	1.25	1.65
90	1.35	1.75
110	1.60	2.00
160	1.75	2.25

Table 5.2: Support bracket spacing; 60°C (without support tray)

Note: For support centres utilising support tray, consult relevant manufacturer's literature.

5.37 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

5.38 PVC-C pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

5.39 Where PVC-C piping is supported using other than standard PVC-C pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

5.40 Thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

Note: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

6. Polybutylene Pipework Specification

General

6.1 Requirements specific to the design and installation of polybutylene (PB) pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2. Paragraph 2.38 is particularly relevant.

6.2 PB pipework and fittings intended for the conveyance of potable cold water and hot water service for use within NHSScotland premises should comply with the requirements of the following.

- DIN 16986/16969;
- DIN 1988;
- BS 5955 Part 8: 2001;
- BS7291, Parts 1 & 2: 2010.

6.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

6.4 The working pressures and operating temperatures of PB pipework and fittings are listed for guidance in Table 6.1, below.

PB Pressure ratings – pipe, fittings and valves		
Product	**Size**	**Pressure rating at 80°C**
Fittings	16mm – 110mm	10 Bar
Valves	20mm – 63mm (PVC-C)	5 Bar
Pipe	16mm – 110mm	10 Bar

N.B: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature. Maximum operating temperature will be 60°C.

Note: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

6.5 The whole of the PB pipework installations should be tested in accordance with the requirements of the following:

- BS CP 312;
- BS6700: 2006+A1: 2009;
- SHTM 04-01 Parts A,B,C & D;
- HSE: Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8). Approved code of practice and guidance (2000).

and the relevant manufacturer's instructions.

6.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to effects of ultra-violet radiation including daylight.

6.7 Care should be exercised in the storage and use of pipe cleaning materials. Degreasing tissues impregnated with 70% isopropyl alcohol should be used.

Pipes

6.8 All PB piping used in DHCW services pipework systems in NHSScotland premises should be to BS 7291: Parts 1 and 2: 2010, BS 5955, Part 8: 2001 DIN 16968/DIN 16969, DIN 1988.

Pipe fittings and valves

6.9 Unless specified otherwise, all associated pipe fittings (i.e. manifolds, unions and flanges) should be of polybutylene manufacture generally in accordance with BS 7291,Parts 1 and 2: 2010 and DZR brass fittings (see paragraph 2.20) manufactured generally in accordance with BS EN 1254-1: 1998, and be fully compatible with the pipe system they are to be installed with.

6.10 Valves for PB pipework should be fully compatible with the pipework system to which they are to be connected, comprising variously:

- PB ball or butterfly valves for pipe sizes up to and including 110mm outside diameter, allowing bi-directional flow with direct sealing of slide in valve body operating at 90° to direction of pump flow with non rising valve spindle.
- PVC-C ball valves, for pipe sizes up to and including 63mm outside diameter, meeting the resistance to pressure requirement of DIN 3441, allowing bi-directional flow with floating ball, and complete with double socket disconnecting ends and removable seals.
- Polyvinylidene fluoride (PVDF) flanged butterfly valves, for pipe sizes over 63mm outside diameter, allowing bi-directional flow, of overall dimensions complying with DIN 3441: Part 5 or ISO 7508 and having valve body holes to allow connection to flanges drilled in accordance with DIN 8063: Part 4, ISO 2536 or BS 10: Table D or E.
- DZR Brass ball valves should be suitable for connection with PB pipe directly, or with adapters to flanged or threaded connectors. Sandwich pattern valves should not be used.
- only pipe thread lubricants and sealants specifically approved by the pipe and fittings manufacturer should be used.

6.11 Where servicing ball valves are required at fitments these shall be of non-dezincifiable construction with female thread ends suitable for PB threaded adapters.

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Cleanliness requirements

6.12 As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the "cleanliness test" described in ASTM: B280-86 clause 12.

Workmanship, finish and appearance

6.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

6.14 The pipes should be delivered in coils or straight lengths with each and every end securely capped against ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, material designation, size, total length or piece count and name of supplier.

Note: Any pipes delivered unprotected or with open ends should be rejected.

6.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

6.16 The pipes and fittings should be entirely compatible with each other, and the jointing should be carried out in strict accordance with the manufacturer's printed instructions.

6.17 Unless indicated otherwise the pipe joints in PB pipework should be made by socket fusion, electrofusion or compression. The assembly of these should be carried out in strict accordance with the manufacturer's instructions, by fully trained and certified installers in the manner indicated below:

- socket fusion, utilising the correct tools for assembly, melting and jointing times in accordance with the manufacturer's instructions;
- electrofusion, utilising correct tools for assembly, melting times in accordance with the manufacturer's instructions;
- DZR Brass compression, fittings to include internal pipe sleeve as integral part of fitting with grip ring to hold pipe in place. Assembly to be in accordance with manufacturer's instructions.

6.18 Where directed, to enable disconnections to be undertaken, socket unions should be fitted on pipes up to and including 63mm outside diameter. Above 63mm outside diameter, flanged joints should be used.

Note: Locations for demountable unions and flanges should be selected by the designer in conjunction with the site supervisor.

6.19 Screwed adapter fittings should be used at screwed joints to appliances up to 63mm outside diameter; PB flange adapters having dimensions in accordance with BS EN 1092-3: 2003 should be provided for connections to pumps, cisterns or equipment above 63mm outside diameter. The flange adapters must incorporate galvanised steel backing to avoid plastics distortion.

Pipework system

6.20 The piping contractor should provide samples of the following for approval:

- PB piping;
- PB pipework regulation and isolation valves;
- PB pipework bends, tees and tap connectors;
- PB cleaner and jointing equipment or (if applicable) compression fittings for use with polybutylene.

6.21 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system proceed until these samples have been approved in writing.

6.22 The approved samples should be retained on site for comparison with the work as actually installed.

6.23 At connections to taps on sinks, worktops etc, the final connector may either be a 0.5metre (approximate) length of stainless steel pipe (to the standard specified in Section 3 of this SHTM.) or the PB pipe manufacturer's suitable DZR brass outlet connectors. Arrangements should be made to ensure that the fitting and the PB pipe to which it is joined are guarded and secured in such a way as to be protected from undue damage or torque.

6.24 No PB pipework should be connected direct to any heat source (for example, a secondary domestic hot water storage calorifier or direct gas-fired water heater). Final connections up to a length of 1.0metre, or as advised by the manufacturer of the PB pipework, should be made with approved stainless steel piping. Clearance between PB piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5metre.

Fire sleeves

6.25 Fire sleeves should be used where PB pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

- they should be constructed with an outer galvanised steel casing and intumescent lining.

- each sleeve should be manufactured in two longitudinal half sections. The sections should be joined together, around the pipe, utilising galvanised steel slide on clamping strips.
- casings should accommodate the expansion of intumescent linings during fire conditions.
- intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accord with the pipe manufacturer's requirements.
- individual sleeves mounted on vertical pipework should:
  - be of construction suitable for surface mounting;
  - not exceed 200mm in length;
  - be fitted with a flanged galvanised steel collar, the flange of which should be drilled for bolt type fixings;
  - be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar buttoned up against the fire barrier and the flange bolted into position).
- Individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

6.26 The contractor should:

- check that the exterior of the piping is marked at intervals not exceeding 1metre with the manufacturer's name, type of material, pipe size and standard with which it complies,
- check that all the piping and fittings supplied are uniform in colour density, and
- exercise particular care in storage, handling and installation, of all piping and fittings to avoid deterioration due to ultra violet light (including daylight) and impact damage.

6.27 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported as indicated upon the drawings and as detailed within the contract documents.

6.28 It is incumbent upon the contractor to ensure that any pipe cleaners being used are within their designated shelf life. Any materials found to be beyond their shelf life should be removed from site.

6.29 It is essential that cleaners are correctly applied to the pipe ends and sockets prior to fusion and electrofusion jointing with cleaning pads changed regularly in accordance with manufacturer's instructions. After fusion jointing, a ring of polybutylene will be visible on the outside of the pipe, as evidence that a joint has been completed. After electrofusion jointing an indicator ‘pip’ will raise above the surface of the fitting as evidence that a joint has been completed.

6.30 Great care should be taken to ensure that the manufacturer's installation procedures are followed and, in particular, that the full cooling period is maintained before any joint is considered to be complete.

6.31 Care should be exercised to ensure that, where practical, the PB pipework does not suffer the effects of heat from other pipes and appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

6.32 On no account should ladders, scaffold or other building items be propped up against the PB pipework installation.

6.33 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. Changes in direction can be achieved using the pipes’ flexibility in accordance with the manufacturer's instructions. No thermally induced bending of PB pipes, through the application of local heating, should be permitted.

6.34 All PB pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer), the spacing of which should not exceed the maximum intervals given in Table 6.2 or as advised and confirmed by the pipe manufacturer.

Note: Some manufacturers supply a metal support tray system for use with pipework up to and including 63mm diameter.

The use of this support system increases the distance between supports and therefore reduces number of support brackets required.

6.35 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the ‘maximum intervals’ stated or advised for each of the pipes being supported.

6.36 If fixed brackets are being used to avoid longitudinal expansion of PB pipes, the installation of both the pipe and bracket manufacturers should be located at fittings and must grip the pipe on both sides of the fitting, or according to manufacturer’s instructions.

6.37 PB pipework in exposed positions (or where distortion is likely to occur) should be supported using the piping manufacturer’s standard pipe clip or support pipe carrier tray.

Pipe outside diameter (mm)	Maximum interval	
	Horizontal (metres)	Vertical (metres)
16	0.64	0.83
20	0.72	0.94
25	0.75	0.98
32	0.85	1.10
40	0.95	1.24
50	1.06	1.38
63	1.19	1.55
75	1.30	1.70
90	1.42	1.85
110	1.73	2.25

Table 6.2: Support bracket spacing; 60°C (without support tray)

6.38 Where PB piping is supported using other than standard PB pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to a rail support or the building fabric.

6.39 Thermal expansion/contraction of the material must be taken into account during both the design stage and installation stage of the work. It is incumbent upon the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

Note: For support centres utilising support tray, consult relevant manufacturer's literature.

7. PE-X Pipework Specification

General

7.1 Requirements specific to the design and installation of PE-X pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2. Paragraph 2.38 is particularly relevant.

7.2 PE-X pipework and fittings intended for the conveyance of potable cold water and hot water service for use within NHSScotland premises should comply with the requirements of the following:

- DIN 4726;
- DIN 16892;
- BS 7291, Parts 1 and 3: 2010.

7.3 The manufacturer of the system proposed for use shall have submitted the materials within the system to WRc plc for toxicological assessment.

7.4 The working pressures and operating temperatures of PE-X pipework and fittings are listed for guidance in Table 7.1.

Pressure ratings – pipe, fittings and valves		
Product	**Size**	**Pressure rating at 80°C**
Fittings	All	As advised by respective manufacturer
Valves	All	As advised by respective manufacturer
Pipe	15mm – 28mm	6 Bar
Pipe	32mm – 110mm	6 Bar

Table 7.1: PE-X pipework – working pressures/operating temperatures

NB**:** The pressure ratings above are for guidance only. The relevant manufacturer should be consulted to advise on temperature/pressure relationship at the maximum operating temperature of the materials.

Normal operating temperatures will be in the range 10°C – 60°C.

Note: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

7.5 The whole of the PE-X pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

- BS6700: 2006+A1: 2009;
- SHTM 04-01 Parts A,B,C & D;
- HSE: Legionnaires' disease: The control of *Legionella* bacteria in water systems (L8). Approved code of practice and guidance (2000).

and the relevant manufacturer's instructions.

7.6 Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing the pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Also, the pipework and fittings should **not** be stored where they may be exposed to the effects of ultra violet radiation including daylight.

7.7 It should be noted that whilst BS 7291 Part 3: 2010 only covers PE-X piping up to 35mm outside diameter, PE-X pipe and fittings are available in a range of sizes up to and including 110mm.

Pipes

7.8 All PE-X piping used in DHCW services pipework systems in NHSScotland premises should be to BS7291, Parts 1 and 3: 2010, DIN 4726/ DIN 16892.

Pipe fittings and valves

7.9 Unless specified otherwise, all associated pipe fittings (i.e. unions and flanges) should be supplied/or approved by the pipework manufacturer for use with the pipework system.

7.10 Valves for PE-X pipework should be fully compatible with the pipework system to which they are connected, comprising variously:

- ¼-turn ball valves with disconnecting unions for pipework up to 54mm diameter or flanged butterfly valves with double-lugging or single-lugging with spool piece, manufactured entirely from non-dezincifiable materials;
- also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used.

7.11 Where servicing ball valves are required at fitments these shall be of non dezincifiable construction with compression ends suitable for direct connection to PE-X pipework, with approved pipe with support liners.

Cleanliness requirements

7.12 As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all SHP pipework installations, and to satisfy this requirement the piping contractor should ensure that the pipe suppliers' manufacturing process is such as to enable the piping products supplies, to pass the 'cleanliness test' described in ASTM: B280-86 Clause 12.

Workmanship, finish and appearance

7.13 The finished tube shall be smooth, free of internal and external mechanical imperfections, and internally shall have a clean appearance.

Packaging and transportation

7.14 The pipes should be delivered in straight lengths with each and every end securely capped against the ingress of dirt, and the capped tubes shall be bundled by size in polythene bags or sleeves, clearly marked with the purchase order number, materials designation, size, total length or piece count and name of supplier. Smaller bore pipes shall be delivered in individually boxed coils.

Note: Any pipes delivered unprotected or with open ends should be rejected.

7.15 The right to inspect the piping at the manufacturer's works, or have it inspected by an appointed delegate, should be stated in the purchase documentation. Also, in the event that batch identification is required, the purchaser shall specify the details desired.

Pipe joints

7.16 The pipes and fittings should be entirely compatible with each other, and jointing should be carried out in strict accordance with the manufacturer's printed instructions.

7.17 Unless indicated otherwise, the pipe joints in PE-X pipework should be made by compression type joints. The specification for these should be dependent on the manufacturer of the PE-X piping and the joints should in all respects be compatible with the installed pipework. They should comprise either:

- type A compression fittings to BS EN 1254 Part 2 (DZR) complete with pipe support inserts for use with pipework 15mm - 28mm diameter; or
- couplings specifically designed for the connection of PE-X piping for diameter 35mm - 100mm.

7.18 Screwed adaptor fittings should be used at screwed joints to appliances and the like.

Pipework system

7.19 The piping contractor should provide samples of the following for approval:

- PE-X piping;
- PE-X pipework valves, or (if applicable) gunmetal gate valves and connectors;
- PE-X pipework bends, tees and tap connectors;
- DZR compression fittings for use with PE-X pipework.

7.20 Orders for the pipework system should not be confirmed, nor should the construction of the installation of the system be proceeded with until these samples have been approved in writing.

7.21 The approved samples should be retained on site for comparison with the work as actually installed.

7.22 No PE-X pipework should be connected direct to any heat source (for example, a secondary domestic hot water heater). Final connections up to a length of 1.0 metre, or as advised by the manufacturer of the PE-X pipework, should be made with stainless steel pipe and clearance between PE- X piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5metre.

Fire sleeves

7.23 Fire sleeves should be used where PE-X pipes of 50mm outside diameter and above penetrate fire barriers. They should generally comply with the requirements of paragraph 2.31 and in particular with the following:

- they should be constructed with an outer galvanised steel casing and intumescent lining;
- each sleeve should be manufactured in two longitudinal half sections. The sections should be jointed together, around the pipe, utilising galvanised steel slide on clamping strips;
- casings should accommodate the expansion of intumescent linings during fire conditions;
- intumescent linings should expand inwards at a temperature of 150°C and completely seal the openings against the passage of flames, fumes and smoke. Such linings should also be in accordance with the pipe manufacturer's requirements;
- individual sleeves mounted on vertical pipework should:
  - be of construction suitable for surface mounting;
  - not exceed 200mm in length;
  - be fitted with a flanged galvanised steel split collar, the flange of which should be drilled for bolt type fixings;
  - be installed on the pipe immediately below the fire barrier. (The collar should be securely fixed to the sleeve, the sleeve and the flanged collar butted up against the fire barrier and the flange bolted into position).
- individual sleeves mounted on horizontal pipework should not exceed 100mm in length.

Installing the pipework system

7.24 The contractor should:

- check that the exterior of the piping is continuously marked with the manufacturer's name, type of material, pipe size and standard with which it complies;
- check that all the piping and fittings supplied are uniform in colour density; and
- exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage.

7.25 The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storing, stacking, handling and installation. The pipework should be supported in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

7.26 Great care should be exercised to ensure that, where practical, the PE-X pipework does not suffer from the effects of undue heat from other pipes and that appropriate clearances, as set out in paragraph 2.43 and/or prescribed by the manufacturer, are maintained. Where an existing heat source has to be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

7.27 On no account should ladders, scaffold or other building items be propped up against the PE-X pipework installation.

7.28 As stated in paragraph 2.43, pipework should be set as close as possible to any local projections. However, with PE-X piping any offsetting required should be formed using fittings, or bending of the pipes in accordance with manufacturer's directions.

7.29 All PE-X pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer) the spacing of which should not exceed the maximum intervals given in Table 7.2 or as advised and confirmed by the pipe manufacturer.

Pipe outside diameter (mm)	Maximum interval	
	Horizontal (metres)	Vertical (metres)
15	0.4	0.5
22	0.6	0.8
28	0.65	0.85
32	0.8	1.0
40	1.0	1.3
50	1.2	1.6
63	1.3	1.7
75	1.45	1.9
90	1.6	2.1
110	1.6	2.1

Table 7.2: Support bracket spacing; 60°C

7.30 Where a support bracket is being used to support a number of pipes of different materials and sizes, the spacing interval between such brackets should not exceed the smallest of the 'maximum intervals' stated or advised for each of the pipes being supported.

7.31 PE-X pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

7.32 Where PE-X piping is supported using other than standard PE-X pipe clips, the supports should comprise steel split pipe rings with rubber inserts, nippling rod nuts and washers with backplate as required, either fixed to rail support or building fabric.

7.33 Thermal expansion/contraction of the material must be taken into account during both the design stage and the installation stage of the work. It is incumbent on the designer and installer to ensure that due allowance has been made for the thermal movement of the pipework system.

Note: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

7.34 The high co-efficient of linear expansion for PE-X compared to metallic pipework results in considerable movement of the pipework due to changes in temperature. This thermal movement is a function of the change in average temperature of the pipe wall. This temperature depends on internal and external environment temperatures.

7.35 To accommodate thermal movement, loops/offsets are included within the pipework system (sized in accordance with the manufacturer's data and the relevant temperature differentials).

8. Water Filtration

General

8.1 This section gives guidance on the filtration of incoming cold water supplies for domestic use in NHSScotland Premises.

8.2 Quality of water is coming under increasingly close scrutiny. Examinations of domestic water systems in numerous Scottish hospitals have revealed that significant deposits of sediment and debris can occur in pipework. These deposits can give rise to breeding grounds for health debilitating bacteria as well as biofilms which can ultimately cause deterioration of adjacent material surfaces. To avoid these potentially damaging circumstances, all incoming cold water supplies destined for domestic use within NHSScotland premises should be filtered. Further guidance on this issue can be found in SHTM 04-01 Part A Section 5.

Requirements

8.3 Filtration should be introduced to:

- ensure that domestic water supply and hence all associated pipework is maintained at high standard of cleanliness, from the supply point to all potable water outlets.
- reduce the build-up in water systems of sediments and deleterious biofilms, which may act as nutrient sources for bacteria.

Limitations

8.4 Filtration should *not* be installed as a means of:

- sterilising or disinfecting water; or
- improving the potability of water.

8.5 Filtration need not be a requirement for incoming cold water destined for non-domestic use, such as fire fighting, boiler feed or other chemically treated or dosed systems.

Responsibilities

8.6 It is the responsibility of the water authority to ensure water reaches the end user in a potable condition. It is the responsibility of the end user to ensure that the water remains potable (wholesome) from point of receipt to point of discharge at potable outlets. Thus, filtration plant must not result in any degradation of the water supply.

8.7 It should be noted that the Control of Substances Hazardous to Health Regulations 2002 impose a personal responsibility on managers to enforce codes of practice relating to potentially harmful micro-organisms.

Description

8.8 Filtration is normally used to prevent ingress of suspended solids into plant and pipework, and as such may be defined as the process of separating solids from liquids using a porous medium. The medium could consist of granular materials (sand, clay, carbon etc.) assisted by chemical and/or bacterial activity, woven meshes and screens made of metals, fabrics, ceramics and polymeric membranes.

8.9 Filtration plants are usually specified by various criteria including minimum particle size diameter retained, expressed in microns. 'Absolute filtration' of a given size indicates that a plant can remove 99.9% of all particulates above a given size. 'Nominal filtration' is normally taken to mean that 95% of all particulates above the specified size will be removed.

8.10 As a guide, suspended materials are normally classified as shown in Table 8.1, below.

Material	Particle diameter	
	(mm)	(micron)
Pebbles	>10	-
Gravel	10 – 2	-
Very course sand	2 – 1	-
Course sand	1 – 0.5	1000 – 500
Medium sand	0.50 – 0.25	500 – 250
Fine sand	0.25 – 0.10	250 – 100
Silt	0.10 – 0.01	100 – 10
Clay	<0.01	<10
Colloid	$10^{-4} – 10^{-6}$	0.1 – 0.001

Table 8.1: Classification of suspended materials

8.11 In practice, water will contain a range of sizes of suspended particulates. The rate of blockage by suspended solids for any given filter will depend on a number of factors such as:

- throughput;
- concentration of suspended solids and other fouling debris;
- size distribution;
- shape of particulates.

8.12 Particles less than 0.1 micron are invisible microscopically. The smallest visible particle is approximately 40 microns in diameter. Particles less than 0.001 micron are considered to be dissolved and in solution.

8.13 The level of filtration within NHSScotland premises where thermoplastic pipework systems are installed should be 5 micron absolute.

8.14 The level of filtration within NHSScotland where stainless steel pipework systems are installed should be 0.5 micron absolute. (However, refer to caveat in paragraph 2.80 of this SHTM)

Process selection

8.15 Plant should be selected to meet the operational requirements of the particular Unit and satisfy the requirements of the user. Generally a filtered water storage cistern would be provided to cope with heavy peak hourly demands. It is also essential that filtration plant suppliers are provided with water samples for the premises in which the plant is to be installed.

Water throughput

8.16 The sizing of the filtration plant is obviously dependent upon water throughput, and is usually specified in litres or cubic metres per hour. This requirement can give rise to gross over estimation since design estimates using the relevant CIBSE Guide yield data in litres per second. A problem arises therefore in deriving hourly rates from this data, since appropriate outlet diversity factors for each type of hospital would be required to enable extrapolation to hourly demand rates. Such extrapolation may not be linear and would be most unlikely to be a constant of the value of 3,600.

8.17 Until more appropriate design data is available it is proposed that conventional estimates be compared with the consumption data presented in SHTM 04-01 Part A, Appendix 1 and/or information potentially available from the Health Board based on records and/or monitoring. (See Note, below)

Note: Where filtration plant is to be installed within existing premises/ refurbishment projects, the existing water metering device should be accurately monitored to provide the designer with data to prepare overall water usage profile and peak hourly demands to enable selection of the most economical plant to achieve the required filtrate flow rate.

Design features

8.18 The filtration equipment supplied should satisfy the filtration levels stated in paragraphs 8.13 and 8.14.

8.19 Where possible filtration plant should be capable of providing fully automatic operation. It should include self-cleaning and 'back-washing' modes so that the filter medium itself does not become a reservoir of bacteria capable of contaminating the service pipework. Cartridge filters should be replaced to ensure economic use of filters and to ensure that the correct quality of water is supplied to the system or piece of equipment which it supplies. Consideration should be given to the incorporation of differential pressure monitoring.

8.20 Where air compressor and associated equipment are used, these should conform to the Code of Practice set out in BS EN 1012-1: 2010 and be mounted within or adjacent to the main filtration unit framework. All control and operating functions should be fully integrated with, and operated from, the main filtration plant control console.

8.23 Filtration plant support framework (when fitted) should be manufactured from a suitable quality steel adequately protected against deterioration from atmospheric corrosion. In addition suitably identified lifting points and attachments should be provided, so that when the complete unit is lifted, no distortion or transference of external loads to the contained filtration plant piping or its components takes place.

8.24 The filtration plant should be fitted with suitable by-pass connections (blanked off) connecting outlet piping. In addition, a suitable by-pass connecting pipe should be supplied but **not** fitted. The capped ends should incorporate quick connect couplings for rapid fitting in emergency. Such a by-pass must be disinfected before being put into use.

8.25 Consideration should be given to the provision of flow meters directly connected to hospital computerised Building Management Systems where fitted. Provision for drawing off water samples should be incorporated as follows:

- at the incoming cold water main;
- at the cold water outlet from cold water storage tank(s);
- at the filtered water outlet from the filtration plant;
- at the cold water feed to hot water generating plant;
- at the hot water flow and return from the hot water generating plant;
- at low points throughout the installation;
- at entries to sensitive departments such as pharmacies and accommodation for immunocompromised patients.

8.26 Consideration should also be given to ensuring that any electronic micro-chip equipment is protected against supply voltage surges. The filtration plant should be connected to the 'essential' electricity supply busbar, supported by a standby generator.

8.27 The installation of all electrical equipment should comply with

- BS7671; 2008, the 17th Edition of the IEE Wiring Regulations;
- SHTM 06-01;
- SHTM 06-02, and
- equipment containing 'live' parts or components in accordance with BS2754: 1976.

The equipment supply and operation parameters should be in accordance with the Electricity Supply Regulations (1988). All specific items of electrical equipment should conform to the relevant British Standard.

Materials

8.28 All materials should comply with the requirements specified in Section 2. Advice on such materials is available from the Healthcare Engineering and Environment Unit, on behalf of the NHS in Scotland, Estates Environment Forum, based on criteria and advice provided by WRc plc.

Operational experience

8.29 The introduction of domestic water systems filtered water supplies is becoming increasingly common in NHSScotland premises and is positively encouraged in Part A of this SHTM with benefits clearly identified. To provide assistance to designers and hospital engineers in the selection, choice, and design of future systems, some examples of the experience gained to date in the design and operation of plant already installed in Scottish hospitals are given below.

8.30 The simplest form of filter is the 'strainer' type which is a perforated metal sheet, the size of perforation being determined by the size of debris the filter or strainer is designed to remove. The early perforated metal sheets have now been generally replaced by more sophisticated designs using paper or plastic felt sheets or membranes designed to withstand the range of fluid pressures pertaining to the particular water or gas system involved. These types of filters are often referred to as 'dead end' filters since they do not normally incorporate 'backwash' facilities. Collected debris is retained and the filter must be replaced when blocked and giving rise to unacceptable pressure losses and correspondingly reduced water flows.

8.31 'Dead end' filters are therefore the best suited for use in systems in which the water particulate content is low, or in conjunction with other units to act as pre-filters for the removal of larger particulate. It is also important to note that filters can harbour and spawn bacteria and must therefore be cleaned and disinfected on a regular basis to avoid infection of the total water system.

8.32 In addition to the above, the water authority's mains water systems, in particular, those using old cast iron or mild steel pipework systems, are often subject to spasmodic flurries of iron oxide corrosion debris. This can occur when mains isolating valves are adjusted to alter system mains water pressures. The effect of these flurries is to 'swamp' water storage cisterns and inline filters with heavy depositions of debris, causing blocked filters and considerable expense.

8.33 To meet the levels of filtration called for in this SHTM requires the provision of suitably designed equipment of proven performance, capable of running unattended for long periods of time and fitted with automatic backwashing and self-cleaning facilities.

8.34 The availability of cross-flow units incorporating automatic back flushing and self-cleaning facilities, providing particulate filtration down to the required level greatly influenced the practicality of achieving high quality clean water for use in hospitals. These units have proved very successful and it is of particular note that much of this success has been due to the proven reliability of the unit control pack.

8.35 In addition, as mentioned in paragraph 8.24, it was initially considered necessary to ensure continuity of domestic water services in the event of failure of the filtration plant, to provide (but not fit) a by-pass between the filter plant inlet and outlet water supply points. This requirement was maintained in spite of manufacturer's statements that all key items of the filtration units could be replaced well within the timescale dictated by the filtered water reserve storage capacity.

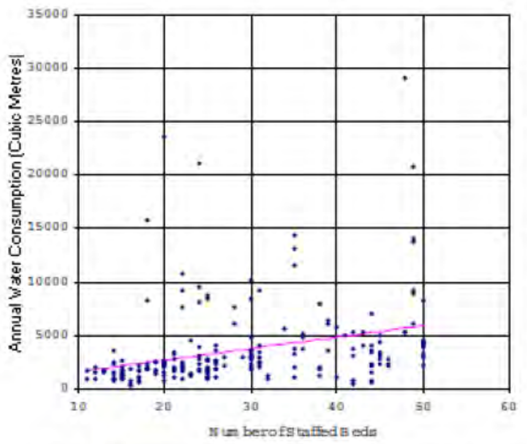
8.36 Since then, experience has shown that rather than adopt the extreme remedy outlined in paragraph 8.34, in which the water systems could be contaminated with 'dirty' water, (thus undoing all the initial care and expense to provide clean water pipework systems), alternative arrangements of filters have been made to maintain the integrity and cleanliness of the water pipework systems and these are briefly discussed below.

8.37 One possibility was to incorporate a series of 'dead end' filters into the proposed by-pass loop identified in paragraph 8.35. In this instance the emergency bypass system would be isolated using locked double non-return valves, so that the by-pass system and filters could not be accidentally brought into use.

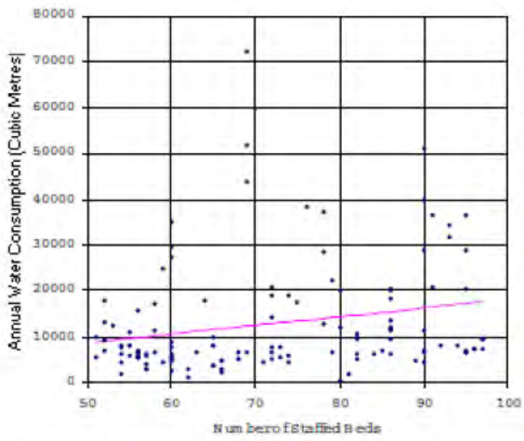
Note: In this arrangement drains and vents require to be fitted and commissioning procedures should comply with those outlined in paragraph 2.65 of this SHTM.

8.38 Alternatively and although not the cheapest option, on occasion two units have been installed. These units can be designed on the basis of say 2 x 100% or 2 x 75% duty machines depending upon the design considerations. In this arrangement it has been found best to run the machines alternately and to design the control circuitry such that for normal water demand rates one machine runs to meet the demand, but in the event that this is not enough then the second machine is also automatically brought into operation.

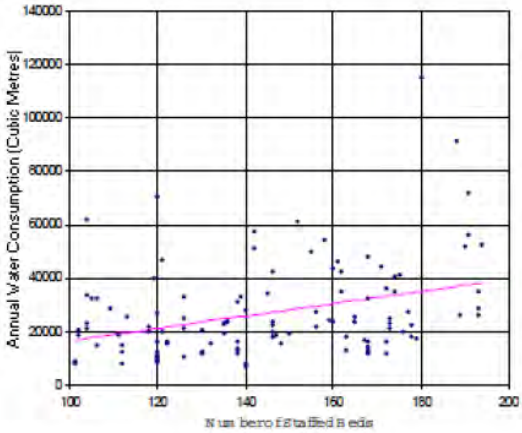
8.39 These units discharge the backwash products at high pressure. These waste products should be discharged to drain via a small closed tank, so that no aerosol dispersion of infected water takes place. Where twin filtration units are installed a common waste tank has been used.



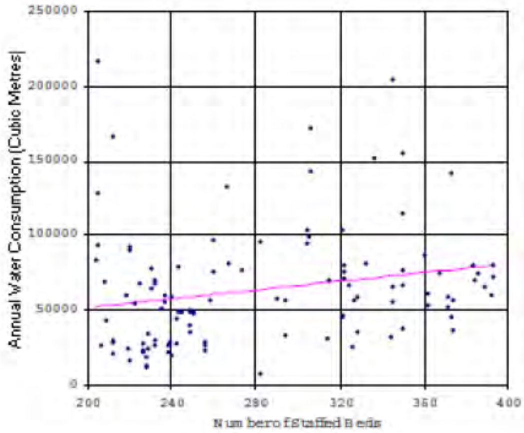
Annual Water Consumption 1995-96 to 1997-98 (10 to 50 Beds)



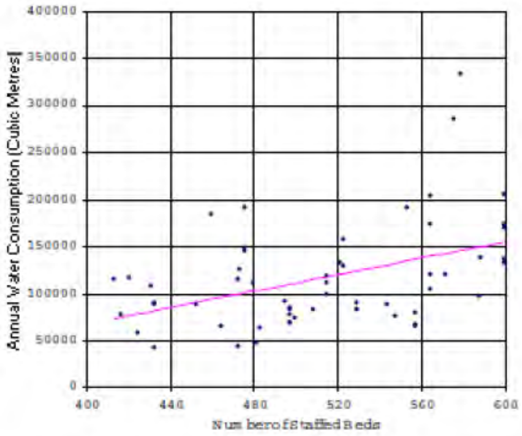
Annual Water Consumption 1995-96 to 1997-98 (50 to 100 Beds)



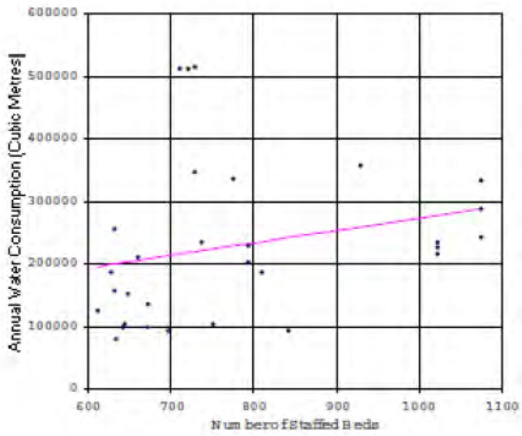
Annual Water Consumption 1995-96 to 1997-98 (100 to 200 Beds)



Annual Water Consumption 1995-96 to 1997-98 (200 to 400 Beds)



Annual Water Consumption 1995-96 to 1997-98 (400 to 600 Beds)



Annual Water Consumption 1995-96 to 1997-98 (600 + Beds)

Water regression analysis charts for 1995-6 to 1997-98

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Glossary

ACOP	Approved Code of Practice
ASTM	American Society or Testing Materials
BS	British Standard CIBSE Chartered Institution of Building Services Engineers DGH District General Hospital
DHCW	Domestic hot and cold water
DIN	Deutsche Industrie-Norm (German Industrial Standards)
DoH	Department of Health
HFS	Health Facilities Scotland
HSE	Health and Safety Executive
ISO	International Organisation for Standardisation
Legionella	name given to a genus of bacteria of which *Legionella* pneumophila is one species
Legionellosis	term used for infections caused by *Legionella neumophila* and other bacteria from the family of Legionellaceae
Legionnaires'	an atypical pneumonia disease caused by *Legionella pneumophila* and other sero-bacteria
MEK	methyl ethyl ketone
NHS	National Health Service
PCD	Post Commissioning Documentation
ppm	parts per million
PTFE	Polytetrafluoroethylene
PVC-U	Unplasticised polyvinyl chloride
PVC-C	Post chlorinated polyvinyl chloride
PB	Polybutylene
PE-X	Cross-linked Polyethylene
SHTM	Scottish Health Technical Memorandum
SHTN	Scottish Hospital Technical Note

TIG	tungsten inert gas (welding process)
UK WBS	United Kingdom Water Byelaws Scheme WHO World Health Organisation
WHO	World Health Organisation
WRAS	Water Regulations Advisory Scheme
WRc	Water Research Centre

Department of Health

Health Facilities Scotland

Department of Health, Social Services and Public Safety

www.dhsspsni.gov.uk

GIG CYMRU NHS WALES Partneriaeth Cydwasanaethau Shared Services Partnership

Estates and Facilities Alert

Action

Ref: EFA/2013/004 **Issued: 19 November 2013**

Device

Cold water storage tanks

Problem

The use of uncapped PVC-U pipes (or similar) within cold water tanks as a support structure for the lid is likely to lead to stagnation and harbouring of harmful micro-organisms.

Action

- Inspect suspect tanks for hollow pipes used as a support structure.
- Replace with solid structures as the preferred option.
- Alert tank manufacturers / installers who use hollow pipe supports.

Action by

- Managers and staff responsible for the procurement, supply and maintenance of cold water tanks.
- Water Safety Groups

Contact

Enquiries about specific cold water tanks should be directed to the relevant supplier, installer or contractor.

Problem

1. Contamination of water supplies has been found in two recent projects within NHS Scotland. Extensive testing traced the source to the cold water storage tanks which gave TVC (Total Viable Count) readings for *Pseudomonas* readings in excess of 500cfu/100ml (after 72-hour incubation). TVC readings fell to 0cfu/100ml immediately after disinfecting the tanks but reverted to high levels following re-testing later.

2. Construction of the tanks utilised vertical 4 inch PVC-U pipes to support the lid, held in position by strategically placed cross-members (see Appendix, Photo 1), a permanent tank design adopted by at least three manufacturers.

3. The pipes were saw-cut to length with the top supporting the lid and the base sitting directly on the tank floor. Since the ends of the pipes were not sealed, water was able to seep into and out of the pipes as the tank water level varied, providing near stagnant conditions for micro-organism growth while at the same time preventing effective disinfection. When the tank was drained and a pipe dislodged, detritus spilled out, further supporting the conclusion that this was almost certainly the source of the contamination.

4. Replacing the pipes with solid supports proved successful in eliminating the source of contamination (see Appendix, Photo 2).

Action

5. If there is any reason to suspect a water tank as a source of micro-organism contamination, it should be inspected for uncapped and semi-submersed hollow pipes (or similar) used as a support structure. These should be removed to eliminate possible contamination and replaced with ‘clean’ solid supports, i.e. ones without cavities, crevices or details allowing water to stagnate and harbour micro-organisms.

6. Tank manufacturers and installers who employ hollow pipe supports in their cold water tanks should be alerted to the issues highlighted in this alert.

Suggested Onward Distribution

- Authorising Engineers (Water)
- Responsible, Authorised & Competent Persons (Water)
- Capital Planning & Design
- Estates/Facilities
- Health & Safety
- Hospices
- Infection Control Staff
- Risk Management

Appendix

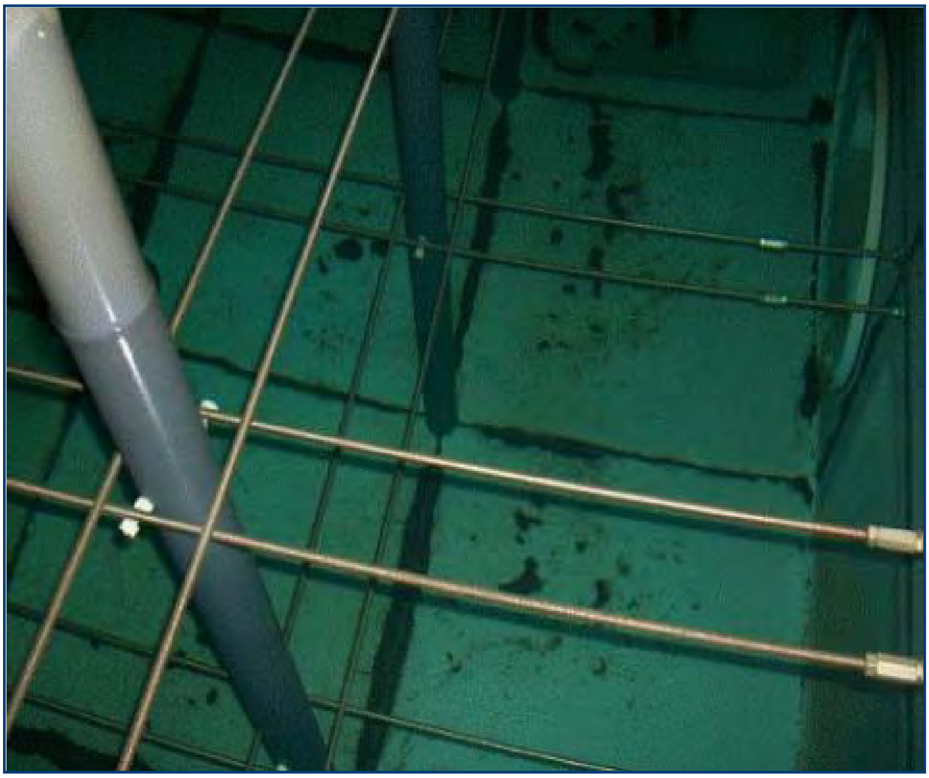


Photo 1
Cold water storage tank interior as constructed
(uncapped vertical PVC-U pipe held in position by cross members)

Photo 2
Cold water storage tank as altered
(solid vertical lid supports)

Additional information for Scotland

The above sections of this Alert were compiled by Health Facilities Scotland and distributed nationally without modification.

Useful guidance in Scotland may be found in:

1) Guidance for neonatal units (NNUs) (levels 1, 2 & 3), adult and paediatric intensive care units (ICUs) in Scotland to minimise the risk of Pseudomonas aeruginosa infection from water: HFS, HPS and Pseudomonas aeruginosa and Water (Scotland) Group http://www.documents.hps.scot.nhs.uk/hai/infection-control/guidelines/pseudomonas-2013-06.pdf

2) CEL 08 (2013) *Water sources and potential infection risk to patients in high risk units – revised guidance,* The Scottish Government, 3 May 2013 http://www.sehd.scot.nhs.uk/mels/CEL2013_08.pdf

3) Scottish Health Technical Memorandum SHTM 04-01 *Water safety for healthcare premises* Part A*: Design, installation and testing;* Part B*: Operational management,* Health Facilities Scotland, NHS National Services Scotland, March 2013 http://www.hfs.scot.nhs.uk/publications/1367575681-Part%20A%20version%201.4.pdf and http://www.hfs.scot.nhs.uk/publications/1367575758-Version%201.4%20Part%20B.pdf

All requests regarding return, replacement or modification of the equipment mentioned in this alert should be directed to the relevant supplier or manufacturer. Other enquiries (and adverse incident reports) in Scotland should be addressed to:

Incident Reporting & Investigation Centre (IRIC)

NHS National Services Scotland, Gyle Square, 1 South Gyle Crescent, Edinburgh EH12 9EB

Tel: 0131 275 7575 Fax: 0131 314 0722 Email: nss.iric@nhs.net

Report options are available on the HFS website at http://www.hfs.scot.nhs.uk/online-services/incident-reporting-and-investigation-centre-iric/how-to-report-adverse-incidents/

Further information about reporting incidents can be found in CEL 43 (2009) or by contacting IRIC at the above address.

Health Facilities Scotland
Engineering and Environment

NHS National Services Scotland

Minutes of special meeting held in the Labs FM Block at the South Glasgow Hospital to discuss and resolve issues with Optitherm taps installed in the Hospital

Date: 5th June 2014

Time: 11/00 am

Chairman: Ian Stewart (IGMS) Health Facilities Scotland

Present:	Lisa Ritchie (LR)	Health Protection Scotland
	Paul Southworth (PS)	Health Protection Scotland
	Alan Gallacher (AG)	NHS Greater Glasgow & Clyde
	Ian Powrie (IP)	NHS Greater Glasgow & Clyde
	Jim McFadden (JMcF)	NHE Greater Glasgow & Clyde
	Gerry Cox (GC)	Golden Jubilee Hospital
	Iain McInally (IMcI)	NHS Ayrshire & Arran
	Jimmy Walker (JW)	Public Health England
	Ian Storrar (IGS)	Health Facilities Scotland
	Angus Horne (AH)	Horne Engineering Ltd
	John Horne (JH)	Horne Engineering Ltd

Apologies: These had been received from Eddie McLaughlan and Geraldine O'Brien

1. **Welcome and introductions:**

   IGMS thanked everyone for their attendance and conducted the necessary introductions.

2. **Background information:**

   IGMS explained that following the neonate deaths in Northern Ireland in 2012 guidance had been published individually by DH and HPS/HFS with the aim of setting out precautions to avoid infections from *Pseudomonas* sp. SHTM 04-01 had been updated to replicate this. Scottish guidance was about to be reviewed.

   Among the recommendations was advice that flow straighteners / aerators / rosettes should not be installed within taps in accommodation occupied by vulnerable (immunocompromised) patients.

   Concern had been expressed that the South Glasgow Hospital- due for handover early in 2015 - incorporated taps with these features, principally Optitherm taps manufactured by Horne Engineering. The meeting had been requested by NHS GG&C to review their situation and an

invitation issued to Horne Engineering had been taken up.
Differences between SHTM and HTM 04-01were referred to and are summarised in the Addendum

3. Horne Engineering presentation;

This was given by Angus Horne, Managing Director, who was grateful for the opportunity to attend.

The issue was illustrated showing the desirability of retaining a solid column of water delivered (laminar flow-fashion) from a tap outlet. It was necessary that this should not be broken up and aerators should *never* be fitted to tap outlets. The importance of the stopping of water delivery coincidentally with the closing of the tap lever was stressed. If water continued to empty from the body of the tap, this would induce air providing scope for retrospective contamination. HSG274 (part 2 clause 2.46) stated that “wetted systems should not be drained down”. While this referred to the commissioning of complete systems it was equally applicable to taps. JW explained this further in the context of self-draining showers that induced air into warm dark places that were introduced on the premise that self-draining would reduce the propensity for *Legionella* in the shower head or hose. This was not, in the end, found to be the case.

A plea was made for the designation “flow straighteners” or “outlet fitting” to be used in guidance. The devices integral with the Optitherm taps relied on a mesh made out of hexagonal holes to maintain surface tension and hold back water within the tap body after shut-off.

4. Discussion:

In discussion, JW illustrated the build-up of biofilms on similar outlet devices found in taps installed in Northern Ireland. JW had been advised that the build-up had occurred within 4 months. AH explained that a more open mesh did not allow surface tension and water retention to be so efficiently achieved. Also illustrated was the extent of *Pseudomonas* contamination around a typical wash hand basin and the splashing that had occurred on the surroundings and floor. Contamination was also likely if correct procedures were not followed in the cleaning regime adopted. A cloth used to clean the WHB surfaces followed by the tap could create a “wicking” process and contamination of the inner surface at the point of discharge. (Current guidance is available on how to clean wash hand basins and outlets). A more open mesh did not allow surface tension and water retention to be so efficiently achieved. JW explained that a test rig had been set up at Porton Down. This had identified weak points liable to be contaminated as the tap outlet, the solenoid and the thermostatic valve. Testing had been carried out by injecting contamination to the pipework. Further research and experimentation would be required with *Pseudomonas* contamination applied at the point of delivery.

It was concluded that spout water retention was unlikely to eliminate *Pseudomonas* although a reduction may be possible. LR stressed the reasons for incorporating the six critical points in the existing and forthcoming updated guidance. Risk management was the key. *Pseudomonas* elimination was the holy grail. Influences on outcomes included, commissioning procedures, operational management, seasonal influences and personnel involved. The approach had to be tailored to individual circumstances. There was no fixed rule.

IGMS thanked Horne Engineering for taking the time to explain the working of their product and suggested that they should take the opportunity to give presentations to the National Water Services Advisory Group on future innovative products.

5. Action arising from presentation:

5.1 **Forthcoming HPS/HFS guidance**: It was felt that the six critical points referred to and the risk-based proportional approach was still appropriate and no alteration appeared necessary. The review of the guidance would be circulated to the Water Group and to SETAG.

Action: IGMS

5.2 **SHTM 04-01** would similarly be unaffected as it replicated the HPS/HFS guidance being issued for review. IGMS pointed out that it now incorporated more helpful advice on the setting up of water safety groups.

5.3 **The South Glasgow Hospital**: it was unanimously agreed that as the taps installed within the new build development had complied with guidance current at the time of its specification and briefing and that the hospital was in the process of being commissioned, it should be regarded as being in the "retrospective" category, not "new build". There was no need to apply additional flow control facilities or remove flow straighteners and any residual perceived or potential risks would form part of the routine management process.

5.4 **Future research**: It was agreed that there was a need to determine whether the retention of water within the body of taps offered a better solution to that of ensuring that none was retained. Further research and experimentation would be required with *Pseudomonas* contamination applied at the point of delivery.

Ian Stewart
Health Facilities Scotland
5th June 2014

ADDENDUM

Differences between HTM and SHTM 04-01

HTM 04-01 Part A

Paragraph 2.6 Devices fitted to, or close to, the tap outlet (for example flow straighteners) may exacerbate the problem by providing the nutrients which support microbial growth, providing a surface area for oxygenation.

Paragraph 3.9 Owing to their high surface-area-to-volume ratio and location at the tap outlet, certain designs of flow straightener may present a greater surface area for colonisation and support the growth of organisms. Therefore, when selecting new taps, where possible flow straighteners should be avoided/not included. Health Building Note 00-09 also advises against using aerators in outlets.

Paragraph 4.49b Where practical, consider removal of flow straighteners. However, the removal of flow straighteners may result in splashing and therefore additional remedial action may need to be taken. If they are seen to be needed, periodically remove them and either clean/disinfect or replace them. Replacement frequency should be verified by sampling/swabbing.

SHTM 04-01 Part A

Note 15 recommends the removal of flow straighteners.

"The Scottish Water Byelaws 2004 place limits on the flow of water to draw-offs where plugs are not provided. Spray-type mixer taps are not recommended in healthcare premises; therefore, the type of tap should be carefully selected to minimise the formation of aerosols. The water flow profile must be compatible with the shape of the wash hand basin. Flow straighteners and aerators can capture biofilm but their removal can create turbulent flow at increased pressure resulting in splashing of surrounding surfaces and flooring. Current advice is that they should be removed."

NHS GREATER GLASGOW & CLYDE

ROYAL HOSPITAL FOR CHILDREN

MINUTES OF INCIDENT MANAGEMENT TEAM MEETING REGARDING *ACINETOBACTER BAUMANNII* ON WARD 1D, RHC MONDAY 4TH DECEMBER 2017 MEETING ROOM 1, WARD 1D

Present:	**Prof Alistair Leanord**	**Infection Control Doctor (Chair)**
	Gael Rolls	**SCN - PICU**
	Linda Canning	**SCN – PICU**
	Patricia MacDonald	**SCN – PICU**
	Fiona Bell	**SCN – Theatres**
	Pamela Joannidis	**IPC Nurse Consultant, GGC**
	Raje Dhillon	**Microbiologist**
	Katie Anderson	**IPCN, RHC**
	Liane McPherson	**SCN – PICU**
	Mark Davidson	**Paediatric Intensivist**
	Kathleen Harvey-wood	**Clinical scientist**
	Susie Dodd	**Lead IPCN, RHC**

ACTION

1. **INTRODUCTIONS AND APOLOGIES**

Professor Leanord welcomed everyone to the meeting and explained that the meeting had been called to discuss cases of *Acinetobacter baumannii* on PICU, RHC. It was agreed by the group that the membership was appropriate. No one declared any conflict of interest.

2. **CONFIDENTIALITY**

Professor Leanord advised that patient identifiable information discussed within this meeting should be regarded as confidential.

3. **REVIEW OF SITUATION TO DATE**

Susie Dodd provided an update of the situation to date.
PAG held 13/11/17 to review 2 new cases of *Acinetobacter baumannii* on PICU who shared the same bed bay (bay 19-22). At that time, only 1 of the 2 was an HAI to PICU. It was noted that there was a 3rd case of *A.baumannii* already known to the IPCT who was on PICU at the time and had occupied the same bed bay sometime prior. A retrospective look back at 3 further cases over September and October found that 2 of the 3 had occupied the bed bay 19-22. In summary, 5 of a total 6 had occupied the same bed bay at some point during their admission. Of the 6 cases, 4 were HAIs to PICU, 1 to NICU and 1 to 1E. 4 of the 6 were cardiac patients and as a result, the surgical history of the patients were reviewed inclusive of the theatre used, the surgeon who operated and dates associated with positive isolates. No association was found. Environmental samples obtained were all negative at the time. An inspection of the cleanliness within the bed bay was unremarkable and staff

practice was noted to be good. 2 points of concern were noted; parent poured dirty basin water down a hand hygiene sink and fans were being used at patient bedsides. It was also noted that trough sinks which were due to be removed and replaced in more suitable locations had not yet been carried out.

A second PAG was held on 30/11/17 following a new HAI *A.baumannii* to ward 1D. This case had not been associated with bed bay 19-22 but was a cardiac patient. As a result, Dr Christine Peters requested that theatre 8 (cardiac) be inspected. Cleanliness was found to be of a high standard but it was noted that the laminar flow had been faulty and not working for a period of time. In summary, total cases is now 7, 5 of which are HAIs to 1D. Of the 7 cases, typing results are available for 4 and 3 of these are a match.

Prof Leanord described that *Acinetobacter baumannii* and the typing puts an isolate into a clonal group. Further molecular testing (which can be done if required) would need to be done to prove/disprove transmission.

4. <u>RISK MANAGEMENT/CONTROL MEASURES</u>

Prof Leanord queried if there was any commonality with bed bay 19-22. Gael Rolls stated that not all patients pass through this bed bay. It is by in large used for cardiac cases but at times a non cardiac patient may be placed in this bay. Prof Leaonard went onto report that over a 12 month period, the background rate of Acinetobacter on 1D had not changed when compared to previous years. No SPC UCLs had been breached at this time.

Prof Leanord asked Susie Dodd and Pamela Joannidis if they felt there should be any additional measures in place at present. Susie Dodd stated that inspections of the bay found cleaning to be of a high standard and as previously reported, the environmental swabs had not isolated *Acinetobacter baumannii* therefore she felt there was no need to re-audit cleanliness and practice at this time. She did remind the group that parents must not pour dirty basin water down sinks, that fans should be removed from use and agreed that she would chase progress on the replacement of the trough sinks. Susie **SD**
Dodd asked Gael Rolls for an update on hand hygiene training which was one of the actions from the first PAG. Stefan Morton, board hand hygiene coordinator, has provided a train the trainer session for staff and hand hygiene audits are ongoing. Failures are almost always down to the amount of time spent washing hands so they are trying hard to re-enforce the 15-30 second message.

Pamela Joannidis asked if all actions from previous PAGs were complete. Susie Dodd reported that there were no outstanding actions.

Prof Leanord reported that there was no risk to public health, visitors or staff at this time. Good Standard Infection Control Precautions (SICPs) should be practised by all staff at all times.

5. **Healthcare Infection Incident Assessment Tool (HIIAT)**

This incident has been assessed and classified by those present at the meeting as a 'Green Category' using the Hospital Infection Incident Assessment (HIIA)Tool.

Severity of illness – Minor
Impact on services – Minor
Risk of Transmission – Minor
Public Anxiety - Minor

6. **Communication**

Local internal communication amongst IMT only at present.

9. **ANY OTHER COMPETENT BUSINESS**

Gael rolls reported that the floors are not being cleaned with Actichlor plus as per the winter plan. Pat Coyne will take this forward with the area supervisor. **PC**

10. **DATE AND TIME OF NEXT MEETING**

No other meetings to be held at present. Once typing of the remaining patient isolates is available, this will be reviewed again.

NHS Greater Glasgow & Clyde

Clinical & Care Governance

Infection Prevention and Control Team **5 December 2017** **Paper No: 17/24**

Report on Concerns Raised re Queen Elizabeth University Hospital (QEUH) and Royal Hospital for Children (RHC)

Recommendation:- The committee are asked to note the concerns raised in relation to the QEUH and RHC and review the current status and actions being progressed.

Purpose of Paper:-

During September 2017 three consultant microbiologists in the South Sector raised a series of concerns about the facilities in QEUH and RHC and the structure of the Infection Prevention and Control (IPCT) Service within NHS Greater Glasgow and Clyde.

On the 4th of October 2017 Board and Acute Directors including the Board Director of Facilities, the Chief of Medicine for Diagnostics and members to the IPCT Senior Management team met with the consultants to discuss these concerns. The consultant microbiologists tabled a list of concerns and this paper identifies each with an action plan setting out the current situation and the steps taken or in progress to address the issues identified. The minutes of the October meeting are appended to this document with each specific issues raised identified and cross referenced to the action plan.

Key Issues to be considered:-

As above

Any Patient Safety /Patient Experience Issues:- yes

Any Financial Implications from this Paper:- no

Any Staffing Implications from this Paper:- no

Any Equality Implications from this Paper:- no

Any Health Inequalities Implications from this Paper:-no

Has a Risk Assessment been carried out for this issue? If yes, please detail the outcome:-

Highlight the Corporate Plan priorities to which your paper relates:- improving quality efficiency and effectiveness

Below is a list of the key themes raised by the Consultants.

Themes

- Positive Pressured Ventilated Lobbied (PPVL) Isolation Rooms.
- Royal Hospital for Children (RHC) – Protective Isolation – Haematology Oncology Unit.
- RHC – HEPA filters in Paediatric Intensive Care Unit (PICU).
- Queen Elizabeth University Hospital (QEUH) – Ward 4B – Upgrade to the Haematology Ward.
- Single Room Specification and Location of Areas that can be used for Protective Isolation.
- Cleaning of QEUH, RHC and Office Block
- Cleaning of Dishwashers in QEUH and RHC linked to a potential outbreak of exophiala
- Water Quality and Water Testing
- Plumbing in the Neurosurgical Block
- Decontamination of Respiratory Equipment
- Structure of the Infection Prevention and Control Team

Each specific item has been identified in the minute of the meeting and cross referenced in the associated action plan which is tabulated below.

Action Plan

Item	Issue	Current Position	Future Actions
1	PPVL rooms not compliant with SHTM standards	Facilities colleagues confirmed that there are 10 air changes per hour and a positive pressure of 10 pascals in the PPVL rooms which is consistent with SHBN 04-01.	Included in item 2
2	PPVL rooms do not provide appropriate protection for patients with infectious diseases of high consequence (IDHC) e.g. MERS, SARS This issue also exists in the Royal Hospital for Children	IDHC should be nursed in negative pressure rooms. These are not available in QEUH. In order to address this issue in the short term a patient pathway has been agreed by the Infectious Disease (ID) Clinicians whereby patients will be routed either to GRI or Lanarkshire ID unit. Chief Nurse (CN) for Paediatrics discussing with clinical teams a pathway for children.	Heath Protection Scotland (HPS) have been sent information on these rooms and we await their advice on whether they can be used for patients with IDHC or if not what actions could be taken to modify these rooms to provide negative pressure. This advice was sought in 2016 & 17.
3	Lack of isolation rooms in the emergency department.	ED was designed with input from clinical staff and observation of patients was a priority. There are single rooms in ED but not negatively pressured isolation rooms.	Property Procurement Facilities Management (PPFM) has commissioned a feasibility study to ascertain if negatively pressured rooms are technically feasible
4	Rooms not built to the standard expected as a tertiary referral centre.	The transfer of the Infectious Diseases Unit was a late addition to the project and was not fully commissioned as an ID unit at the outset.	Actions as described in item 2.
5	Microbiologists not aware of plans to upgrade areas.	Lead Infection Control Doctor (ICD) was aware of this proposal.	Work continues with input from the Coordinating ICD.
6	HEPA filters in PICU for the protection of patients in the Bone Marrow Transplant Unit (BMTU) that might need critical care during treatment. The BMTU is ward also referred to as ward 2A.	HEPA filters were installed within PICU/Ward 2a week commencing 6 November 2017, within room numbers 12 and 17 – previously installed within room 18. HEPA filter still to be fitted in room 5 (access to be agreed with clinical colleagues). HEPA filters were also fitted into RHC Ward 3c week commencing 13 November 2017 within rooms 9 & 10.	Work commenced mid November 2017, therefore ahead of May 2018, as noted above.

Item	Issue	Current Position	Future Actions
7	HEPA filters in prep room	HEPA filters have not been routinely fitted (as standard) within prep rooms, however HEPA filters are fitted within QEUH Ward 4b. Instruction required to determine whether HEPA filter should be fitted into RHC Ward 2a prep room.	A feasibility study will be undertaken to ascertain if HEPA filters can be installed in the prep room.
8	IVs prepared in treatment room.	IVs are prepared in the preparation room but not chemotherapy which is prepared in a specialist unit.	CN paediatrics confirmed that this was the standard practice.
9	Outbreak of Aspergillus associated with poor air quality	There were two cases of aspergillus associated with the ward in March 2017. This was fully investigated and was possibly associated with a leak into the ceiling space which was not immediately apparent. On review of cases in the new BMTU and the unit previously located in Yorkhill there is no significant increase in the number of cases of this infection. This was fully reported as per Chapter 3 of the National Infection Prevention and Control Manual to Health Protection Scotland.	HPS have been contacted for advice on what would be an appropriate regime for air monitoring in this area.
10	Concern that the statement issued advised that BMT services in RHC were unaffected by issues identified in the adult BMTU.	Clarification from the NHSGGC Comms Team "To the recollection of colleagues involved, the Communications team were not briefed at the time of the release about the adult BMT move of any testing underway at the Royal Hospital for Children. The final line of the press release of 8th July 2015 "Bone Marrow Transplant Service Temporary Relocation" was written to make clear to media that the move of the adult service did not include the paediatric service at the Royal Hospital for Children and that the latter was not moving. "	Clarification issued to the meeting attendees. No further action required. This perhaps appears to be misinterpretation of the media communication.
11	HEPA filters not in place in PICU	Action complete as previously agreed and noted within point 6.	

Item	Issue	Current Position	Future Actions
12	Increase in the number of line infections in Ward 2A	Two years' retrospective data were analysed in May 2017 and it was noted that there was an increase in line related infection. The initial baseline infection rate per 1000 total line days was 3.25 and this had risen to 6.33. A group led by CN Paediatrics first met in **May 2017** to review this information and put actions in place to reduce this incidence. The last 4 months (July to October) have shown improvement in infection rates. CN Paediatrics presented a paper to the Board Infection Control Committee on the 27 November 2017 outlining several work streams and the most recent infection rates in this area.	There are currently four work streams in place to look at key initiatives to reduce line infections in BMTU, these include: • Line Insertion and access in theatre. • Access and Maintenance of lines • Staff Education • Patient and Parent engagement Next Steps From 1st December 2017 every CLABSI (line associated infections) will be subject to rigorous review utilising Event Cause Analysis methodology within 72 hours of a reported CLABSI
13	Increase in the number of line infections	IPCT participating in above work. Line related surveillance was subsequently picked up by the Directorate.	Ongoing assessment of surveillance activity and resource within the IPCT to enable IPCT to respond to local clinical needs.
14	Dr Redding concerned that the ongoing work would not accurately pick up any concerns.	• As above work streams in place re line infections. • IPCT audit process is in place and ongoing; this includes audit of the environment, audits of line and urinary catheter care. Audits of standard Infection Control Precautions (SIPS). • IPCT twice weekly visits. • GGC compliant with the National IPCT Manual – this lists all types of infections that should be reviewed and what should be reported if an outbreak or incident occurs. • Weekly report to Board and Acute Directors weekly on an IPC issues throughout GGC.	IPCT and CN Paediatrics will continue to have a clear focus on this area.
15	Microbiologists do not have the information to advise clinical staff on where to place immunocompromised patients.	Director of Regional Services stated that this had never been raised as an issue by clinicians within his service that care for patients who are immunocompromised. Most patients who are immunocompromised are cared for within this directorate. It was agreed by the group that placement of immunocompromised patients was a decision that should be taken by the clinical team looking after the individual patients.	Dr Peters agreed to circulate a document she had used in another board area. David Loudon (Director of PPFM) agreed to send the microbiologists a list of where the PPVL rooms were in the QEUH and RHC. It was agreed that this would be reviewed at the Regional Services Governance Forum

Item	Issue	Current Position	Future Actions
16	Infection rates are not being monitored.	• GGC compliant with the National IPCT Manual – this lists all types of infections that should be reviewed and what should be reported if an outbreak or incident occurs. • Every patient with a notifiable infection is reviewed and monitored. • NHSGGC is fully compliant with all elements of the national Mandatory Surveillance of Infection Programme (mainly specific surgical site and blood stream infections. • Weekly report on exceptions is sent to the Board Directors. • Monthly reports are sent to Senior Management teams. • All outbreak and incidents are reviewed by the Board, Partnership and Acute Infection Control Committees. • The most recent National Point Prevalence Survey in 2016 indicated that both the QEUH and RHC were under the national average in terms of the incidence of Hospital Acquired Infections.	ICM has invited HPS to review the NHSGGC systems for surveillance and reporting of infections – this assessment took place on the 29.11.17, the initial feedback was positive but we await the full report.
17	There are three air changes and chilled beam technology instead of the 6 air changes recommended.	There are three air changes in the single rooms within both QEUH and RHC.	Director of Facilities agreed to take this issue forward with NHS D&G to share learning with regards to this type of technology and draw to their attention concerns regarding cleaning of the beams. Action complete.
18	Use of cleaning agents.	NHSGGC has for several years changed the cleaning regimens each winter to include a chlorine based detergent as a strategy to reduce norovirus outbreaks. This switch commences on the 1st of November and continues until the 30 April each year or longer if the season is prolonged. This is not recommended in the National Infection Control Manual because of lack of scientific evidence but is put in place in GGC based on local site knowledge.	This policy and practice will continue unless new evidence emerges

Item	Issue	Current Position	Future Actions
19	Roles and responsibilities with regards to cleaning of the dishwashers in the ward pantries was not clear.	IPCT held an Incident Management team Meeting (IMT) on 22nd of September. Dishwashers were removed from use until they could be serviced and re-sampled.	Catering staff agreed to assume the responsibility for cleaning of the dishwashers going forward.
20	Issue with dishwasher not picked up during routine monitoring.	GGC fully compliant with the National Monitoring of Domestic Services	Roles and responsibilities had been clarified and a process in now in place.
21	Cleaning of Temperature Control Values (TCVs)	TCVs are maintained in all high risk areas and plans are in place to carry this out in all areas despite this not being mandatory. Protocols are in place to manage this process.	Agreed works within QEUH-plant room 31, almost complete and being led by Site Maintenance Manager. Anticipated date of completion by end of January 2018.
22	Water testing is not as per national guidance	Board water safety is in place and water systems and processes are monitored as per national guidance.	None
23	Sewage leaks in institute not reported to microbiologists	Leaks in any clinical areas that required advice from an ICD are reported	Ensure reporting is ongoing.
24	Plumbing not replaced in Neuro Surgical Block	The Director of Regional Services advised that there is ongoing work in the neuro building that would because of its complexity, take several years to complete, in the meantime the new operating theatres were due to open in January 2018.	Works are ongoing as planned.
25	Perceived Increase in surgical site infections	Regional Services has funded 1.5 WTE surveillance nurses to carry out prospective surgical site surveillance in this area. For context, there are 3 surveillance nurses that provide this service for the rest of GGC therefore the investment in the INS to monitor SSI is significant. Although it is difficult to obtain benchmark rates for SSI in this area, continuous surveillance will pick out trends and therefore any increase. This is monitored via a group unique to Regional Services – the RS Surgical Site Infection Group. The group in turn reports into the Regional Service Clinical Governance Group	Continue to monitor trends in surgical site infection in this area.

Item	Issue	Current Position	Future Actions
26	Decontamination facilities	Most decontamination of equipment is conducted in the central Decontamination Unit or Endoscopy facilities. Respiratory equipment is easily damaged and advice from manufacturers is often difficult to implement. There should be dedicated facilities with established work flow patterns (dirty to clean). At this point in time the Decontamination group (which is a sub group of the Board Infection Control Committee) has give advice on many items of equipment and had obtained room designs which could be used if space was identified in QEUH and RHC. This has been submitted to management colleagues for consideration. In addition a list of specialist equipment that we require national advice on has been submitted to Health Protection Scotland.	Pursue HPS for advice regarding the list of equipment provided. Establish status of planning for new decontamination areas.
27	Roles of IPCT have changed	The current IPCT all have Job Descriptions which have been in place for several years. There is a clear documented governance structure that has been reviewed by Price Waterhouse Cooper and approved by the Infection prevention Committees within NHSGGC. There is a clear management structure which complies with the recommendations contained within the Vale of Leven Report and the Healthcare Environment Inspectorate Standards	A review of the roles and responsibilities of the Infection Control Doctors in South Glasgow will be undertaken by the Chief of Medicine for Diagnostics. The ICM has invited HPS to undertake a review of IPC surveillance and reporting systems in place.

Minutes of Meeting
Meeting Room L02-001, Teaching & Learning Centre
Queen Elizabeth University Hospital

Wednesday 4th October 2017 at 8:00am

PRESENT

Dr Jennifer Armstrong (**Chair**)	JA	Medical Director
David Loudon	DL	Director of Property, Procurement & FM
Morag Gardner	MG	Chief Nurse
Sandra McNamee	SMcN	Associate Nurse Director IPC
Ian Powrie	IP	Depute General Manager, Estates
Professor Brian Jones	BJ	Head of Service, Microbiology
Tom Walsh	TW	Infection Control Manager
Anne Harkness	AH	Director, South Sector
Jonathan Best	JB	Acting Chief Operating Officer
Gary Jenkins	GJ	Acting Director, North Sector
Dr Penelope Redding	PR	Consultant Microbiologist
Dr Christine Peters	CP	Consultant Microbiology
Dr Ash Deshpande	AD	Consultant Microbiologist/ICD
Dr Rachel Green	RG	Chief of Medicine, Diagnostics

In Attendance

Ann Lang (Minutes) PA, Infection Prevention and Control

Item		Action
1.	**Welcome & Introductions** Dr Armstrong welcomed everyone to today's meeting to discuss Infection Control and estates issues at QEUH and RHC and round the table introductions were made. The group noted that colleagues from Women's and Children's Directorate were not in attendance but were aware of the issues raised and had helpfully submitted information via email which could inform the relevant areas of the discussion.	
2.	**Purpose, Format and Conduct of Meeting** Dr Armstrong advised that a series of emails have been received from Dr Redding and Dr Peters regarding Infection Control and estates issues on the QEUH and RHC site. Dr Armstrong had requested a document setting out the issues of concern and thanked Drs Redding and Peters for providing the SBAR document which provided a helpful basis for the discussion. Dr Armstrong proposed that the meeting is focused on patient safety and a review and update on the current status of the issues identified. She asked that if there are any comments during the meeting if these could be addressed through the chair and to adhere to the GMC and Board guidance regarding respect, professionalism and working as part of a team. The group agreed the importance of issues raised being discussed in the context of the appropriate roles, responsibilities and governance structures.	

Item		Action
3.	**Review of SBAR / Concerns** It was agreed to go through the items detailed in the SBAR from Dr Redding and Dr Peters, to look at the points raised and address any outstanding issues. • <u>Patient Placement</u> Dr Redding outlined that there are challenges for the microbiologists regarding source isolation of infected patients. She said the current situation is that the positive pressure ventilated lobby rooms were not built to SHTM standard and she and others were concerned that they do not provide appropriate protection when managing a small number of patients with significant respiratory pathogens of high consequence such as MERS and MDRTB **(Items 1&2)**. Dr Peters advised that Microbiologists and ICDs and ID colleagues feel there is a lack of provision for isolation rooms in A&E **(Item 3)**. David Loudon replied that this specification was signed off by the board and clinical teams; he also confirmed that remedial work had been carried out due to issues raised at the snagging stage of the build. David also stated that although there were some modifications to the design the rooms did conform to SHTM 04-01 and that it was incorrect to state that this was not the case. Ian Powrie addressed specific points raised in respect of the ventilation specification and agreed to provide the detailed information to support this. Sandra McNamee commented that the inclusion of the Infectious Diseases service was a late amendment to the QEUH project and therefore not commissioned as an ID unit at the outset. The group noted that the Brownlee Clinical Team put a strong clinical case to the board to be co-located on QEUH site with the Intensive Care Unit and other critical clinical services. The issues identified were discussed with HPS at the time and they agreed to advise the Board on what standard these rooms would need to be to accommodate these patients. When this information has been received, estates colleagues will review the advice to determine if these modifications were feasible. Dr Redding stated she would like to see the evidence relating to this. Sandra advised that a follow up meeting took place with HPS on Monday 2nd October and that the relevant information was expected in the next few weeks, however in the meantime a patient pathway has been in place which routes these patients to appropriate isolation rooms in other hospitals. Dr Peters reported that these patients with significant airborne pathogens are being sent from A&E to the isolation rooms in ITU before being transferred to other hospitals as reported by ID colleagues. The group noted that this would be the case for other hospitals within NHSGGC and across NHS Scotland. Dr Peters however intimated that there is a risk of exposure to a large number of patients and staff and reiterated that, in her opinion, the ITU isolation rooms are not adequate for these types of patients. Furthermore other hospitals have not been recently built and are not a tertiary ID referral centre such as the QEUH **(Item 4).** Dr Redding also recognised that work may be ongoing but the microbiologists are not aware of this **(Item 5).** Anne Harkness advised that as these issues were raised she met with Directors and ID Physicians and they agreed a pathway for these patients to be transferred to other sites. She also commented that based on the external advice, unless the existing rooms can be modified in some way the only alternative was to build a new Infectious Disease Unit which would require a significant resource. David Loudon confirmed that changing the specification to negative pressure would be reviewed to assess technical feasibility.	

Item	Action
It was agreed to await the response from HPS and to deal with any further issues via the Acute and Board Infection Control Committees and the relevant Directorate Governance Committees.	
• <u>Protective Isolation</u> Currently HEPA filters are not fitted in PICU isolation rooms **(Item 6)** and in the prep rooms in Ward 2A **(Item 7).** Dr Redding also commented that IVs are prepared in the treatment room **(Item 8).** She stated that there has been a perceived high rate of infections in immune compromised patients in Ward 2A and air quality has remained an issue in this ward since it opened.	
She also commented that there was an outbreak of Aspergillus **(Item 9)** in the unit and that there is still a risk to patients.	
Dr Peters said there was a public statement made by NHSGGC that BMT services at RHC are separate and unaffected and that both she and an ICD colleague had objected to the wording of the statement at the time and had asked to step down from ICD roles immediately after it was released. Dr Armstrong advised that she will check with the Comms team regarding the wording in the statement as this required some additional clarity around context **(Item 10).**	**JA**
With regards to the cases of Aspergillus, Sandra McNamee updated that there were two cases in March and April associated with a leak in the ceiling space. This was investigated and the tiles were removed and replaced with no further cases of Aspergillus.	
Ian Powrie advised that the HEPA filters were installed in two of the rooms in adult ITU but there has been no request to add these to isolation rooms throughout the adult or children's hospital. Work in RHC, Ward 2A is scheduled to start this month and with the scribe being signed off he can now contact the contractors to start the work. Sandra McNamee confirmed that this was raised at a meeting she attended yesterday and that she was aware that there is a plan to put HEPA filters in two of the rooms in PICU as contingency. (this action is complete)	
Ian Powrie said that the only reason this had not been done is that there was a requirement for the rooms to be unoccupied for 24 hours whilst this work was done and validation carried out and that up to this time it was not possible because the beds had been fully occupied and that there were ongoing discussions with the team in Ward 2A as to whether these patients could be accommodated in isolation rooms within other wards where HEPA Filters could be fitted to address the overspill contingency.	
Dr Peters commented that this was necessary in PICU, not just as an overspill for Ward 2A, but for these extremely vulnerable patients if they required intensive care treatment because of their illness **(Item 11).**	
Dr Redding advised that the clinical team in Ward 2A have reported that in their experience there seemed to be an increase in the number of line related infections and Sandra advised that this was investigated by Infection Prevention Control and the clinical team when first raised and work had been ongoing for several months **(Item 12)**.	

Item	Action
She also reported that IPCT and the Clinical Team were working with Timothy Bradnock, Consultant Paediatric Surgeon to look at improvement work. Sandra noted that there was no effective benchmark available for this area. Dr Peters noted that rates of line infection were important to determine and that IPCT had stated there was no resource to do this (**Item 13**).	
Jen Rodgers, Chief Nurse has an improvement group looking at PVC and CVC bundles and Sandra said that this should have an impact on the number of infections. Dr Armstrong added that there has been a focused piece of work carried out in Ward 2A and they were on a weekly reporting process to ensure compliance with infection control standards had improved. Dr Redding was concerned that this may not accurately pick up any concerns **(Item 14).**	
In relation to the chemotherapy being prepared in the treatment rooms Gary Jenkins advised the group that chemo was prepared in a designated area and there was an audit process to confirm this. He also commented that this process had been reviewed recently and offered to provide Dr Redding the document that was produced. Dr Armstrong confirmed that chemo is not being made up in these rooms and is carried out in the Aseptic Dispensing unit. Dr Armstrong agreed to confirm this with Pharmacy.	**JA**
With regards to safe placement of immunocompromised patients, Dr Peters asked if there was a list of which rooms were of the standard that would be acceptable for this group of patients. She commented that when she worked in Crosshouse Hospital they had a list of where these particular patients could be placed. She said the microbiologists receive calls asking this question by clinical staff (**Item 15**).	
The group debated the definition and severity of immunocompromised patients and agreed, with input from Sandra McNamee and Prof Jones that this was a decision best considered by the clinical team looking after the individual patients. Dr Armstrong advised that this should be discussed at AICC and Gary Jenkins commented that this has not been raised as an issue via his Regional Clinical Governance Committee. Dr Armstrong recommended that this be addressed through the Regional Clinical Governance Committee. She also said it would be helpful to have a copy of the document that Dr Peters used in Crosshouse. Dr Redding reiterated that Microbiologists need to know which rooms are the most suitable for different categories of patients.	**GJ** **CP**
Dr Redding commented that she feels the infection rates are not being monitored **(Item 16)** and Dr Armstrong replied that the Board and Acute Directors receive a weekly report of all outbreaks and infection control incidents.	
Dr Armstrong agreed to ask the Women & Children directorate to take forward the points raised above.	**JA**
• <u>Single Side Room Accommodation</u> Dr Redding outlined that air changes per hour for all clinical accommodation in QEUH and RHC are 3 instead of 6 as per guidelines with the inclusion of chilled beam technology. The grills also collect dust as air is entrained over chilled beams which she suggested is not recommended in a healthcare setting **(Item 17).** Dr Peters advised this initially came to light when investigating issues regarding CF patients.	

Item	Action
David Loudon advised that Dumfries and Galloway have chilled beam technology and Dr Peters stated that Monklands Hospital is at the commissioning stage of a new build and suggested that we share our learning with them. It was agreed that it was important to share the GGC knowledge around chilled beam technology with colleagues in other Boards and David Loudon agreed to take this forward. Ian Powrie informed the group that all chilled beams on site are being cleaned and maintained and Dr Redding asked if the air changes can be changed from 3 to 6 in some rooms but not in all areas and David Loudon advised this was not realistically possible. Ian Powrie confirmed that cleaning and monitoring is being carried out to determine how quickly dust has built up and once this has been established a cleaning schedule will be organised and this can be shared with other hospitals. Dr Redding suggested involving Microbiologists regarding cleaning to look at the microbiological counts. Dr Jones suggested that rates of infection may also be a useful indicator. In this context Sandra McNamee reported that during the point prevalence survey QEUH was under the national average for infections and that all alert organism/conditions were monitored by the IPCT and that there were no indications that this site had a higher than average infection rates. It was noted that infections occurring post discharge would not be picked up by the point prevalence survey.	**DL**
• <u>Cleaning</u> In relation to cleaning Dr Redding stated that cleaning agents were not being used on floors in clinical areas **(Item 18).**	
Dr Redding also outlined that dishwashers had not been cleaned, installed or operated according to manufacturing instructions **(Item 19).** This was brought to light with the investigation into CF patients with Exophiala. Sandra McNamee updated regarding the occurrence of Exophiala in CF patients and said this was referred to HPS as an amber HIIAT score but they downgraded this to a green HIIAT as this is considered to be a ubiquitous organism and the modes of spread, incubation period and occurrence in the population and environment was largely unknown. Dr Peters stated that she had already discussed the outbreak in her role as CF Microbiologist with mycology experts and given the striking epidemiology of increasing numbers, it is a reasonable hypothesis to assume a link to the dishwashers as a possible source. She had also discussed the HIIAT rating with HPS and agreed with green rating as the intervention with dishwasher was rapidly and appropriately dealt with.	
With reference to the cleaning agents Sandra McNamee responded that Actichlor cleans are used throughout the winter norovirus season which normally runs from November to April. She also stated that Actichlor was used in specific areas at the recommendation of IPCT, for example. Actichlor was used in GGH for a month in the summer due to an increase in CDI across the site. This has also been introduced for general cleaning into the wards with CF patients in QEUH and RHC, PICU, NICU and Ward 2A.	
At a recent meeting with HPS Sandra said HPS have found no evidence that using Actichlor is effective but further guidance was awaited.	
With regards to dishwashers in the ward area there had been some debate in the ward regarding whose responsibility it was to clean these but Sandra said this has been addressed. The manufacturer has come in to check the dishwashers and Catering Services have confirmed they will commence a cleaning programme for the dishwashers. It was also noted that Environmental Health Officers prefer dishwashers to be used over hand washing in sinks/ basins.	

Item	Action

Dr Peters commented that the audit system did not pick up this problem **(Item 20),** and raised concerns about gaps in the environmental audit programmes and this was possibly the same with regards to ward refrigerators or other equipment. Sandra McNamee advised that nursing staff have a requirement to check the temperature in fridges and stated again that the catering department have agreed to take responsibility for the ward dishwashers. The group noted that dishwasher maintenance had been overlooked in the overall system but that this had now been rectified.

- Water Quality and Testing

In the SBAR it stated that all taps are fitted with TMVs and the cleaning and maintenance policy has not been reported and Dr Redding stated that we need to ensure this is up-to-date **(Item 21)** She also commented that the water in Ward 4B has not been tested to a high standard **(Item 22).**

The group was assured that there was a Board Water Safety Policy in place that is approved by the appropriate governance committees.

David Loudon reported that we have strict guidance on how to monitor water systems and processes are in place to comply with ECOPs. Ian Powrie also confirmed that water testing is carried out as per protocol and only exceptions are reported to the Infection Control Teams and this was previously agreed with Dr Inkster.

He said testing is mainly carried out in high risk areas. David Loudon stated that we are not required to test all taps but a sample and that this was in accordance with guidance. He also confirmed that if requested by an ICD additional sampling was undertaken. Dr Deshpande said that Dr Inkster was managing the water testing and he perceived there was a problem with the environment. He said that he requested gram negative testing but did not receive the results from Estates. Ian Powrie replied that recent changes in staff in both estates and IPC could have been the reason why he did not receive the information. It was agreed that GGC are compliant with the water testing protocol. Dr Peters stated that the issue was not the overall testing protocols but the ICD role in requesting and receiving the results in a timely manner in exceptional circumstances where a water source of infection needed to be investigated.

In relation to TMVs Ian Powrie advised that these are maintained in all high risk areas and they are working towards carrying this out in all areas. He said the end piece of the taps cannot be removed and an SBAR is in place for this. Estates are finalising the installation of a heat sanitation system and once complete this will be sent to the Board Water Safety Committee for approval.

In terms of serratia Ian said they would test the water for this if requested by a clinician.

- Plumbing in Neuro Surgical Block

Dr Redding stated that there has been sewage leaking in the theatre suite since before 2015 and is still ongoing and not all incidents have been reported to ICDs **(Item 23).**

Gary Jenkins advised that there is ongoing work in the neuro building that would, because of its complexity, take several years to complete. In the meantime the new operating theatres were due to open in January 2018.

Item	Action
He stated that his directorate has a specific focus on IPC and that they had a dedicated group to look at surgical site infection. He said they funded 1.5 WTE surveillance nurses to carry out prospective surgical site surveillance in this area. Dr Armstrong updated that Dr Inkster carried out a detailed inspection of the area previously and she suggested that SSI surveillance was carried out here. Sandra McNamee advised for context that there are 3 surveillance nurses that cover all of GGC so the resource to actively do this in the INS was significant. She acknowledged that the ICDs were concerned about infections in EVD and stated that the clinical teams were currently developing an EVD bundle. Ian Powrie reported that remedial work was carried out in this building over the past year but that there had been an incident with sewage last week. There has been a delay in the opening of the ICE theatres as GGC were not satisfied with the standard but a programme of work has been agreed with the clinicians. Dr Peters said she requested to know the number of instances from when the theatres closed two years ago due to problems with the pipe work to date and she stated that she was told at the time of the initial problems that the plumbing was to be replaced **(Item 24)**. Gary Jenkins responded that that the pipes run through multiple floors and a process is in place with IPC and Capital Planning to take this forward in stages. Anne Harkness commented that increases in SSI should be discussed at the Regional Clinical IPC Group which Dr Deshpande is a representative of **(Item 25).** Ian Powrie advised that he has arranged to meet with Dr Deshpande and Dr Balfour to discuss the INS theatre issue. • <u>Decontamination Provision for Respiratory Clinics</u> The SBAR also stated that the decontamination facilities in both Paediatric and adult respiratory clinics have been identified as inadequate on a number of occasions **(Item 26).** Sandra McNamee informed that remedial actions have been put in place and a list of items has been sent to HPS for advice on how to decontaminate them. Dr Peters stated that QEUH ICD had not been informed of timeline for revision works to decontamination area to take place. • <u>Infection Control Structure</u> Dr Redding advised that the ICDs in the South Sector had stated that the roles within the Infection Control team are unclear and appear to have changed **(Item 27)**. Dr Armstrong proposed that consideration is given to having a further separate meeting to discuss the issues referred to in this section. Jonathan Best offered to support this discussion.	

Item		Action
4.	**Agreement of Further Actions / Next Steps** - Ian Powrie to provide documents supporting work on PPVL rooms - David Loudon to liaise with colleagues re GGC experience with chilled beams - In relation to safe patient placement and availability of isolation rooms, this is to be raised via the Regional Clinical Governance Committee. - Dr Peters to issue the group a copy of the document listing isolation rooms from Crosshouse Hospital. - Dr Armstrong to relay issues pertaining to Ward 2A to Women & Children directorate. - Dr Armstrong to confirm chemotherapy preparation in Aseptic Unit. - Consideration to be given to a further meeting with a smaller group to discuss the issues contained in the Infection Control Structure section of the SBAR. - Dr Armstrong to check with the Comms team regarding the wording in the public statement regarding BMT services	
5.	**A.O.C.B.** Nil. Dr Armstrong thanked everyone for their attendance today.	

NHS SCOTLAND

Healthcare Infection, Incident and Outbreak Reporting Template (HIIORT)

The Scottish Government

Complete within 24 hours for all HIIAT Red and Amber;
for HIIAT Green complete only if HPS Support requested.

Section 1 :Contact Details	
NHS Board/Care organisation	Greater Glasgow and Clyde NHS board
Date and time of reporting	29/05/18 @ 1600 hours
Person Reporting and designation	Susie Dodd – Lead Nurse IPC Dr Teresa Inkster – Lead Infection Control Doctor
Telephone number and email	Susie Dodd – [redacted] Dr Teresa Inkster – [redacted]
Section 2: Infection Incident/outbreak Details	
Care facility/hospital	Royal Hospital for Children
Clinical area/ward and speciality	Ward 2A Haemato oncology (inpatient) Ward 2B (outpatient) Haemato oncology
Total number of beds	25 in Ward 2A. 2B is an OPD
Total number of beds occupied	25 in Ward 2A
Section 3: Initial assessment	
Type: Incident/outbreak/ data exceedance e.g. Gastrointestinal, decontamination failure	Increased incidence of Enterobacter cloacae in blood cultures
Infectious agent known or suspected	Enterobacter cloacae
Case definition	Any patient associated with ward 2A or 2B with Enterobacter bacteraemia.
Date of first case (if applicable)	04/05/18

Total number of confirmed Patient cases	Total number of probable patient cases	Total number of possible patient cases:	Total number of Staff cases:
5	0	0	0

Number of patients giving clinical cause for concern as a consequence of this incident/outbreak	All patients currently stable.
Number of deaths as a consequence of this incident/outbreak	Nil
Was the infectious agent cited as a cause of death on a **death certificate*** (if yes, state which part of the certificate)	N/A

Additional information:

5 cases of Enterobacter cloacae in blood cultures amongst 5 patients associated with ward 2A and/or 2B. Of the 5 cases, only 2 are considered HAIs using the 48 hour rule. However, it was noted that the 3 non HAI have had day visits to ward 2B in the days or week prior.

Section 4: Healthcare Infection Incident Assessment Tool (HIIAT) (link to tool)		
Severity of illness	Minor/Moderate/Major	Moderate (Patient required line removal and delay to treatment as a result).
Impact on services	Minor/Moderate/Major	Minor
Risk of transmission	Minor/Moderate/Major	Moderate (Evidence of ongoing transmission)
Public anxiety	Minor/Moderate/Major	Minor
HIIAT Assessment	Red Amber Green	Amber
Section 5: Organisational Arrangements		

PAG/IMT meeting held	Yes	PAG - Date: 18.05.18 Chair: Dr Teresa Inkster IMT - Date: 29.05.18 Chair: Lead IPCN Susie Dodd
Next planned IMT	Following any further cases	Date: N/A
Press statement (send with HIIORT or provide date for receipt)	Holding	Date: 29.05.18
HPS support requested	HPS support accepted for 2A review.	Date: 22.05.18
Other information: e.g. decisions from IMT		

Complete this update section weekly as a minimum if red or amber or as agreed with IMT and HPS for onward reporting to SGHSCD.

Section 6: Update						
On this date:						
Cumulative total of confirmed patient cases						
Cumulative total of probable patient cases						
Cumulative total of possible patient cases						
Cumulative total of staff cases						
Total number of symptomatic patients today						
Number of patients giving cause for concern						
Total number of deaths as a consequence of the incident since last HIIORT report						
Is the ward/services closed						
Is a service restricted						
HIIAT assessment						

Organisation update Comments (including changes to any control measures, case definition or death) certification information)	
Date: 29.05.18	A PAG was held on 18.05.18 to assess 4 cases of Enterobacter cloace bacteraemia associated with wards 2A or 2B. Only 2 of these were HAI however the IPCT felt that those considered non HAIs had had regular visits to ward 2B and therefore the was a risk that acquisition is associated with the hospital setting. A run chart plotting cases of Enterobacter cloacae on ward 2A and 2B over the last 2 years provides evidence of a definite data exceedence. A number of actions were generated from the PAG as listed below: • Send all isolates for typing. • Follow up on progress of cleaning tool for underside of parent beds. • Increase IPCN ward visits to daily. • Domestic concerns to be reported to the Interim director for facilities on a background of multiple concerns raised around domestic cleaning over the last 14 months. • Chase progress of IPC information leaflet specifically designed for parents.

	• Continue to request that parents keep rooms clutter free and assist with access to clean. This will be rolled out to staff again to enforce the message. • Task a staff member with auditing the number of people coming onto ward 2A and their purpose for being on the ward. • Contact relevant parties regarding use of HPV. • Continue parent education. Yesterday (28.05.18) a further Enterobacter cloacae bacteraemia was confirmed. This patient was non HAI by definition but she too had had contact with ward 2B. Typing of 2 cases also found both patients to have unique strains. Typing results are awaited for the others. An IMT was held today 29.05.18. All the above actions were reviewed and noted to have been completed. The following additional actions were agreed; • Drains within clinical hand wash basins to be swabbed on ward 2A and 2B • Request to be made to facilities to clean all drains in 2A and 2B following swabbing. • Chilled beams swabbed and request made for clean of chilled beams. • Linen bins to be ordered for patient en suite areas for parents to dispose of dirty linen. • Peer review of Aseptic non touch technique to be repeated on ward 2A and 2B. • To chase proposals for development of a new treatment room on ward 2A. • To review potential for development of a new sluice room at the opposite end of the ward. In additions to the actions above, daily visits by IPCNs continue and clinical staff on ward 2A continue to carry out SICPs and Hand hygiene audits weekly. 2B staff carry out hand hygiene audits monthly and SICPs audit twice yearly.
Date:	
Date:	
Date:	
Date:	

ONCE COMPLETED, EMAIL TO: NSS.HPSInfectionControl@nhs.net

From: INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE)
Sent: 07 June 2018 11:53
To: STORRAR, Ian (NHS NATIONAL SERVICES SCOTLAND)
Subject: Re: 2018-06-07 Dishwashers

Hi, yes we do . This was a separate incident from last year whereby we had noticed cystic fibrosis patients colonised with a fungus called Exophiala. It does not cause clinical infection but we decided to check dishwashers - Christine Peters was involved at the time and swabs she took grew Exophiala.

There were issues with cleaning and plumbing of these which was addressed and I reswabbed a few weeks back. The fungus is still there so I have requested online filters before swabbing again

At the moment these dishwashers are out of use in Cystic fibrosis wards .
until we get negative results

We have not grown EXophiala from any other water sample so it does seem unique to the dishwashers

KR
Teresa

Dr Teresa Inkster
Lead Infection Control Doctor NHSGGC
Training Programme Director Medical Microbiology
Dept of Microbiology
Queen Elizabeth University Hospital
Glasgow
[redacted]

From: STORRAR, Ian (NHS NATIONAL SERVICES SCOTLAND)
Sent: 07 June 2018 11:23
To: INKSTER, Teresa (NHS GREATER GLASGOW & CLYDE)
Subject: 2018-06-07 Dishwashers

Hi Teresa

Sorry to bother you.
I know that you have mentioned that you have dishwashers at QEUH and RCH which have been contaminated.
Is this still the case as I can't find any correspondence or notes of the test results.
Is the plan to put on point of use filters?

Regards

Ian
Ian Storrar
Principal Engineer - Health Facilities Scotland
Procurement, Commissioning and Facilities
NHS National Services Scotland
3rd Floor
Meridian Court

5 Cadogan Street
Glasgow
G2 6QE

Tel (direct): [redacted]
Reception: 0141 207 1600

www.hfs.scot.nhs.uk

REVIEW OF RECOMMENDATIONS AND ACTIONS ARISING FROM THE REPORTS ON WATER SYSTEMS AT QEUH AND RHC – 'PRE-OCCUPANCY RISK ASSESSMENT'

DELIVERY STATUS

Using the descriptors below describe your overall assessment of the current delivery status for each recommendation? Where available please provide and embed supporting evidence. **DESCRIPTORS**

Fully Implemented (F)	➢ Policy in place ➢ Health Board taking action ➢ Being monitored/evidenced
Mostly Implemented (M)	➢ Policy in place ➢ Health Board taking action ➢ Not yet fully evidenced ➢ Close but not 'perfect fit' ➢ More can be done
Partially Implemented (P)	➢ Policy/discussions started ➢ Different ways of doing things/testing ➢ More can be done ➢ No evidence yet
Not Started (NS)	➢ Yet to begin

	RECOMMENDATION	CURRENT POSITION INCLUDING SUPPORTING EVIDENCE	WHAT MORE NEEDS TO BE DONE	TIMESCALE FOR COMPLETION	DELIVEY STATUS (F, M, P, NS)
1	Water Source Basement Main Tank plantroom Hardgate Road (small) - As this mains lines is likely to have a low turnover of water DMA would recommend the NHS confirms that this main is separated from domestic water mains by a double check valve or similar (possibly external to building) to prevent potentially stagnant water from contaminating the domestic mains.	This supply only feeds the basement fire tank. This is now on flushing regime.			F
2	Water Source Basement Main Tank plantroom Hardgate Road (Large) - Mains to Raw Water Tank 1A valved off at time of survey (and had been for a considerable period of time) prior to DMA surveying. Mains line should be incorporated into the site flushing regime until such times as issues with valves etc corrected. Please refer to CWST section for further recommendations.	The issue identified in the 2015 RA was due to a faulty automatic control valve. This issue was identified pre-full occupation. The mains line is now fully operational with no valves closed. There is now no requirement to be part of any flushing regime. The issue identified in the 2017 RA is not as suspected. This is a pressurisation line to close the keraflow automatic float valve.			F
3	Water Source Basement Main Tank plantroom Hardgate Road (Large) - Deadlegs (drain points/injection points) should be removed or incorporated into low use outlets flushing regime (for recs on isolated mains into T1A please see CWST recommendations)	New drain points have been fitted due to limited access and a flushing regime is in place. See evidence pack submitted at clause 2 above.			F
4	CWST Basement Raw Water 1A - At the time of survey DMA noted that the Hardgate Road supply into Raw Water Tank 1A has been isolated creating a deadleg and NHS Estates confirmed this had been isolated for a number of weeks pending repair by Mercury Engineering. This has still not been completed at the time of this report. The outlet from this tank has remained live during this period which means this is acting as a balance tank with no through flow of water leading to stagnation and film formation on the water surface. DMA would recommend this tank is completely isolated from service until the mains inlet can be repaired, and the CWST cleaned and disinfected prior to re-use (including the mains line).	This works was completed by Mercury on behalf of Multiplex in 2015. However there is no evidence to support this although it has been confirmed by a member of the estates team at that time that it was carried out.			F
5	CWST Basement Raw Water 1A - At the time of survey DMA noted that the Hardgate Road supply into Raw Water Tank 1A has been	This works was completed by Mercury on behalf of Multiplex in 2015. However there is no evidence to support			F

	isolated creating a deadleg and NHS Estates confirmed this had been isolated for a number of weeks pending repair by Mercury Engineering. This has still not been completed at the time of this report. The outlet from this tank has remained live during this period which means this is acting as a balance tank with no through flow of water leading to stagnation and film formation on the water surface. DMA would recommend this tank is completely isolated from service until the mains inlet can be repaired, and the CWST cleaned and disinfected prior to re-use (including the mains line).	this although it has been confirmed by a member of the estates team at that time that it was carried out.			
6	CWST Basement - Raw Water Storage temperatures indicate heat gain between incoming mains and stored water. Further monitoring recommended with capacities altered if required to match usage requirements.	This was considered to be an issue due to RA being carried out 'pre-occupancy 'and therefore turnover of water was significantly lower than when the building was put into use. Full occupancy of the building has eliminated this risk as turnover increased. The risk has diminished, however the screenshot shown as evidence is a more recent screenshot when external air temperatures had been much higher than normal. Subsequently this has had an impact on ground temperatures and incoming mains water temperatures. NHSGG&C have highlighted this issue to Scottish Water who are investigating. If these temperatures go above 20deg then a legionella sampling regime will come in to play. Item 6 & 8 QEUH Mains water tempera			F
7	CWST Basement Tank Plantroom - Raw Water Shut off mains to T-1A requires to be disinfected prior to reinstatement.	This works was completed by Mercury on behalf of Multiplex in 2015. However there is no evidence to support this although it has been confirmed by a member of the estates team at that time that it was carried out.			F
8	CWST Basement Tank Plantroom - Raw Water Greater than 2°C temp rise from mains to stored water in CWST 1A and 1B, investigate and correct.	This is no longer a concern and the issue highlighted here would have been a result of there being low or no occupancy in the building and low turnover of water from the tanks. The risk has diminished, however the screenshot shown as evidence is a more recent screenshot when external air temperatures had been much higher than normal. Subsequently this has had an impact on ground			F

		temperatures and incoming mains water temperatures. NHSGG&C have highlighted this issue to Scottish Water who are investigating. If these temperatures go above 20deg then a legionella sampling regime will come in to play. For evidence see files attached to clause No.6 above.			
9	CWST Basement Tank Plantroom Trades Water - RHS side of the Trades tank was valved off due to a reported inlet valve issue (though tank full with signs of stagnation). DMA would advise the tank is cleaned and disinfected prior to the tank being reinstated.	It should be noted this tank provides water to fire fighting services for the Helipad only and is isolated from the rest of the domestic water system. Item 9 - NHS QEUH A&C TANK C&D Repo Item 9 Trade Water Tank Pipework Altere			F
10	CWST Basement Tank Plantroom Bulk Water - There are however some connection points onto other “nondomestic” outlets such as renal dialysis, endoscopy wash, pressurisation units, steam humidifier units and MRI Chiller cooling which are connected to the Bulk water system. It is advised that Estates (or Brookfield/Mercury) confirm these systems have suitable backflow protection installed or if necessary suitable backflow protection fitted. It is also advised that as the lines to these systems will often have a very low turnover a double check valve or similar should be fitted as close as practicable to the tee-off point to prevent potentially stagnant water from contaminating the domestic system.	Humidifiers serving aseptic suite were disconnected from the system in plant room 41 around February 2018. Piping for the other "non-domestic" systems described need to be checked. Task issued to plumber to confirm whether these non-domestic connections include backflow protection; work started 10.07.18."	Report identifies that there are a number of check valves not in situ. Added to flushing regime until check valves fitted. Some check valves still awaiting delivery but are on order. Flushing regime is in place as stated so action can be closed.	14/8/2018	F
11	Bulk Water CWSTs (and Filtration Units) - Until site staff have access to the BEMS and the filter system monitoring it may be advantageous to leave the bypass on Bulk Water tanks open to link all 4 tank outlets, ensuring all tanks are balanced and to introduce an inspection/monitoring regime at suitable intervals.	This was no longer applicable as soon as the BMS was online. Approx June 2015.			F

12	Calorifier Plantroom 21-01/02/03 - When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day were 40-45°C. This represented a significant break in the control system and there were no records of any remedial or corrective actions and no records of additional control measures. DMA would advise corrective actions and additional control measures (e.g. system pasteurisation/disinfection) should be carried out in accordance with SHTM 04-01 in instances of this type. When DMA re-checked the affected calorifier temperatures on 27th April 2015 the temperatures had partially recovered though the central calorifier was still reading low.	Item 12 & 13 - Plant room 21 Calorifiers 1			F
13	Calorifier Plantroom 21-01/02/0 Central calorifier (02) flow temperature lower than those wither side suggesting this is acting a lead calorifier. Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier	This is factually incorrect. The pipework has been installed as designed by the contractor to ensure correct operation of the system. For evidence see files attached No.12			F
14	Calorifier Plantroom 22 01/02/03 Central Calorifier (02) temperature lower than the other calorifiers. Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier. DMA understand this is due to an issue with the MTHW system being shut off (or not operational in some other way). Corrective actions should be taken and calorifier pasteurised/disinfected and brought up to full temperature.	Temperature issues were caused by a failure with the MTHW heating system. Outstanding issue here is around what remedial actions were taken by NHS / Contractor. NHS re-set point for DHW calorifiers to 65degC as recommended by DMA from another action." See evidence below. Item 14 - Plant room 22 Calorifiers 1 - 2 - 3			F
15	Calorifier Plantroom 31-01/02/03 When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day were 40-45°C. This represented a significant break in the control system and there were no records of any remedial or corrective actions and no records of additional control measures. DMA would advise corrective actions	Refer to action above for Calorifier Plantroom 21-01/02/03. Although for a different calorifier, answer will reflect this action. Item 15 & 16 - Plant room 31 Calorifiers 1 Item 15 & 16 - Plant room 31 Calorifiers 4			F

	and additional control measures (e.g. system pasteurisation/disinfection) should be carried out in accordance with SHTM 04-01 in instances of this type. When DMA rechecked the calorifiers on 27th April they appeared to have recovered fully.	Item 15 & 16 - Plant room 31 Calorifiers 7			
16	Calorifier Plantroom 31-07/08/09 When DMA were on site on the 21st of April there was a significant drop on the temperatures of the calorifiers which we understand was caused by a failure on the heating system. Temperatures recorded on these calorifiers on this day were 40-45°C. When DMA re-checked the affected calorifier temperatures on 27th April 2015 the calorifiers were still significantly lower than expected (see return line gauge photos in Section 11). This represents a significant break in the control system and DMA would advise corrective actions and additional control measures (e.g. system pasteurisation/disinfection) should be carried out in accordance with SHTM 04-01.	Refer to action above for Calorifier Plantroom 21-01/02/03. Although for a different calorifier, answer will reflect this action. For evidence see files attached to No.15			F
17	Calorifier Plantroom 32 01/02/03 Calorifier 32-03 was offline when DMA had an initial site familiarisation walk-round with Mercury Engineering in early January 2015. This calorifier was still offline when DMA were on site on 21st April 2015. This was creating deadlegs on the cold supply, hot flow and hot return to the calorifier and Estates staff were unable to confirm the reason for this calorifier being offline. This calorifier had been reinstated when DMA revisited on 27/04/15 though Estates not aware of any flushing, pasteurisation or disinfection of calorifier being carried out prior to reinstatement. DMA would recommend the calorifier (and hot system) is disinfected/pasteurised and legionella samples taken from the calorifier and system prior to reinstatement to confirm these corrective actions have been effective.	Refer to action above for Calorifier Plantroom 21-01/02/03. Although for a different calorifier, answer will reflect this action. Item 17 - Plant room 32 Calorifiers 1 - 2 - 3 For evidence see files attached to No.14			F
18	Calorifier Plantroom 33-01/02/03 There is a deadleg on the cold feed at these calorifiers – this should be removed or included in site flushing regime	Investigation to confirm function of pipework completed, no dead leg found Item 18 - Plant room 33 Calorifiers 1 - 2 - 3 Item 18 - Plantroom 33 Calorifier dead leg			F

19	All calorifiers The return temperatures recorded at the calorifiers were consistently below 55°C which DMA were advised was the control set point for these, though when calorifiers were at full temperature the returns were reaching 50°C. It may be prudent to increase calorifier set points to ensure calorifier returns remain above 55°C as this is the control set point. This may also help maintain a 60°C minimum flow temperature when demand is placed on the calorifiers as the building becomes occupied. Increasing the calorifier temperatures may also have the beneficial effect of increasing the cold water usage as more cold water will be required at TMVs to blend water to TMV set point and so may assist in reducing the high cold water temperatures being recorded within the system.	Informed that set point was changed from 60degC to 65degC approximately May 2015 and are still set to 65degC Items 19 & 24 Plant room 41 Calorifiers 1			F
20	South Glasgow University Hospital (including Children's Hospital) As the building is used by persons with acute underlying medical conditions which increases susceptibly to contracting legionella then the requirements for L8, HSG 274 and HTM/SHTM 04-01 compliance is of paramount importance.	Note only. L8, HSG274 & SHTM04-01 are followed.			F
21	Domestic Water System There are numerous connection points onto other "nondomestic" outlets such as renal dialysis, endoscopy wash, pressurisation units, steam humidifier units and MRI chiller cooling which are connected to the Bulk Water system. It is advised that Estates (or Brookfield/Mercury) confirm these systems have suitable backflow protection installed or if necessary suitable backflow protection fitted. It is also advised that as the lines to these systems will often have a very low turnover a double check valve or similar should be fitted as close as practicable to the tee-off point to prevent potentially stagnant water from contaminating the domestic system.	Duplicate of point 10 above.			F
22	Domestic Cold Water System - The distribution temperatures on the domestic water systems recorded by DMA have largely replicated those provided to DMA (on Zutec) for the commissioning phase and those being recorded by estates staff. The cold water temperatures recorded by DMA vary considerably with the majority being more than 5°C higher than those recorded at the water tanks and with peak temperatures of 30°C being noted. Additional control measure such as flushing, disinfections and background dosing flushing should be implemented until such times as the area/department fully occupied, storage and distribution temperatures and	Temperature issues were due to lack of occupancy on the site and has subsequently been resolved around full occupancy. Each sector/ward area had a robust flushing and sampling regime carried out prior to occupancy by clinical staff/patients etc.. Partial evidence submitted previously to Ian Storrer as part of overall documentation list			F

	microbiological results are consistently satisfactory.				
23	Domestic Water System Cold Water Dump Valve System - DMA have been advised by Estates there are ongoing commissioning problems on the cold water dump valve system and the system is not operating as intended. DMA have noted during site surveys there were areas with cold water temperatures in excess of 20°C and dump valves are fitted, but the valves not discharging. Corrective action should be taken and once fully operational the control set points and parameters for discharging should be referenced in site written scheme.	Dump valves were not fully operating at this time since they had been installed without the valve heads connected correctly. New Draft written scheme has been amended. Flushing occurred for 12 week commissioning period. The control set points have been checked on the BMS strategy and is as follows: Open at 23deg: Close at 20deg			F
24	Domestic Hot Water System(s) -The hot water distribution temperatures again largely replicate those from the commissioning phase and estates, with hot temperatures frequently recorded below 55°C at supply to TMVs. It should be noted though that direct hot taps did reach temperatures of 55°C and supply to TMVs was almost invariably above 50°C (see following pages for supportive data and exceptions). As 55°C at all outlets is the control parameter set by SHTM 04-01 corrective actions should be carried out to ensure this is achieved. This may include increasing the calorifier set points - see calorifier sections for further comments and recommendations. Increasing the calorifier temperatures may also have the beneficial effect of improving the cold water temperature profile as more cold water will be required at TMVs to blend water to TMV set point.	Advised by estates manager (Mel MacMillan) that set point was changed from 60degC to 65degC approximately May 2015 and are still set to 65degC For evidence see files attached to No.19			F
25	Domestic Water System - Due to the temperature deviations from the control parameters noted during the commissioning and handover phase and out of specification NHS microbiological sampling results DMA would recommend fitting supplementary control systems (e.g. background dosing such as chlorine dioxide), in order to maintain microbiological control and/or biofilm monitors (such as BioSense sensors/controller) to assist in focusing remedial actions onto identified areas of microbial activity.	SHTM04-01 provides guidance around chemical dosing.It is not normal practise to install background dosing as a standard operational control especially around new builds. It should only be installing when it is recognised there is an on-going issue with temperatures in the building over a long period of time. This building had only recently been opened and as such there was no real information/data to support the installation of chemical dosing plant.			F
26	Domestic Water System - Domestic water pipework runs above ceilings throughout the building. Access for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS monitoring points not be sufficient for the hot flow and	This is a note, not a non-compliance.			F

	return system (e.g. additional BEMS monitoring points installed).				
27	Domestic Water System - There are numerous connection points on the domestic water system within plantrooms and risers (which DMA have assumed were installed for flushing purposes and bypasses) which are creating deadlegs on the system. It is advised that these be removed wherever practicable or a register of the locations created and points incorporated into the site flushing regime.	Flushing was ad-hoc after handover. All connection points identified are required for flushing purposes. For evidence see files attached to No.2			F
28	Arjo Baths (attached shower) Consider shortening shower hoses as it was noted that these can in some areas reach into adjacent WCs and WHBs.	Shortening hoses does not allow clinical bath functionality. A PoU filter has now been attached as agreed by the NHSGG&C Water Technical Group (WTG).			F
29	All unused equipment connection points Deadlegs were recorded though these appear to be connections for drinks machines or kitchen appliances which have not been fitted at the time of survey. These should be included into the site flushing regime until such times as they are installed and department area fully functioning.	All vending machines and kitchen appliances are now in place and connected. This was an issue at pre-occupancy only.			F
30	Outlet 00C Decontamination DCU-003 (Wet Room) Area should be assessed after building works completed	Preoccupancy issue only.			F
31	Outlet 00 Concourse ENT-054 (Shower) Area/outlets should be flushed/disinfected prior to it being brought into use.	This is picked up under the phased occupancy checks that took place.			F
32	Outlet 00 A&E Courtyard Cold water temperature too high. Investigate and correct.	Confirmed on 07/07/2018 that this outlet has been removed. FMFirst docket 1807760747. Temperature Checks - FM 1807760747.pdf			F
33	Outlet 00 A&E EMC-018 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that this is now a mixed sensor tap. For Evidence see file attached to No.32			F
34	Outlet 00 A&E EMC-093 (Bed Bay 18) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperature is below 20degC. For Evidence see file attached to No.32			F
35	Outlet 00 A&E EMC-111 (Female Change) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperature is below 20degC. For Evidence see file attached to No.32			F
36	Outlet 00 A&E EMC-135 (Store) Cold water temperature too high. Investigate and correct.	No outlet could be found at this location. For Evidence see file attached to No.32			F
37	Outlet 00 Acute Assess AAW-032 (Bathroom) Cold water	Confirmed on 07.07.18 that temperature is below 20degC.			F

	temperature too high. Investigate and correct.	For Evidence see file attached to No.32			
38	Outlet 00 Acute Assess AAW-038 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
39	Outlet 00 Acute Assess AAW-045 (Treatment Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
40	Outlet 00 Acute Assess AAW-060 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
41	Outlet 00 Acute Assess AAW-096 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
42	Outlet 00 Acute Assess AAW-108 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
43	Outlet 00 Acute Assess AAW-163 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
44	Outlet 00 Acute Assess AAW-193 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
45	Outlet 00 Acute Assess AAW-226 (Lab) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
46	Outlet 00 Acute Assess AAW-240 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32.			F
47	Outlet 00 Acute Assess AAW-306 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
48	Outlet 00 Concourse ENT-052 (Gents Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that this is now a mixed sensor tap. For Evidence see file attached to No.32			F
49	Outlet 00 Discharge DLO-006 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that this is now a mixed sensor tap. For Evidence see file attached to No.32			F
50	Outlet 00 Discharge DLO-008 (Consulting Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
51	Outlet 00 OPD OPD0-049 (Treatment Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
52	Outlet 00 Orthotics ORT-015-2 (Staff Change) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
53	Outlet 00 Orthotics ORT-017 (Disabled) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
54	Outlet 00 Radiology RAG-068 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
55	Outlet 00 Radiology RAG-079 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
56	Outlet 00C A&E EMC-006 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that this is now a mixed sensor tap. For Evidence see file attached to No.32			F

57	Outlet 00C A&E EMC-059 (Bed Bay 6) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
58	Outlet 00C A&E EMC-060 (Bed Bay 5) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
59	Outlet 00C A&E EMC-100 (Triage) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
60	Outlet 00C Observation OBW-020 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
61	Outlet 00C Observation OBW-061 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
62	Outlet 00C OPD OPD-073 (Plaster Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
63	Outlet 00C OPD OPD-075 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
64	Outlet 00C OPD OPD-120 (Toilet) Cold water temperature too high. Investigate and correct.	Stated that no outlet could be found at this location. For Evidence see file attached to No.32			F
65	Outlet 00C Radiology RCG-087 (Dirty Utility) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
66	Outlet 01 Critical Care CCW-017 (Facilities) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
67	Outlet 01 Medical Day Unit MDU-046 (Facilities) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
68	Outlet 01 Medical Day Unit MDU-050 (Consulting Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
69	Outlet 01 OPD POA-040 (Consulting Room) Cold water temperature too high. Investigate and correct.	Stated that no outlet could be found at this location. For Evidence see file attached to No.32			F
70	Outlet 01 OPD OPD1-006 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
71	Outlet 01 OPD OPD1-008 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that this is now a mixed sensor tap. For Evidence see file attached to No.32			F
72	Outlet 01 OPD OPD1-085 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
73	Outlet 01 OPD OPD1-113 (Measurement Bay) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
74	Outlet 01 Radiology RAF-087 (Male Change) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
75	Outlet 01 Radiology RCF-001 (Facilities) Cold water temperature too high. Investigate and correct.	Stated that no outlet could be found at this location. For Evidence see file attached to No.32			F

76	Outlet 01 Radiology RCF-003 (Facilities) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
77	Outlet 01 Radiology RNM-007 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
78	Outlet 01 Radiology RNM-027 (Office) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
79	Outlet 01 Stroke STW-036 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
80	Outlet 01 Stroke STW-047 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
81	Outlet 01 Stroke STW-072 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
82	Outlet 01C Critical Care CCW-014 (Clinical Physics) Cold water temperature too high. Investigate and correct.	10.07.18: No access - access to be arranged. For Evidence see file attached to No.32			F
83	Outlet 01C Critical Care CCW-098 (Critical Care Bed) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
84	Outlet 01C Medical Day Unit MDU-008 (Beverage Prep) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
85	Outlet 01C Theatre THE-078 (Prep room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
86	Outlet 01C Theatre THE-102 (Facilities) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
87	Outlet 01C Theatre THE-106 (Anesthetic room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
88	Outlet 01C Theatre THE-157 (Recovery room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
89	Outlet 02 Renal RENO-033 (Clean Utility) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
90	Outlet 02 Theatres THE-280 (Disabled Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
91	Outlet 02 Theatres THE-289 (Bed Bay A1) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
92	Outlet 02 Theatres THE-327 (Recovery) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
93	Outlet 02C Ward AFD-022 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
94	Outlet 02C Ward SCH-022 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
95	Outlet 02C Ward SCH-023 (Bathroom) Cold water temperature too	Confirmed on 07.07.18 that temperatures is below 20degC.			F

	high. Investigate and correct.	For Evidence see file attached to No.32			
96	Outlet 02C Ward SCH-040 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
97	Outlet 02C Ward SCH-061 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
98	Outlet 02C Ward SCH-063 (Treatment Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
99	Outlet 03C Ward GW1-002 (Renal Day Unit) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
100	Outlet 03C Ward GW1-048 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
101	Outlet 03C Ward GW2-025 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
102	Outlet 03C Ward GW2-035 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
103	Outlet 03C Ward GW2-036 (Play Room) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
104	Outlet 03C Ward GW2-054 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
105	Outlet 03C Ward GW3-004 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
106	Outlet 03C Ward GW3-068 (Lab) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
107	Outlet 03C Ward GWS-004 (Staff Kitchen) Cold water temperature too high. Investigate and correct.	Confirmed n 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
108	Outlet 03C Ward GWS-033 (Toilet) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
109	Outlet 04 WS4-017 (Male Change) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
110	Outlet 04A HOW-024 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
111	Outlet 04A HOW-027 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
112	Outlet 04B HOW-030 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
113	Outlet 04C Child Forensic Psychology DCFP-049 (Kitchen) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
114	Outlet 04C RENW-153 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F

115	Outlet 04D RENW-091 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
116	Outlet 04D RENW-094 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
117	Outlet 05A GENWA-029 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
118	Outlet 05B GENWD-032 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
119	Outlet 05B GENWD-036 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
120	Outlet 05C GENWC-028 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
121	Outlet 05C GENWC-034 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
122	Outlet 05C GENWC-065 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
123	Outlet 05D GENWB-028 (Bedroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
124	Outlet 05D GENWB-034 (Bathroom) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
125	Outlet 05D GENWB-081 (Clean Utility) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
126	Outlet 08 WS8-021 (Male Change) Cold water temperature too high. Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
127	Outlet 02 Dermatology DOPD-025 (Technician) Confirm air gap on dump valve connection to waste is suitable and alter if required	Alteration has been completed. See attached. Item 127 - Dump Valve.msg			F
128	Outlet 00C Concourse ENT-028 Connection to vend machine capped off. Ensure this is included in flushing regime.	Confirmed on 07.07.18 that this has been removed. For Evidence see file attached to No.32			F
129	Outlet 01C Critical Care CCW-014 (Clinical Physics) Discoloured water from outlet(s). Investigate and correct.	Confirmed on 07.07.18 that temperatures is below 20degC. For Evidence see file attached to No.32			F
130	Outlet 01C Special Feeds SPF-007 (Facilities) Discoloured water from outlet(s). Investigate and correct.	Confirmed on 07.07.18 that colour is ok. For Evidence see file attached to No.32			F

131	Outlet 03C Ward GWS-004 (Staff Kitchen) Dish washer connection not used currently. Include in flushing regime.	Confirmed on 07.07.18 that this is in use. For Evidence see file attached to No.32			F
132	Outlet 01 FM Facilities FMA1-001 (Facilities) Drain leaking and should be repaired.	Confirmed on 07.07.18 that this is now resolved. For Evidence see file attached to No.32			F
133	Outlet 01 Radiology RAF-005 (Reception) Ensure unused connection point included in flushing regime until put into use	Confirmed on 07.07.18 that this is in use. For Evidence see file attached to No.32			F
134	Outlet 00 Concourse ENT-003 (Bute vend) Ensure unused vend connection included in flushing regime	Confirmed on 07.07.18 that this has been removed. For Evidence see file attached to No.32			F
135	Outlet Basement KIT-031 Ensure unused vend connection included in flushing regime	Stated that no outlet could be found at this location. For Evidence see file attached to No.32			F
136	Outlet 02C Corridor ARU-001 (Kitchen) Hot flow and return not working. This requires investigation and correcting.	Confirmed on 07.07.18 that this is now resolved. For Evidence see file attached to No.32			F
137	Outlet 00C Consultancy CPS-003 (Consulting Room) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Confirmed on 07.07.18 that this is on a long leg. For Evidence see file attached to No.32			F
138	Outlet 01 Critical Care CCW-130 (Service) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Confirmed on 07.07.18 that this is on a long leg. For Evidence see file attached to No.32			F
139	Outlet 01C Critical Care CCW-021 (Bathroom) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Confirmed on 07.07.18 that this is on a long leg. For Evidence see file attached to No.32			F
140	Outlet 02C Ward SCH-087 (Store) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Confirmed on 07.07.18 that this is on a long leg. For Evidence see file attached to No.32			F
141	Outlet 04C Child Forensic Psychology DCFP-049 (Kitchen) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Confirmed on 07.07.18 that this is on a long leg. For Evidence see file attached to No.32			F
142	Outlet 00C Consultancy CPS-003 (Consulting Room) Hot water temperature too low. Investigate and correct.	No outlet could be found at this location. For Evidence see file attached to No.32			F
143	Outlet 00C Observation OBW-061 (Bedroom) Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F
144	Outlet 01 Critical Care CCW-130 (Service) Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F
145	Outlet 01C Critical Care CCW-021 (Bathroom) Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F
146	Outlet 01C Theatre 001-011 Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F

147	Outlet 03C Ward GWS-004 (Staff Kitchen) Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F
148	Outlet 03C Ward GWS-033 (Toilet) Hot water temperature too low. Investigate and correct.	This is confirmed as satisfactory. For Evidence see file attached to No.32			F
149	Outlet Hydrotherapy Plantroom A-1FMB-030 Include bib tap & Emergency Shower in flushing regime	Confirmed by MRM that this is complete. For Evidence see file attached to No.32			F
150	Outlet 00 OPD/Concourse OPD0-072 (Toilet) IR tap not working creating deadlegs. Tap should be repaired and lines thoroughly flushed.	Confirmed on 07.07.18 that this is working. For Evidence see file attached to No.32			F
151	Outlet 00 OPD/Concourse OPD0-073 (Shower) IR tap not working creating deadlegs. Tap should be repaired and lines thoroughly flushed.	Confirmed on 07.07.18 that this is working. For Evidence see file attached to No.32			F
152	General System It may be prudent to consider installing a background dosing system on this site (e.g. Chlorine Dioxide) due to control issues identified during this assessment.	Chemical dosing is not recommended in SHTM04-01 for new installations and would only be installed where regular on-going temperature issues have been found.			F
153	Outlet 00 Radiology RAG-108 (Anaesthetic) No access to TMV supply pipework. Access should be provided for further assessment.	No TMV present. For Evidence see file attached to No.32			F
154	Outlet 01 Critical Care CCW-048 (Bed Bay 1) No access to TMV supply pipework. Access should be provided for further assessment.	No TMV present. For Evidence see file attached to No.32			F
155	Outlet 01 Stroke STW-082 (Bath) No access to TMV supply pipework. Access should be provided for further assessment.	Confirmed on 07.07.18 that this is working. For Evidence see file attached to No.32			F
156	Outlet 01 Stroke STW-082 (Bath) 'Out of Order' outlets in room creating deadleg–repair/replace.	Confirmed on 07.07.18 that flow is ok. For Evidence see file attached to No.32			F
157	Outlet 00 Acute Assess AAW-088 (Bathroom) Poor flow from outlet(s). Investigate and correct.	Confirmed on 07.07.18 that flow is ok. For Evidence see file attached to No.32			F
158	Outlet 01 Radiology RNM-007 (Toilet) Poor flow from outlet(s). Investigate and correct.	Confirmed on 07.07.18 that flow is ok. For Evidence see file attached to No.32			F
159	Outlet 07A GENW5-029 (Bathroom) Poor flow from outlet(s). Investigate and correct.	Confirmed on 07.07.18 that flow is ok. For Evidence see file attached to No.32			F
160	Outlet 01 Medical Day Unit MDU-005 (Beverage) Remove all deadleg pipework in this area.	This has now been actioned. 24/7/2018.			F
161	Outlet Hydrotherapy Plantroom A-1FMB-030 Remove all deadleg pipework in this area.	These are the fill points for the drench shower / bib tap and are on a flushing regime. For Evidence see files attached to No 1			F

162	Trades Water Outlets The bib taps, irrigation points etc. and 12th floor heli-pad fire suppression system which are fed from the Trades system have very long runs through the building and plantrooms to the outlets. All points on the trades system should be included in the site flushing regime – though additional flushing (outlets run for extended periods) may be required to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently).	Irrigation system was disconnected early 2017 and trade water system now only supplies the fire-fighting equipment for the helipad. No flushing required. For Evidence see file attached to No.32			F
163	Trades Water Outlets No outlets on the Trades system have been designated as “sentinel outlets”. Due to the type of system and the extended pipe runs to the outlets it may be prudent to designate all outlets from this system as sentinel and include in monthly monitoring and site flushing regime.	Confirmed that this is N/A since trade water only feeds the fire suppression system. For Evidence see file attached to No.32			F
164	Domestic Water System There are numerous connection points onto other “nondomestic” outlets such as renal dialysis, endoscopy wash, pressurisation units, steam humidifier units and MRI chiller cooling which are connected to the Bulk Water system. It is advised that Estates (or Brookfield/Mercury) confirm these systems have suitable backflow protection installed or if necessary suitable backflow protection fitted.	Duplicate of point above.			F
165	It is also advised that as the lines to these systems will often have a very low turnover a double check valve or similar should be fitted as close as practicable to the tee-off point to prevent potentially stagnant water from contaminating the domestic system.	Duplicate of point above.			F
166	MRI Chillers Wet/Dry (Adiabatic) Cooling) Depending on the actual design and operation of these units they may require to be registered with the local authority under the NCTEC Notification Requirements (See HSG 274 Part 1 Para 1.18 – 1.21 inclusive of Figure 1.4 and Info Box 1.1). These may also require ongoing treatment or monitoring programmes to be implemented depending on assessment. Maintain in accordance with manufacturers/installers instructions.	No adiabatic chillers are installed. Item 166 - MRI Chillers.msg	Email sent to Lynn Ross (GM for Diagnostic Imaging) to gain confirmation on maint of the chiller supporting the MRI scanner.		F
167	Consider use of POU disinfection system such as UV for spray water.	There is no spray water as these are sealed units. N/A.			F

168	Connection point to MRI unit(s) should be included in site flushing regime and have suitable backflow protection fitted.	Confirmed that this is fitted with CAT 5 backflow protection. Flushing is not applicable in this case. For evidence see files attached to No.10			F
169	Emergency Showers HSG 274 Part 3 recommends minimum six monthly flushing of emergency/deluge shower, though Risk Control Notice 11/advises "flush through and purge to drain twice per week– source SHTM 04-01 Part G (Draft). NHS Estates should formulate an appropriate flushing regime and maintain in accordance with manufacturers/installers instructions.	Confirmed by Mel MacMillan that these are flushed twice per week. Item 169 - Hydro Therapy Pool Emerge			F
170	Dental Chairs/System HSG 274 Part 3 states "Drain down, clean, flush and disinfect all system components, pipework and bottles twice daily. Disinfectant contact time as recommended by manufacturer. Take microbiological measurements (Refer to Decontamination HTM 01-05)	This is a dental service action and is done locally.	.		F
171	SHTM 04-01 Part G (Draft) states "Drain down and clean at the end of each working day".	This is a dental service action and is done locally. For evidence see files attached to No.170			F
172	HTM 01-05 provides advice and recommendations for ongoing maintenance and this should be followed in addition to manufacturers and installers instructions.	This is a dental service action and is done locally. For evidence see files attached to No.170			F
173	Hydrotherapy Pool Maintain in accordance with manufacturers/ installers instructions and "PHLS Hygiene for Hydrotherapy Pools" and Pool Water Treatment Advisory Group (PWTAG) Code of	This is being carried out and records are being kept.			F

	Practice (Feb 2015).	Item 173 - RHC Hydrotherapy Pool Te			
174	CWST requires to be cleaned and disinfected as stagnation noted at time of survey.	At the time of the RA, this was not handed over to us and was under Brookfield/Multiplex control. In operation with the hydrotherapy pool in use, there is no stagnation of water due to weekly backwashing of filtration system and refilling of system."			F
175	Air Conditioning/Ventilation Maintain in accordance with manufacturers/installers instructions and SHTM 03-01 and SHTM 04-01 Part G (Draft).	This applies to glass traps, drip trays etc and this is carried out as part of the AHU quarterly PPM. This was confirmed by the estates manager (Darryl Conner) that all AHUs on our asset register have this carried out as part of their quarterly PPM. Item 175 - Example AHU PPM.pdf			F
176	Steam Humidification Maintain in accordance with manufacturers/installers instructions and SHTM 03-01 and SHTM 04-01 Part G (Draft). Offline at time of survey.	The steam humidification plant has never been operated and is isolated. N/A.			F
177	Medical Gases/Medical Equipment (e.g. Nebulisers, incubators, etc.) Conduct a risk assessment of each system, preferably using an assessment team comprising members knowledgeable in legionella management and control, as well as those familiar with the design and operation of the system and Infection Control/Clinical staff where appropriate. Control procedures within appropriate SHTM (or other relevant guidance) for system being assessed should be taken in to account during assessment(s). Any water softeners or other filtration equipment connected to these systems should be assessed at this time. Devise a control scheme based on the risk assessment.	This needs further discussion with clinical staff including infection control. Item 177 - Meeting Regarding Water Saf Adobe Acrobat Document			F

178	Sprinkler System Minimise aerosol creation during maintenance procedures. Consider wearing suitable masks to prevent ingestion as recommended by the FIA guidance. Maintain in accordance with manufacturers/installers instructions.	The pumps are maintained on contract but there is no aerosol creation from the work they carry out.			F
179	12th Floor Heli-pad fire suppression system Minimise aerosol creation during maintenance procedures. Consider wearing suitable masks to prevent ingestion as recommended by the FIA guidance. Maintain in accordance with manufacturers/installers instructions.	There is weekly testing of the system carried out by security personnel. Item 179 - Heli-Pad Fire Suppression System Testing.msg			F
180	Include all points on the 12th floor Trades system (including inlet to fire tank) in site flushing regime.	Confirmed after discussion with estates manager that there were previously a number of points coming off this trade system but there is now only one point coming off that system and this will be added to the flushing regime." For evidence see files attached to No.1			F
181	Irrigation System Include in site flushing regime. Additional flushing may also be required (outlets run for extended periods) to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently).	The irrigation system is disconnected and all dead legs removed.			F
183	Decorative Bubble Lamps If aerosols are likely to be released then this should be viewed as an “indoor water feature” and should be removed.	This is not water but gel in a sealed unit. N/A.			F
185	Water Source Basement MTHW/Chilled plantroom Govan Road Deadlegs (drain points/injection points) should be removed or incorporated into low use outlets flushing regime.	Room naming data in RA is incorrect and should refer to the main manifold room. There are drain/injection points on the MTHW system but these would not require flushing. The only drain/injection points on the cold water supply is on the 6in main with a 22mm pipe with a valve and cap. This will be added to the flushing regime." Item 185 - Drain.msg For evidence see files attached to No.2			F

186	All Raw & Bulk CWSTs A suitable screened vent should be fitted to the warning pipe	This has been completed by DMA. Item 186 - Basement Tanks Warning Pipes			F
187	CWST Basement Tank plantroom Bulk Water DMA noted small debris including washers in Bulk Water Tank 2B and would advise that this tank is cleaned to remove debris and then disinfected. The volume of debris within the water tanks appeared to be more than would be expected considering the Bulk Water tanks are fed via 0.5 micron filter sets.	Tank cleaning complete. For evidence see files attached to No.9			F
188	CWST Basement Tank plantroom Bulk Water Ensure short connection between booster sets is thoroughly flushed before use should it ever be required.	Confirmed that this spool piece between the booster sets contains a drain point allowing all water to be drained once operation to switch between booster sets has been carried out. Confirmed to be empty of water upon investigation.			F
189	CWST Basement Tank plantroom Bulk Water Ideally drain points should be fitted to pump manifolds to allow end of lines to be flushed.	Currently there are blanks on the ends of these lines without drain points. This is an OEM off-the-shelf product which has no drain point included. After further investigation there is no room to install a drain point. Not practical. A Risk Assessment has been put in place to address this issue.			F
190	CWST Basement Tank plantroom Bulk Water There are various drain points and bypass valves fitted to the pipework in the plantroom. These should be included in site flushing regime.	Flushing regime in place. For evidence see files attached to No.2			F
191	All Raw & Bulk CWSTs Additional access hatches on tanks for cleaning/inspection purposes should be considered.	This was considered and discussed with DMA and given design of tanks, the risk to integrity of the tanks was considered to outweigh the benefits of having hatches. A.Wilson: This has been completed by DMA. A separate RA is in place to support this decision.			F
192	CWST Basement Tank plantroom Raw Water There are drain down points on pipework. These should be included in site flushing regime.	This is included in the flushing regime. For evidence see files attached to No.2			F

193	CWST Basement Tank plantroom Trades Water A suitable screened vent should be fitted to the overflow.	The screened vent is fitted within the tank and not visible externally,			F
194	All expansion vessels Wherever possible/practical expansion vessels should be 'flow through' vessels.	Require confirmation of whether it is possible to retro-fit a flow-through valve to the pressurisation units we have or whether new units would be required. Since this is described as "wherever possible", it is not seen as a requirement. However there is a monthly flushing regime for the expansion vessels and calorifiers. For evidence see files attached to No.2	Capital requested to change expansion vessels to 'pass through' type.		F
195	All expansion vessels Expansion vessel should be suitably insulated.	Expansion vessels are not normally insulated.	n/a		F
196	All expansion vessels As expansion vessels as not 'flow through' vessels these should be included in the site flushing regime.	Require confirmation of whether it is possible to retro-fit a flow-through valve to the pressurisation units we have or whether new units would be required. Since this is described as "wherever possible", it is not seen as a requirement. However there is a monthly flushing regime for the expansion vessels and calorifiers. For evidence see files attached to No.2	Capital requested to change expansion vessels to 'pass through' type.		F
197	CWST Basement Tank plantroom Trades Water Ideally a drain should be fitted to pump manifold to allow end of lines to be flushed.	There is a drain on the pump manifold and confirmed on as-built drawing.			F
198	All Calorifiers Ensure linked calorifiers are balanced to provide equal throughput of water through each calorifier.	This is factually incorrect. The pipework has been installed as designed by the contractor to ensure correct operation of the system.			F
199	All Calorifiers (Circulation Pumps) Fit caps to ends of spare circulation pump.	Review of pumps carried out against FM First job number 1807761734 and caps fitted where required.			F
200	All expansion vessels Expansion vessel should be suitably insulated.	Duplicate to point above.			F
	All expansion vessels As expansion vessels are not 'flow through' vessels these should be included in the site flushing regime.	Require confirmation of whether it is possible to retro-fit a flow-through valve to the pressurisation units we have or whether new units would be required. Since this is described as "wherever possible", it is not seen as a requirement. However there is a monthly flushing regime for the expansion vessels and calorifiers.	Capital requested to change expansion vessels to 'pass through' type.		F

		 All Evidence.zip			
203	Outlet 01 OPD OPD1-006 (Toilet) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
204	Outlet 01 OPD OPD1-008 (Toilet) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
205	Outlet 02C Corridor ARU-001 (Kitchen) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
206	Outlet 02C Ward AFD-022 (Toilet) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
207	Outlet 02C Ward SCH-022 (Bathroom) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
208	Outlet 02C Ward SCH-023 (Bathroom) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
209	Outlet 02C Ward SCH-092 (Hospital Night Team) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
210	Outlet 03C Ward GW1-002 (Renal Day Unit) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
211	Outlet 03C Ward GW1-048 (Toilet) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
212	Outlet 03C Ward GWS-004 (Staff Kitchen) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
213	Outlet 03C Ward GWS-011 (Facilities) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F

214	Outlet 03C Ward GWS-014 (Renal Technician) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 that there is no aeration. For Evidence see file attached to No.32			F
215	Outlet 06 WS6-027 (Facilities) Aeration at outlet(s). Investigate and correct.	Confirmed on 07.07.18 there is no aeration. For Evidence see file attached to No.32			F
216	Domestic Water System Pressure Reducing Valves Flexible hoses have been noted on the boosted bulk water system on pressure reducing valves. If possible these should be hard piped (stainless steel) or WRAS approved hoses with linings other than EPDM should be considered. Should these not be available for these types of units/connections then a regular inspection and replacement schedule should be implemented for these.	Confirmed by AP Water (Jim Guthrie) that the whole valve as an assembly with the hoses is WRAS approved.			F
217	Outlet 00 A&E EMC-086 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. See evidence below. Temperature Checks - FM 1807760750.pdf			F
218	Outlet 00 Acute Assess AAW-007 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For Evidence see file attached to No.217			F
219	Outlet 00 Acute Assess AAW-125 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
220	Outlet 00 Acute Assess AAW-208 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
221	Outlet 00 Acute Assess AAW-313 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
222	Outlet 00 Concourse ENT-003 (Bute vend) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F

223	Outlet 00 Concourse ENT-062 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
224	Outlet 00 Concourse FMA0-001 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
225	Outlet 00 OPD OPD0-067 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
226	Outlet 00 Pharmacy PHA-002 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
227	Outlet 00 Radiology RAG-004 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
228	Outlet 00C Concourse ENT-036 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
229	Outlet 00C OPD OPD-026 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
230	Outlet 00C Radiology RCG-087 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
231	Outlet 01 Critical Care CCU-004 (Patients Pantry) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
232	Outlet 01 Critical Care CCW-017 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
233	Outlet 01 Critical Care CCW-126 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
234	Outlet 01 Critical Care CCW-200 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F

235	Outlet 01 FM Facilities FMA1-001 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
236	Outlet 01 Medical Day Unit MDU-005 (Beverage) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
237	Outlet 01 Medical Day Unit MDU-046 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
238	Outlet 01 Radiology RAF-127 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
239	Outlet 01 Radiology RCF-001 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217.			F
240	Outlet 01 Radiology RCF-003 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
241	Outlet 01 Stroke STW-079 (Arjo Bathroom) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
242	Outlet 01C Critical Care CCW-092 (Dirty Utility) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
243	Outlet 01C Critical Care CCW-118 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217.			F
244	Outlet 01C Medical Day Unit MDU-008 (Beverage Prep) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
245	Outlet 01C Special Feeds SPF-007 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
246	Outlet 01C Theatre THE-102 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F

247	Outlet 02 Decontamination DCT-015 (Wash Room DSR) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217.			F
248	Outlet 02 Endoscopy END-013 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
249	Outlet 02 Theatres THE-060 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
250	Outlet 02C Corridor ARU-001 (Kitchen) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
251	Outlet 02C Ward SCH-087 (Store) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
252	Outlet 03C Ward GWS-004 (Staff Kitchen) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
253	Outlet 04 WS4-014 (Facilities Regen) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
254	Outlet 04C Child Forensic Psychology DCFP-049 (Kitchen) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
255	Outlet 06 WS6-027 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
256	Outlet 06A GENW1-001 (Arjo Bathroom) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
257	Outlet 08 WS8-027 (Facilities) All EPDM flexible hoses should be removed and replaced with hard piped connection.	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F
258	Outlet Hydrotherapy Plantroom A-1FMB-030 Fit check valve to emergency shower (& bib tap if not fitted)	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F

259	Outlet 00 A&E EMC-059 (Bed Bay 5) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
260	Outlet 00 A&E EMC-060 (Bed Bay 6) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
261	Outlet 00 A&E EMC-063 (Bed Bay 8) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
262	Outlet 00 A&E EMC-076 (Bed Bay 12) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
263	Outlet 00 A&E EMC-093 (Bed Bay 18) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
264	Outlet 00 A&E EMC-135 (Store) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
265	Outlet 00 Acute Assess AAW-017 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
266	Outlet 00 Acute Assess AAW-045 (Treatment Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
267	Outlet 00 Acute Assess AAW-163 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
268	Outlet 00 Acute Assess AAW-226 (Lab) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be	Hot outlets now comply. For evidence see file attached to No217			F

	carried out to increase temperatures to 55°C.				
269	Outlet 00 Acute Assess AAW-375 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
270	Outlet 00 Concourse ENT-038 (Baby Change) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
271	Outlet 00 Concourse ENT-052 (Gents Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
272	Outlet 00 Discharge DLO-006 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
273	Outlet 00 Discharge DLO-008 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
274	Outlet 00 Medical Illustration MIL-010 (Studio) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°	Hot outlets now comply. For evidence see file attached to No217			F
275	Outlet 00 OPD OPD0-013 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
276	Outlet 00 OPD OPD0-049 (Treatment Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
277	Outlet 00 OPD OPD0-067 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
278	Outlet 00 Orthotics ORT-015-2 (Staff Change) Hot outlets do not comply with latest SHTM regulations, though achieving	Hot outlets now comply. For evidence see file attached to			F

	temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
279	Outlet 00 Orthotics ORT-017 (Disabled) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
280	Outlet 00 Orthotics ORT-027 (Treatment Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. evidence see file attached to No217			F
281	Outlet 00 Orthotics ORT-045 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
282	Outlet 00 Pharmacy PHA-008 (Clinical Trial Prep) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
283	Outlet 00 Radiology RAG-004 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
284	Outlet 00 Radiology RAG-029 (X-Ray 6) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
285	Outlet 00 Radiology RAG-054 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
286	Outlet 00 Rehab REH-006 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
287	Outlet 00 Rehab REH-013 (OT Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°	Confirmed that flexible hoses have been removed. For evidence see file attached to No217			F

288	Outlet 00C A&E EMC-006 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
289	Outlet 00C A&E EMC-059 (Bed Bay 6) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
290	Outlet 00C A&E EMC-060 (Bed Bay 5) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
291	Outlet 00C A&E EMC-100 (Triage) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
292	Outlet 00C OPD OPD- (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
293	Outlet 00C Radiology RCG-068 (Baby sleep) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
294	Outlet 00C Radiology RCG-087 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
295	Outlet 01 Critical Care CCU-036 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
296	Outlet 01 Critical Care CCW-087 (Bed Bay 37) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
297	Outlet 01 Critical Care CCW-089 (Bed Bay 38) Hot outlets do not comply with latest SHTM regulations, though achieving	Hot outlets now comply. For evidence see file attached to			F

	temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
298	Outlet 01 Critical Care CCW-092 (Gowning Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
299	Outlet 01 Critical Care CCW-109 (Bed Bay 26) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
300	Outlet 01 Critical Care CCW-126 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
301	Outlet 01 Critical Care CCW-131 (Pharmacy Support) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/ practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217.			F
302	Outlet 01 Critical Care CCW-141 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
303	Outlet 01 Critical Care CCW-214 (Male Change) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217.			F
304	Outlet 01 Medical Day Unit MDU-012 (Treatment Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/ practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
305	Outlet 01 Medical Day Unit MDU-020 (Blood Test) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
306	Outlet 01 Medical Day Unit MDU-050 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/	Hot outlets now comply. For evidence see file attached to No217			F

	practical remedial action should be carried out to increase temperatures to 55°C.				
307	Outlet 01 Medical Day Unit MDU-051 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/ practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
308	Outlet 01 OPD POA-006 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
309	Outlet 01 OPD POA-015 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/ practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
310	Outlet 01 OPD POA-040 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
311	Outlet 01 OPD OPD1-006 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
312	Outlet 01 OPD OPD1-008 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
313	Outlet 01 OPD OPD1-037 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
314	Outlet 01 OPD OPD1-047 (Dietician) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
315	Outlet 01 OPD OPD1-048 (Blood Lab) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

316	Outlet 01 OPD OPD1-063 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
317	Outlet 01 OPD OPD1-085 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
318	Outlet 01 OPD OPD1-113 (Measurement Bay) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
319	Outlet 01 Radiology RAF-003 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
320	Outlet 01 Radiology RAF-087 (Male Change) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
321	Outlet 01 Radiology RAF-095 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
322	Outlet 01 Radiology RAF-115 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
323	Outlet 01 Radiology RAF-127 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
324	Outlet 01 Radiology RNM-018 (Shower room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
325	Outlet 01 Radiology RNM-027 (Office) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of	Hot outlets now comply. For evidence see file attached to			F

	50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
326	Outlet 01 Restaurant RES-019 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
327	Outlet 01 Restaurant RES-034 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
328	Outlet 01 Stroke STW-014 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
329	Outlet 01 Stroke STW-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
330	Outlet 01 Stroke STW-047 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
331	Outlet 01C Cardiology CAR-036 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
332	Outlet 01C Critical Care CCW-082 (Critical Care Bed) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
333	Outlet 01C Critical Care CCW-098 (Critical Care Bed) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/ practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
334	Outlet 01C Theatre 23HU-008 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

335	Outlet 01C Theatre THE-009 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
336	Outlet 01C Theatre THE-042 (Female Change) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
337	Outlet 01C Theatre THE-069 (Lab) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
338	Outlet 01C Theatre THE-078 (Prep room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
339	Outlet 01C Theatre THE-090 (Theatre Scrub) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
340	Outlet 01C Theatre THE-117 (Theatre Scrub) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
341	Outlet 01C Theatre THE-157 (Recovery room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
342	Outlet 02 Dermatology DMW-004 (Photo Therapy) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
343	Outlet 02 Dermatology DMW-025 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
344	Outlet 02 Dermatology DMW-031 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action	Hot outlets now comply. For evidence see file attached to No217			F

	should be carried out to increase temperatures to 55°C.				
345	Outlet 02 Dermatology DOPD-004 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
346	Outlet 02 Endoscopy END-029 (Examination Area) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
347	Outlet 02 Renal RENO-003 (CAPD Training) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
348	Outlet 02 Renal RENO-016 (Room 3) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
349	Outlet 02 Renal RENO-046 (Female Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
350	Outlet 02 Theatres THE-287 (Bed Bay A9) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
351	Outlet 02 Theatres THE-289 (Bed Bay A1) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
352	Outlet 02 Theatres THE-302 (Bed Bay A7) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
353	Outlet 02 Theatres THE-319 (Dirty Utility) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
354	Outlet 02 Theatres THE-327 (Recovery) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of	Hot outlets now comply. For evidence see file attached to			F

	50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
355	Outlet 02 Transport Base TPB-001 (Clinical Workroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
356	Outlet 02C Ward ARU-085 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
357	Outlet 02C Ward SCH-061 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
358	Outlet 03C Ward GW1-002 (Renal Day Unit) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
359	Outlet 03C Ward GW2-035 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
360	Outlet 04 WS4-004 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
361	Outlet 04 WS4-009 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
362	Outlet 04A HOW-024 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
363	Outlet 04A HOW-027 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

364	Outlet 04A RENW-005 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
365	Outlet 04A RENW-055 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
366	Outlet 04B HOW-030 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
367	Outlet 04B HOW-064 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
368	Outlet 04B HOW-193 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
369	Outlet 04C RENW-127 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
370	Outlet 04C RENW-188 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
371	Outlet 04D RENW-060 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
372	Outlet 04D RENW-091 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
373	Outlet 04D RENW-094 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out	Hot outlets now comply. For evidence see file attached to No217			F

	to increase temperatures to 55°C.				
374	Outlet 04D RENW-124 (Consulting Room) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
375	Outlet 05 WS5-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
376	Outlet 05 WS5-011 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
377	Outlet 05A GENWA-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
378	Outlet 05A GENWA-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
379	Outlet 05A GENWA-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
380	Outlet 05B GENWD-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
381	Outlet 05B GENWD-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
382	Outlet 05C GENWC-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
383	Outlet 05C GENWC-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C.	Hot outlets now comply. For evidence see file attached to			F

	Wherever possible/practical remedial action should be carried out to increase temperatures to 55°	No217			
384	Outlet 05D GENWB-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
385	Outlet 05D GENWB-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
386	Outlet 05D GENWB-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
387	Outlet 05D GENWB-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
388	Outlet 05D GENWB-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
389	Outlet 06 WS6-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
390	Outlet 06 WS6-011 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
391	Outlet 06 WS6-019 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
392	Outlet 06A GENW1-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

393	Outlet 06A GENW1-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
394	Outlet 06B GENW4-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
395	Outlet 06B GENW4-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
396	Outlet 06B GENW4-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
397	Outlet 06C GENW3-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
398	Outlet 06C GENW3-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
399	Outlet 06C GENW3-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
400	Outlet 06D GENW2-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
401	Outlet 06D GENW2-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

402	Outlet 06D GENW2-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
403	Outlet 06D GENW2-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
404	Outlet 07A GENW5-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
405	Outlet 07A GENW5-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
406	Outlet 07A GENW5-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
407	Outlet 07B GENW8-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
408	Outlet 07B GENW8-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
409	Outlet 07B GENW8-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
410	Outlet 07C GENW7-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

411	Outlet 07C GENW7-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
412	Outlet 07C GENW7-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
413	Outlet 07D GENW6-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
414	Outlet 07D GENW6-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
415	Outlet 07D GENW6-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
416	Outlet 08 WS8-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
417	Outlet 08 WS8-011 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
418	Outlet 08 WS8-021 (Male Change) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
419	Outlet 08A GENW9-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
420	Outlet 08A GENW9-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C.	Hot outlets now comply. For evidence see file attached to			F

	Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
421	Outlet 08A GENW9-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
422	Outlet 08A GENW9-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
423	Outlet 08B GENW12-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
424	Outlet 08B GENW12-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
425	Outlet 08B GENW12-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
426	Outlet 08C GENW11-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
427	Outlet 08C GENW11-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
428	Outlet 08C GENW11-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
429	Outlet 08D GENW10-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

430	Outlet 08D GENW10-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
431	Outlet 08D GENW10-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
432	Outlet 08D GENW10-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
433	Outlet 08D GENW10-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
434	Outlet 09 WS9-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
435	Outlet 09A GENW13-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
436	Outlet 09A GENW13-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
437	Outlet 09A GENW13-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
438	Outlet 09A GENW13-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
439	Outlet 09B GENW16-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be	Hot outlets now comply. For evidence see file attached to No217			F

	carried out to increase temperatures to 55°C.				
440	Outlet 09B GENW16-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
441	Outlet 09B GENW16-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
442	Outlet 09C GENW15-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
443	Outlet 09C GENW15-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
444	Outlet 09C GENW15-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
445	Outlet 09D GENW14-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
446	Outlet 09D GENW14-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
447	Outlet 09D GENW14-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
448	Outlet 09D GENW14-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

449	Outlet 09D GENW14-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
450	Outlet 10 WS10-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
451	Outlet 10 WS10-011 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
452	Outlet 10A GENW17-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
453	Outlet 10A GENW17-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
454	Outlet 10A GENW17-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
455	Outlet 10A GENW17-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
456	Outlet 10B GENW20-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
457	Outlet 10B GENW20-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
458	Outlet 10B GENW20-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out	Hot outlets now comply. For evidence see file attached to No217			F

	to increase temperatures to 55°C.				
459	Outlet 10C GENW19-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
460	Outlet 10C GENW19-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
461	Outlet 10C GENW19-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
462	Outlet 10D GENW18-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
463	Outlet 10D GENW18-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
464	Outlet 10D GENW18-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
465	Outlet 11 WS11-005 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
466	Outlet 11 WS11-011 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
467	Outlet 11 WS11-019 (Toilet) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
468	Outlet 11A GENW21-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C.	Hot outlets now comply. For evidence see file attached to			F

	Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	No217			
469	Outlet 11A GENW21-029 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
470	Outlet 11A GENW21-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
471	Outlet 11A GENW21-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
472	Outlet 11B GENW24-032 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
473	Outlet 11B GENW24-036 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
474	Outlet 11C GENW23-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
475	Outlet 11C GENW23-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
476	Outlet 11C GENW23-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
477	Outlet 11D GENW22-001 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F

478	Outlet 11D GENW22-028 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
479	Outlet 11D GENW22-034 (Bathroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
480	Outlet 11D GENW22-057 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
481	Outlet 11D GENW22-065 (Bedroom) Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
482	Outlet Basement KIT-031 Hot outlets do not comply with latest SHTM regulations, though achieving temperatures of 50°C. Wherever possible/practical remedial action should be carried out to increase temperatures to 55°C.	Hot outlets now comply. For evidence see file attached to No217			F
483	Outlet 00C Concourse ENT-048 (Toilet) Hot temperature slow to rise. It should be confirmed that hot outlet(s) are on a long leg and not that the flow and return has failed locally in this area.	Hot outlets now comply. For evidence see file attached to No217			F
484	General System Pipework runs above ceilings in throughout every floor of the building. Access to these for ongoing monitoring will be problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS monitoring points not be sufficient for the hot flow and return system. additional BEMS monitoring points installed). DMA identified a very small number of localities where the hot water system did not appear to be functioning correctly and these should be investigated with corrective actions taken.	Duplicate of point above MEMS monitoring points are considered sufficient. For Evidence see file attached to No.217.			F
485	Outlet 03C Ward GWS-011 (Facilities) Potential scald risk. Fit scald risk signs and/or consider fitting TMV(s) to hot outlets.	Confirmed on 08.07.18 that signs are in place. For Evidence see file attached to No.217			F
486	Outlet 06A GENW1-001 (Arjo Bathroom) TMV inaccessible during survey. Access should be provided for assessment /maintenance.	Confirmed on 08.07.18 that there is access. For Evidence see file attached to No.217			F

487	Irrigation System Maintain in accordance with manufacturers /installers instructions.	Duplicate of 181.  All Evidence.zip		14/10/2018	F
	Arjo Bath Maintain in accordance with manufacturers/installers instructions. Where flexible hoses (i.e. internal to bath unit) cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered.	Duplicate.			F
489	Water Softeners Maintain in accordance with manufacturers/installers instructions (including cleaning and disinfection of resin and brine tanks). Ensure aerosol creation is minimised during maintenance and testing procedures.	No water softeners used in the water system by estates.			F
490	Endoscopy Wash Maintain in accordance with manufacturers/installers instructions and current NHS (SHTM) protocols. Ensure aerosol creation is minimised during maintenance and testing procedures.	Not under estates control. This will be maintained by the service;			F
491	Renal Dialysis (Adult) Maintain in accordance with manufacturers/installers instructions, current NHS (SHTM) protocols and "Clinical Practice Guideline by the UK Renal Association of Renal Technologists". Ensure aerosol creation is minimised during maintenance and testing procedures.	Not under estates control. This will be maintained by the service.			F
492	Renal Dialysis (Children's) Maintain in accordance with manufacturers/installers instructions, current NHS (SHTM) protocols and "Clinical Practice Guideline by the UK Renal Association of Renal Technologists". Ensure aerosol creation is minimised during maintenance and testing procedures.	Not under estates control. This will be maintained by the service;			F
493	Closed Chilled Systems Minimise aerosol creation during maintenance procedures. Maintain in accordance with manufacturers/installers instructions.	Not under estates control. This will be maintained by the service;			F
494	Closed Heating Systems Minimise aerosol creation during maintenance procedures. Maintain in accordance with manufacturers/installers instructions.	N/A.			F
495	Decorative Bubble Lamps Maintain in accordance with manufacturers/installers instructions and ensure aerosols	This is not water but gel in a sealed unit. N/A.			F

	minimised during maintenance.				
496	Water Source Basement Main Tank plantroom Hardgate Road (Large) All plant items, pipework and valves should be labelled for identification purposes.	This is a duplicate of the action above against "Water Source Basement Main Tank plantroom Hardgate Road (Small)" and will be covered by that action."			F
497	Water Source Basement Main Tank plantroom Hardgate Road (Small) All plant items, pipework and valves should be labelled for identification purposes.	Should have been carried out by Mercury Engineering but has now been carried out by Estates. No valve schedule or tagging of valves was delivered as part of handover and drawings delivered were inaccurate. 497 - Valve Identification Baseme			F
498	Water Source Basement MTHW/Chilled plantroom Govan Road All plant items, pipework and valves should be labelled for identification purposes.	This is a duplicate of the action above against "Water Source Basement Main Tank plantroom Hardgate Road (Small)" and will be covered by that action.			F
499	All CWSTs - All plant items, pipework and valves should be labelled for identification purposes.	This is a duplicate of the action above against "Water Source Basement Main Tank plantroom Hardgate Road (Small)" and will be covered by that action.			F
500	All Calorifiers - Where practical calorifier internal surfaces should be inspected annually.	Confirmed with APs Water (Jim Guthrie and Mel MacMillan) that this has been taking place and is on a PPM schedule. All Evidence.zip			F
501	All Calorifiers All plant items, pipework and valves should be labelled for identification purposes. The calorifiers do not have labels on them, instead being labelled at present by a marker pen, with a separate small identification plate on the side of each calorifier. The labelling does not match up in every instance between the hand written and id plate. It is advised that calorifiers have formal identification label attached to each one.	Should have been carried out by Mercury Engineering but has now been carried out by Estates. Complete.			F

502	Calorifier Plantroom 41 01/02/03 Vibration couplings should be regularly inspected and maintained in accordance with manufacturers instructions.	Discussed with DMA and described material breakdown over time can lead to cracks and places for growth of bacteria. Clarified that what is described here is what we know as expansion couplings or bellows. Inspection will be picked up under PPM regime for the site." Item 502 Vibration Coupling Inspections. Items 19 & 24 Plant room 41 Calorifiers 1			F

	NHS Greater Glasgow & Clyde
Purpose:	Briefing Paper: Ward 6a (Haematology/Oncology)
From:	Incident Management Team
To:	Clinical team ward 6A
Date:	16th September 2019
Subject/ situation:	There has been an increase in gram negative bacteraemia* possibly caused by an environmental source. The list of organisms included in this increase was based on the organisms found in water or drains during 2018 investigations and the HPS 2A/2B situational report. The split of environmental v non-environmental was based on list included in the 2A/2B report, with further advice from the lead ICD. Defined as: Environmental': [*Achromobacter*], *Acinetobacter, Aeromonas, Brevundimonas , Burkholderia* , [*Cedecea*] , *Chryseobacterium*,[*Commamonas*], *Cupriavidus , Delftia, Elizabehtkingia*, ,[*Morganella*], *Pantoea*, [*Paracoccus*], *Pseudomonas*,[*Pseudoxanthomonas*],[*Ralstonia*], *Rhizobium, Serratia*, [*Shewanella*], *Sphingomonas, Stenotrophomonas* 'Non-environmental': *Citrobacter, Enterobacter, Klebsiella*
Background	On 20 June 2019 GGC reported to HPS an increased Incidence of Gram Negative Bacteraemia (GNB): Five cases over an 8-week period and two cases of Mycobacterium chelonae in 12 months - typing linked the second case of mycobacteria to water in the hospital. The first case was also typed; no link to the hospital water supply was confirmed (NB novel typing technology). Of the five cases of GNB identified between ; one was considered by clinicians to be gut translocation; two were considered to be hospital acquired (one of these was a patient with gut translocation); the remaining three cases were considered to be healthcare associated.* **Case definitions were as follows** *(based on a precautionary principle)***:** Any patient in Ward 6a with a laboratory confirmed bloodstream infection from an environmental organism(s) associated with the QEUH or RHC since…

	Previous Definition-GNB: any patient with an HAI due to an organism previously linked to water or drains. M.chelonae: any patient ?in Ward 6A testing positive for M chelonae (in any sample not exclusively BC). From (insert date) there were no further cases of M.chelonae. **Two key Hypothesis were proposed during this incident:** **<u>Hypothesis 1</u>** Patients were exposed to unfiltered water outside of Ward 6a but within the hospital environment, for example in theatre, in school (RHC) or when visiting either of the main atriums with families. As of (insert date) PoU filters installed to all tap outlets in Ward 6a and… **<u>Hypothesis 2</u>** In July 2019 the outside temperature increased significantly for several days. It was hypothesised that during this time the 'hot' circuit in the chilled beams temperature reduced to a level where there was a constriction of the metal which reduced the seal of the circuit at the end of the unit, which in turn lead to a leak from the beam. The water in the chilled beam system is circulated at 75 degrees so it is considered unlikely to be harbouring microorganisms. The cold chill beam circulates at a constant 15 degrees so is not prone to extremes of temperature and therefore constriction and leakage. The route of transmission was proposed that water (leaks / condensate) from the beams was falling directly into the patient care environment leading to direct contact with the patient, or indirectly from the patient's immediate care environment e.g. into the patient's bloodstream possibly via central lines. ***Healthcare Associated Infection Definition – Health Protection Scotland** Positive blood culture obtained from a patient within 48 hours of admission to hospital and fulfils one or more of the following criteria: Was hospitalised overnight in the 30 days prior to the positive blood culture being taken OR Resides in a nursing home OR IV, or intraarticular medication in the 30 days prior to the positive blood culture being taken, but excluding illicit drug use OR Regular user of a registered medical device OR

	Underwent a medical procedure which broke mucous or skin barrier in the 30 days prior to the positive blood cultures being taken
	OR
	Underwent care for a medical condition by a healthcare worker in the community which involved contact with non-intact skin, mucous membranes or the use of an invasive device 30 days prior to the positive blood culture being taken
	
	Summary
	
	From 13th April to date, 12 GNB have met the case definition i.e. any patient in Ward 6a with a bloodstream infection from an environmental organism associated with the QEUH or RHC and were included in the time line. It should be noted that admission restriction has been in place since 2nd August 2019. One case has been included since 2nd August 2019.
	
	• 12 cases of GNB
	    o 4 considered to be hospital acquired (48hr rule – one of these was considered to be due to gut translocation); 8 were considered to be healthcare associated.
	    o Of those able to be typed all are unique.
	
	A review of data has established:
	• Current numbers of bacteraemia are consistent with historical norms; the split between environmental and gram negative BSI and… has also been broadly consistent over time (appendix 1).
	• Incidence of Central Line Associated Blood Stream infections is at the lowest level ever recorded for ?QEUH (appendix 2) and is consistent with those recorded by Great Ormond Street Hospital (appendix 3).
	• All organisms isolated have been isolated previously in the Royal Hospital for Sick Children, Yorkhill.
	• Since 20xx, patient acuity has increased as has occupancy (appendix 5). There has been no identified link between clinical isolates and results from environmental sampling in Ward 6A except for the case of M. chelonae which was isolated from pre filtered water.
	A SBAR report from HPS concluded that following the move in September 2018 the rates of positive blood cultures for both gram negative and environmental bacteria in Glasgow Unit were no different when compared to the rates of the combined Lothian & Aberdeen Units. This provides additional independent evidence (appendix 4). However, for the GN organisms The differences in the HPS data in the SBAR to the data provided by GGC email include:
	
	Location

	HPS data as well excluding pathology samples code laboratory samples by unit location and speciality to identify patient population where as GGC excluded neonatal, maternity and pathology samples. **Episode definition** HPS used a definition to exclude patients who had a number of positive isolates cultured within the first 48 hours (polymicrobial samples) whereas GGC counted all isolates. **Environmental grouping** The following genus where not included in the GGC environmental group - *Citrobacter, Enterobacter, Klebsiella.* HPS acknowledged that the environmental grouping there is cross over between environmental and non-environmental grouping and the SBAR stated the following limitation 'Environmental bacteria grouping include bacteria commonly found in the environment however they may also be associated with normal human microbiome and laboratory surveillance is unable to distinguish'. •
Actions/Assurance	These actions have been split into those linked to proposed hypothesis and those which should provide assurance going forward. **<u>Hypothesis 1</u>** Patients were exposed to unfiltered water outside of the ward environment. **Actions** • Additional point of use filters (POU) were installed to all areas (except clinic 2 and nuclear medicine – taps being sourced which would enable a POU filter to be added) where this cohort of patients may attend. • Point of use filters were installed in the DSR and the kitchen areas within ward 6A. • Toilet seat covers were fitted to patient en-suites in ward 6A. **<u>Hypothesis 2</u>** Leaking chilled beams were contaminating the patients' environment and leading to colonisation of patients and resulting infection. **Actions** • Biocide dosing introduced to the chilled beam water system.

	• Push fittings replaced with mechanical fittings for all chilled beams in Ward 6A?. • Increase cleaning of chilled beam outer grilles from 3 monthly to 6 weekly. • A new algorithm regarding the functionality of chilled beams was implemented. This should eliminate the problem experienced during fluctuations in outside temperatures. Additional actions taken • HEPA filtration units to be installed in all en-suites in Ward 6A. • Appraisal of options for this cohort of patients will be completed. • A closed NHSGGC face book page developed for parents and carers. • Water pipes to/from the Arjo bath were capped. • New shower hoses procured to ensure that shower heads could not reach the drain if left out of the holder. • Review of line care by practice development was carried out in all areas. • Commencement of antibiotic and antifungal prophylaxis.. Further actions agreed to provide ongoing assurance: • A root cause analysis review to be completed for all clinical cases identified in this incident • An environmental pathogen SOP will be developed with reset triggers as before; in addition to this, a multidisciplinary review will be conducted for all new positive BC with any gram negative or environmental organism going forward. • An air/environmental sampling regimen will be developed with agreed parameters that would trigger additional action. NB there is no agreed standards for air quality in non-ventilated areas so this will be a local SOP. The previously issued HPS SBAR for adult BMT services will be reviewed and will inform this SOP. • Water sampling will continue as per the Water Technical Group recommendations; and ICD can trigger additional water sampling in order to investigate a cluster or trigger. • An external peer review - still being actively pursued by Acute Medical Director. • Enhanced supervision of practice will continue at intervals agreed by Chief Nurse and IPC.
Recommendations	The IMT is asked to ?Note the above, and consider/support? the recommendation of the IMT from Friday 13th September 2019 that the ward is re-opened to new admissions. I think it's important to state in here how the re-opening might happen taking into consideration what happens in 4 weeks' time when the Hepa filter units arrive? Will any decanting be required during this work?

	Who will be kept informed regarding the assurances in place? SCRIBE documents and an installation plan for the additional HEPA filters will be forwarded to HPS for information. SOP for air and environmental sampling with detail expected and unexpected levels and what to do if these occur.

	NHS Greater Glasgow & Clyde
Purpose:	Briefing Paper: Ward 6a (Haematology/Oncology)
From:	Incident Management Team
To:	Clinical team ward 6A
Date:	2 October 2019
Subject/ situation:	Since the middle of April 2019 there has been a reported increase in gram negative bacteraemia hypothesised to be caused by an environmental source (11 cases from the 13 of April 2019 until 2 August 2019). The organisms identified in this increase were also organisms found in water and drains during 2018 investigations; reported in the HPS 2A/2B situational report. Environmental organism defined as': [*Achromobacter*], *Acinetobacter, Aeromonas, Brevundimonas , Burkholderia ,* [*Cedecea*] *, Chryseobacterium,*[*Commamonas*], *Cupriavidus , Delftia, Elizabehtkingia, ,*[*Morganella*]*, Pantoea,* [*Paracoccus*]*, Pseudomonas,*[*Pseudoxanthomonas*],[*Ralstonia*]*, Rhizobium, Serratia,* [*Shewanella*]*, Sphingomonas, Stenotrophomonas* 'Non-environmental': *Citrobacter, Enterobacter, Klebsiella*
Background	On 20 June 2019, NHSGGC reported to HPS an increased incidence of Gram Negative Bacteraemia (GNB) linked to Ward 6A: Five cases over an 8-week period (April 13 2019 until June 12 2019) and two cases in 12 months of Mycobacterium chelonae, the second of which was a cutaneous infection. Laboratory typing linked the second case of mycobacteria to water in the hospital. The first case was also typed; no link to the hospital water supply was confirmed (NB novel typing technology). However this case was not sent for typing at the time of case identification along with water samples obtained at this time (12 months earlier).It was also agreed at the initial IMTs (based on expert opinion) that typing would be used to include and not exclude cases. This case was not considered at the time of acquisition as M.Chelonae had not been reported from the water samples tested. Of the five cases of GNB identified between April 2019 and June 2019; one was considered by clinicians to be gut translocation; two were considered to be hospital acquired (one of these was a patient with gut translocation); the remaining three cases were considered to be healthcare associated.

	Case definitions were as follows *(based on a precautionary principle)***:** Any patient linked to Ward 6a with a laboratory confirmed bloodstream infection from an environmental organism(s) associated with the QEUH or RHC since 2017. *Previous case definition-GNB: any patient with an HAI due to an organism previously linked to water or drains.* M.chelonae: any patient who had contact with QEUH or RHC testing positive for M chelonae (in any sample not exclusively BC) from 2017. There were no further cases of M.chelonae. **Two key Hypothesis were proposed during this incident:** **<u>Hypothesis 1</u>** Patients exposed to unfiltered water outside of Ward 6a but within the hospital environment, for example in theatre, in school (RHC) or when visiting either of the main atriums with families. As of September 2018 PoU filters were fitted to all tap outlets in Ward 6a and this was extended to include the Domestic Services Room (DSR) and Kitchen during this incident. The route of transmission was proposed that… **<u>Hypothesis 2</u>** In July 2019 the outside temperature increased significantly for several days. It was hypothesised that during this time the 'hot' circuit in the chilled beams temperature reduced to a level where there was a contraction of the metal which reduced the seal of the circuit at the end of the unit, which in turn lead to a leak from the beam. The water in the chilled beam system is circulated at 75 degrees so it is considered unlikely to be harbouring microorganisms. The cold chill beam circulates at a constant 15 degrees so is not prone to extremes of temperature and therefore constriction and leakage. Need to put a bit in about the boiler failure (Tom would you mind having a look at this section). The route of transmission was proposed that water (leaks / condensate) from the beams was falling directly into the patient care environment leading to direct contact with the patient, or indirectly from the patient's immediate care environment e.g. into the patient's bloodstream possibly via central lines. **Hypothesis**

	Healthcare Associated BSI Definition – Health Protection Scotland
	
	Positive blood culture obtained from a patient within 48 hours of admission to hospital and fulfils one or more of the following criteria:
	
	Was hospitalised overnight in the 30 days prior to the positive blood culture being taken
	OR
	Resides in a nursing home
	OR
	IV, or intraarticular medication in the 30 days prior to the positive blood culture being taken, but excluding illicit drug use
	OR
	Regular user of a registered medical device
	OR
	Underwent a medical procedure which broke mucous or skin barrier in the 30 days prior to the positive blood cultures being taken
	OR
	Underwent care for a medical condition by a healthcare worker in the community which involved contact with non-intact skin, mucous membranes or the use of an invasive device 30 days prior to the positive blood culture being taken
	
	Summary
	
	From 13th April 2019 to date, 12 GNB have met the case definition i.e. any patient in Ward 6a with a bloodstream infection from an environmental organism associated with the QEUH or RHC and were included in the time line. It should be noted that inpatient admission restriction to Ward 6a has been in place since 2nd August 2019. One case has been included since 2nd August 2019.
	
	• 12 cases of GNB
	    o 4 considered to be hospital acquired (48hr rule – one of these was considered by clinicians on the unit to be due to gut translocation); 8 were considered to be healthcare associated.
	    o Of those able to be typed all are unique.
	
	A review of data has established:
	• Current numbers of bacteraemia are consistent with historical figures; the split between environmental and gram negative BSI and has also been broadly consistent over time (appendix 1).
	• Incidence of Central Line Associated Blood Stream infections is at the lowest level ever recorded (appendix 2) and is consistent with those recorded by Great Ormond Street Hospital (appendix 3).
	• All organisms considered to be unusual have been isolated previously in this patient group in the Royal Hospital for Sick Children, Yorkhill.

	• Since 2016, patient acuity has increased as has bed occupancy (appendix 5). • There has been no identified link between clinical isolates and results from environmental sampling in Ward 6A except for the case of M. chelonae which was isolated from pre filtered water. A SBAR report from HPS concluded that following the move in September 2018 the rates of positive blood cultures for both gram negative and environmental bacteria in Glasgow Unit were no different when compared to the rates of the combined Lothian & Aberdeen Units. This provides additional independent evidence (appendix 4 – To be inserted after update – this was previously submitted HPS SBAR).
Actions/Assurance	These actions have been split into those linked to proposed hypothesis and those which should provide assurance going forward. **<u>Hypothesis 1</u>** Patients were exposed to unfiltered water outside of the ward environment. **Actions** • Additional point of use filters (POU) were installed in all areas (except clinic 2 and nuclear medicine – taps being sourced which would enable a POU filter to be added) where this cohort of patients may attend. • Point of use filters were installed in the DSR and the kitchen areas within ward 6A. • Toilet seat covers were fitted to patient en-suites in ward 6A. **<u>Hypothesis 2</u>** Leaking chilled beams were contaminating the patients' environment and leading to colonisation of patients and resulting in infection. **Actions** • Biocide dosing introduced to the chilled beam water system. • Push fittings replaced with mechanical fittings for all chilled beams in Ward 6A. • Increase cleaning of chilled beam outer grilles from 3 monthly to 6 weekly. • A new algorithm regarding the functionality of chilled beams was implemented. This should eliminate the problem experienced during fluctuations in outside temperatures. **Additional actions taken** • HEPA filtration units to be installed in all en-suites in Ward 6A.

	• Water pipes to/from the Arjo bath were capped. • New shower hoses procured to ensure that shower heads could not reach the drain if left out of the holder. • Review of line care by practice development was carried out in all areas. • Commencement of antibiotic and antifungal prophylaxis **Further actions agreed to provide ongoing assurance:** • A root cause analysis review to be completed for all clinical cases identified in this incident • Appraisal of options for this cohort of patients will be completed. • A closed NHSGGC face book page developed for parents and carers. • An environmental pathogen SOP will be developed with reset triggers as before; in addition to this, a multidisciplinary review will be conducted for all new positive BC with any gram negative or environmental organism going forward. • An air/environmental sampling regimen will be developed with agreed parameters that would trigger additional action. NB there is no agreed standards for air quality in non-ventilated areas so this will be a local SOP. The previously issued HPS SBAR for adult BMT services will be reviewed and will inform this SOP. • Water sampling will continue as per the Water Technical Group recommendations; and ICD can trigger additional water sampling in order to investigate a cluster or trigger. • An external peer review - still being actively pursued by Acute Medical Director. • Enhanced supervision of practice will continue at intervals agreed by Chief Nurse and IPC.
Recommendations	The IMT is asked to note the above, and support the recommendation of the IMT from Friday 13th September 2019 that the ward is re-opened to new admissions. The Senior Management Team Women and Children will be kept informed of all results, triggers and reports. It is anticipated that they will liaise with clinical staff as appropriate SCRIBE documents and an installation plan for the additional HEPA filters will be forwarded to HPS for information.

NHS Greater Glasgow & Clyde	
Meeting:	**Acute Infection Control Committee**
Date of Meeting:	**Wednesday 30th September 2020**
Purpose of Paper:	**For Noting/Information**
Classification:	**Official Sensitive**
Sponsoring Director:	**Tom Steele**

Paper Title
Water Exceptions Update Operational Estates

Recommendation
The members of ICBEG are asked to:

- Note paper contents.

Purpose of Paper

Exception reporting on Water Systems within GG&C

Any Patient Safety /Patient Experience Issues

No direct impact identified.

Any Financial Implications from this Paper

None.

Any Staffing Implications from this Paper

None.

Any Equality Implications from this Paper

None.

Any Health Inequalities Implications from this Paper

None.

Has a Risk Assessment been carried out for this issue? If yes, please detail the outcome.

N/A.

Author: Mark Riddell
Tel No: [redacted]
Date: 9th September 2020

The purpose of this paper is to report exceptions within the GG&C Water Systems

Royal Alexander Hospital (RAH)

The installation of the Chlorine Dioxide Plant (CLO2) is complete at both locations, main supply and maternity supply.

A review of the siting of monitoring stations has led to the positions being altered for the main supply. 2 stations still to be installed at the top of North and South towers.

The installation of the Maternity monitoring stations was paused whilst discussions take place to assess the impact of CLO2 on neo-nates/maternity service. A meeting invite has been issued to discuss the impact with clinical colleagues and ensure all risks are mitigated.Once Estates are cleared to continue with the proposal so stations can be installed.

Connection of the monitoring stations to the BMS system is also required and currently being looked at.

Painting Programs

An annual painting program has been initiated at the QEUH, GRI, GGH, and IRH currently to address DMT painting requests.

QEUH Campus Water Management Report Updated 11/09/20

Out of spec Summary for Retained Estates

DMA Sample Number	Re sample	Lab Reference	Date	Results Date	Analysis Required	Building	Department/Floor	Unique Outlet Identification	Sample Point	Outlet Type (Tap Shower, CWST)	Hot, Cold, Mixed (TMV)	Sample Temp	Legionella cfu/L	Lp Sero Group	Summary of latest actions taken
MAT/0808	Y	20.1863777.E	27/08/20	09/09/20	Legionella	Old Maternity	Ground Floor	L0/159	Theatre 1 Anaesthetic Rm SSS	Tap	Cold	27.1	50	2-14	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with). **WR2007140929**
MAT/0768	0	20.1846111.W	24/08/20	28/08/20	Potable	Old Maternity	Ground Floor	L3/44	Kitchen SSS	Tap	Cold	17.8	-	-	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. Emailed Facilities to review cleaning regime
MAT/0786	0	20.1846113.C	24/08/20	28/08/20	Potable	Old Maternity	Ground Floor	L2/16	Kitchen SSS	Tap	Cold	19	-	-	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with)
MAT/0787	0	20.1846114.K	24/08/20	28/08/20	Potable	Old Maternity	Ground Floor	L2/16	Kitchen SSS	Tap	Cold	66.7	-	-	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with)
MAT/0799	0	20.1863739.Y	24/08/20	07/09/20	Legionella	Old Maternity	Ground Floor	L0/41	Well Woman Sluice SSS	Tap	Cold	32.9	350	Species	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with)
MAT/0806	0	20.1863744.P	24/08/20	07/09/20	Legionella	Old Maternity	Ground Floor	D.31	Ultrasound Room 10 WHB	Tap	Cold	26.7	250	Species	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with)
MAT/0807	0	20.1863745.F	24/08/20	07/09/20	Legionella	Old Maternity	Ground Floor	D.31	Ultrasound Room 10 WHB	Tap	Mixed	39.6	100	Species	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with)
MAT/0802	0	20.1846117.X	24/08/20	28/08/20	Potable	Old Maternity	Ground Floor	L3/198	Day Ward Kitchen SSS	Tap	Cold	25.1	450	2-14	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if litte used requires to be put on their flushing register. (we will be checking to see if this has been complied with). **WR2007140929**
ICE083	N	20.1863611.K	20/08/20	00/01/00	07/09/20	Legionella	0	Ice	Ground Floor	LHS Shower	Shower	0	500	[illegible]	Incident TBC DMA after they initially became aware that the showers had come back positive, both shower heads were disinfected using shower head plus (done to DMA-Canyon RAMS). Resampling were then done. Daily flushing for a minimum period of 3 minutes was also commenced, recorded and continues. Both of the shower heads that were originally fitted have now been changed out for Dupal fixed head showers and these will be exchanged on a 3 monthly basis going forward. The daily flushing and weekly resampling will continue until such time as the micro sampling results improve in line with SHTM guidelines." Shower filters also been chlorinated. **08/09/20** Further review to be carried out to identify soruce of issue (DMA/Estates)
ICE084	N	20.1863104.T	04/08/20	00/01/00	18/08/20	Legionella	0	Ice	Ground Floor	RHS Shower	Shower	0	2600	Species	Incident TBC DMA after they initially became aware that the showers had come back positive, both shower heads were disinfected using shower head plus (done to DMA-Canyon RAMS). Resampling were then done. Daily flushing for a minimum period of 3 minutes was also commenced, recorded and continues. Both of the shower heads that were originally fitted have now been changed out for Dupal fixed head showers and these will be exchanged on a 3 monthly basis going forward. The daily flushing and weekly resampling will continue until such time as the micro sampling results improve in line with SHTM guidelines." Shower filters also been chlorinated. **08/09/20** Further review to be carried out to identify soruce of issue (DMA/Estates)

A number of out of specs' for Legionella have been identified with Old Maternity. Full maintenance of these taps and TMV's have been arranged. A number of the taps within Old Maternity also returned out of specs for TVC's.

Estates Water AP arranged a meeting with Senior Clinical Staff to ensure that these are flushed in accordance with requirements and any little used outlets identified.

Both showers with ICE Building returned out of spec's for legionella including LP1 in one shower. . Full maintenance of these taps and TMV's have been carried out. However out of spec results retuned. Further investigates are being carried out by the team on site including Estates/DMA (Water Service Provider). Note : These were already flushing these as part of the identified little used outlets by DMA.

Out of spec summary - Adults & Children’s

DMA Sample Number	Re sample	Lab Reference	Date	Results Date	Analysis Required	Building	Department/Floor	Unique Outlet Identification	Sample Point	Outlet Type (Tap Shower, CWST)	Hot, Cold, Mixed (TMV)	Sample Taken Through Pall Filter (Yes/No)	Out of spec Sample	Summary of latest actions taken	Next Action	Checks carried out cfu/ml TVC @ 22C cfu/ml Coli form cfu/ 100ml E.coli cfu/ 100ml Legionella cfu/L Lp Sero Group Pseudo monas Species SAB @ 30C / Mould @ 25oC SAB @ 22C / Yeast @ 25oC Cupria vidus AMS cfu/ 100ml Other (Count only) Bacteria/Mould found TVC @ 37C
KID7899	N	20 1863551 V	24/08/20	31/08/20	Potable, Pseudomonas, GNB	Children's	Ward 1A	23HU-013	Kitchen	Swan neck	Hot	No	Legionella	Incident TBC - Ensure tap is flushed and resampled NOTE: This is a tap which is being tested for the removal of a filter. After test a 31 day filter is added and then resampled the following week. This process continues until an all clear result Incident TBC - Carry out full service of tap NOTE CL02 is 0 which indicates tap is not being flushed. Escalated to IC	Carry out resample	26/08/20 Legionella Species 50
KID 8152	0	20 1846333 F	01/09/20	04/09/20	Potable	Children's	Ward 1A	23HU-013	Kitchen	Contour	Hot	No	TVC	Incident TBC Ensure tap is flushed and resampled NOTE: This is a tap which is being tested for the removal of a filter. After test a 31 day filter is added and then resampled the following week. This process continues until an all clear result Incident TBC - Carry out full service of tap	Carry out resample	01/09/20 - TVC@37c 2275
KID 8168	0	20 1846339 S	01/09/20	04/09/20	Potable	Children's	Ward 2C	ARU-081	Room 32	Optitherm	Hot	No	TVC	Incident TBC Ensure tap is flushed and resampled NOTE: This is a tap which is being tested for the removal of a filter. After test a 31 day filter is added and then resampled the following week. This process continues until an all clear result Incident TBC - Carry out full service of tap	Carry out resample	01/09/20 - TVC@37c 1275
KID 8092	0	20 1846156 X	26/08/20	01/09/20	Potable & GNB	Children's	1st Floor Ward 1D PICU	CCW 108	Bed 22 (With Filter)	Optitherm	Mixed	Yes	TVC	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime	Carry out resample	20/07/20 – TVC@37c 137 Sphingomonas Paucimobilis >100 29/07/20 – Not Detected 05/08/20 TVC@22c 1 Enhydrobacter Aerosaccus 1 12/08/20 – Not Detected 17/08/20 – Not Detected 21/08/20 – Not Detected 26/08/20 - TVC@37c 22c 16 Sphingomonas Paucimobilis 53
KID7964A	N	20 1846035 B	24/08/20	28/08/20	Potable, Pseudomonas, GNB	Children's	1st Floor Ward 1D PICU	CCW-096	Bed 13 (With Filter)	Optitherm	Mixed	Yes	Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime	Carry out resample	24/08/20 Acidetbacter lwoffii 1
KID 7965A	N	20 1846036 X	24/08/20	28/08/20	Potable, Pseudomonas, GNB	Children's	1st Floor Ward 1D PICU	CCW-096	Bed 14 (With Filter)	Optitherm	Mixed	Yes	Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime	Carry out resample	25/08/20 Stenotrophomonas Maltophilia 4
KID 8141	0	20 1846328 P	01/09/20	04/09/20	04/09/20	Potable, Pseudomonas, GNB	1st Floor Ward 1D PICU	CCW-103	Clean Utility (With Filter)	Optitherm	Mixed	Yes	Other	Incident TBC - DMA arranged to change filter. Liaise with Microbiology to check whether filter should be sent fo integrity testing. Spoke to Facilities to review cleaning regime	Carry out resample	01/09/20 - Sphingomonas Paucimobilis 48
KID 8103	0	20 1846171 F	28/08/20	01/09/20	GNB	A&C	6th Floor Ward 6A	GENW1-007	Room 2 En-Suite (With Filter)	Shower	Mixed	Yes	TVC / Other	Incident TBC - DMA change filter. Liaise with Microbiology to check whether filter should be sent fo integrity testing **YES**. Spoke to Facilities to review cleaning regime which they have arranged from 04/09/20	Carry out resample	14/07/20 – Not Detected 18/08/20 – 1 Acinetobacter lwoffii 26/08/20 – 1 Enhydrobacter Aerosaccus 01/09/20 - Enhydrobacter Aerosaccus 1
KID 7972	N	20 1846125 E	25/08/20	31/08/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-020	Room 8 En-Suite (With Filter)	Contour	Mixed	Yes	TVC / Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime Filter going to PAL for integrity testing **YES**	Carry out resample	25/08/20 TVC@37c 104 TVC@22c 53 Sphingomonas Pacimolis >100
KID 8115	0	20 1846268 C	31/08/20	04/09/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-021	Room 9 En Suite (With Filter)	Contour	Mixed	Yes	TVC / Other	Incident TBC - DMA change filter. Liaise with Microbiology to check whether filter should be sent fo integrity testing **YES**. Spoke to Facilities to review cleaning regime which they have arranged from 04/09/20	Carry out resample	01/09/20 - Sphingomonas Paucimobilis >100
KID 7979	N	20 1846132 F	25/08/20	28/08/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-037	Room 16 En-Suite (With Filter)	Shower	Mixed	Yes	TVC	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime Filter going to PAL for integrity testing **YES**	Carry out resample	25/08/20 TVC@37c 100
KID 7982	N	20 1846135 V	25/08/20	31/08/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-045	Room 19 En-Suite (With Filter)	Shower	Mixed	Yes	TVC / Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime Filter going to PAL for integrity testing **YES**	Carry out resample	25/08/20 TVC@37c 5 TVC@22c 13 Sphingomonas Pacimolis >100
KID 7974	N	20 1846127 P	25/08/20	28/08/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-047	Room 28 WHB (With Filter)	Optitherm	Mixed	Yes	TVC	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime. Filter going to PAL for integrity testing **YES**	Carry out resample	25/08/20 TVC@37c 100
KID7975	N	20 1846128 F	25/08/20	04/09/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-046	Room 28 En-Suite (With Filter)	Optitherm	Mixed	Yes	TVC / Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime	Carry out resample	25/08/20 TVC@37c 100 Microbacterium Flavescens
KID7794	N	20 1845831 J	18/08/20	28/08/20	Potable, Pseudomonas, GNB	Children's	6th Floor Ward 6A	GENW1-050	Room 21 En-Suite (With Filter)	Shower	Mixed	Yes	TVC / Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime	Carry out resample	14/07/20 – Not Detected 18/07/20 - M Sterilla 1 18/08/20 – TVC@37c 1 SAB/Mould 20 H Hyhomcete SAB/Yeast 4
KID 7983	N	20 1846136 R	25/08/20	31/08/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-053	Room 23 WHB (With Filter)	Optitherm	Mixed	Yes	TVC / Other	Incident TBC - DMA changed filter, liaised with IC and Facilities to review cleaning regime Filter going to PAL for integrity testing **YES**	Carry out resample	25/08/20 TVC@37c 115 TVC@22c 64 Sphingomonas Pacimolis >100
KID 8130	0	20 1846283 N	31/08/20	04/09/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-064	Room 27 En Suite (With Filter)	Shower	Mixed	Yes	TVC / Other	Incident TBC - DMA change filter. Liaise with Microbiology to check whether filter should be sent fo integrity testing **YES**. Spoke to Facilities to review cleaning regime which they have arranged from 04/09/20	Carry out resample	01/09/20 - Microbacterium Flavescens
KID 8122	0	20 1846275 B	31/08/20	04/09/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-41	Room 17 En Suite (With Filter)	Shower	Mixed	Yes	TVC / Other	Incident TBC - DMA change filter. Liaise with Microbiology to check whether filter should be sent fo integrity testing **YES**. Spoke to Facilities to review cleaning regime which they have arranged from 04/09/20	Carry out resample	01/09/20 - Microbacter Sp4 Sphingomonas Paucimobilis >100
KID7986	0	20 1846139 Z	25/08/20	01/09/20	Potable, Pseudomonas, GNB	A&C	6th Floor Ward 6A	GENW1-062	Room 26 WHB (With Filter)	Optitherm	Mixed	Yes	TVC / Other	Incident TBC - DMA change filter. Spoke to Facilities to review cleaning regime which they have arranged from 04/09/20	Carry out resample	01/09/20 - Microbacter Sp4 Sphingomonas Paucimobilis >100
KID8091	N	20 1846162 G	26/08/20	01/09/20	Potable & Pseudomonas, GNB	Adults	11th Floor 11C	GENW23 001	Bed 57 WHB	Tap	Cold	No	Other	Incident TBC - Ensure tap is flushed and resampled. Inspect Tap for damage. Speak to ward of importance of flushing. Estates to investigate tap further. AP arranging with L8 team	Carry out resample	20/07/20 Sphingomonas Paucimobilis 29/07/20 Not Detected 05/08/20 Not Detected 12/08/20 Blastomonas Ursincola > 100 21/08/20 Blastomonas Ursincola 31 26/08/20 Blastomonas Ursincola > 100

RHC Ward 1A – Kitchen (TESTING FOR REMOVAL OF FILTERS)

Out of spec for legionella species (50 cfu/l) was detected via an outlet). Full maintenance of the taps has been arranged by Estates. CL02 results were 0 from this outlet which indicated that this is potentially not being flushed on hot. NOTE: This is a tap which is being **tested for the removal of a filter**. After test a 31 day filter is a dded and then resampled the following week. This process continues until an all clear result. This has also been escalated to Infection Control.

Note: This is the first out of spec for legionella within the QEUH/RHC since March 2019.

Additionally high TVC’s were detected on another tap within the same kitchen. This is a tap which is being **tested for the removal of a filter**

RHC Ward 2C- Room 32 (TESTING FOR REMOVAL OF FILTERS)

High TVC’s were detected on another tap within the same kitchen. This is a tap which is being **tested for the removal of a filter**

<u>RHC Ward 1C PICU (FILTRED TAPS)</u>

A number of out of specs from the **FILTRED TAPS** including:-

- Sphingomonas Paucimobilis
- Enhydrobacter Aerosaccus 1
- Acidetbacter Iwoffii
- Stenotrophomonas Maltophilia

Discussions have taken place with Infection Control, Microbiology regarding these. Additionally liaised with Facilities to review cleaning regime as per agreed procedures and have arranged refresher training. In all cases the filters are changed as and when Estates receive updated from the Lab.

<u>QEUH Ward 6A (FILTRED TAPS)</u>

A number of out of specs from various **FILTRED TAPS AND SHOWERS** including:-

- High TVC's
- Sphingomonas Paucimobilis
- Micro bacterium Flavsecens
- Acidetbacter Iwoffii
- Stenotrophomonas Maltophilia
- M Sterilla
- H.Hyhomcete

Discussions have taken place with Infection Control, Microbiology regarding these. Additionally liaised with Facilities to review cleaning regime as per agreed procedures. Facilities Management are carrying out refresher training.

In all cases the filters are changed and Estates have arranged for 11 of the filters to be sent to PAL for integrity testing which was agreed with Infection Control and Microbiology. Further analysis and possible caused should be discussed at the Water Technical Group.

QEUH Ward 11C (Bed 57) (TESTING FOR REMOVAL OF FILTERS)

A number of out of specs for Blastomonas Ursincola have been detected from this tap. Further maintenance of the tap has been arranged.

Raw Tank Monitoring – QEUH Tank Room

A number of out of specs have been identified in the **RAW** water tank samples drains over the month:-

- SAB's
- H. Hyphomycete
- M. Sterilia
- Delfia Acidovorans
- Acinetobacter Ursingii
- TVC's
- Roseomonas Mucosa
- Enhydobacter Aerosaccus
- Acinetobacter Iwoffii
- Sphingobium Xenophagum

A number of out of specs have been identified in the **RAW** water dip samples over the month:-

- SAB's
- Roseomonas Mucosa
- H. Hyphomycete
- M. Sterilia
- Acinetobacter Iwoffii
- Sphingomonas Paucimobilis
- Methylobacterium Sp

Bulk Filtration Tanks

Over the last month one sample (13/08) returned an out of spec from Bulk filtrate tanks 2A **drain** for Aspergilus Furnitigas and Purprcillium Lilacinum although within agreed parameters . Following two samples indicated not detected.

Post Filtration units

A number of out of spec results for TVC's and gram negative bacteria have been found in the post filtration sample points. Estates and Microbiology have been investigating and the 6 week testing programme including all sample points within the unit pre-and post-filter. (Before and after backwash)

These include at different sample points and different samples:-

- TVC
- Stenotrophomonas Maltophilia
- Hyphomycete
- M. Sterilia,
- SAB
- D. M.Sterilia
- Sphingomonas Paucimobilis
- P. Lilacinum
- Acinetobacter Ursingii
- D. Hyphomycete
- Sphingomonas Paucimobilis
- Delftia Acidovornas
- Acinetobacter Iwoffii
- Coliform
- Raoultella Species

- Raoultella Terrigena
- Kluyvera Intermedia
- PS Fluoesecens
- Acidovorax Delafieldii
- Flavescens Laevaniformans
- Cuprivadis
- C.Pauculus

A detailed report from the above will be prepared by DMA for further discussion with Estates and Microbiology, DMA & Veolia following the 6 week programme in September.

A meeting was held with DMA, Estates, Scotomas (CL02 providers/equipment maintainers) and Veolia (Filtration supplies/equipment maintainers) regarding the possible increase of CL02 on the backwash.

The commissioning of the backwash filter systems at QEUH, a starting value of 0.5mg/l ClO_2 was selected for backwash disinfection in order to provide an element of biocidal treatment against sessile bacteria that may have built up on the PVDF membrane surfaces on the Veolia filtration systems.

This biocidal treatment on the backwash was completed for 2 reasons –

- To guard against the risk of any “breakthrough” on the filters due to the accumulation of biofouling over time.
- To improve the efficiency and reduce the energy consumption of the filtration plants by removing fouling that can inhibit the transfer of water through the membrane.

This approach is commonly used in commercial RO systems throughout the World.

Following recent microbiological testing has indicated higher than expected levels of biofouling on the “dirty” side of the membrane, and for this reason it is proposed to increase the level of ClO_2 dosing to the backwash in order to increase the Ct value in order to combat pseudomonas based biofilms established on the surface. Proposal is for 2.0mg/l CL02.

Value of 2.0mg/l CL02 is compatible with the filter unit components and would not have an adverse effect.

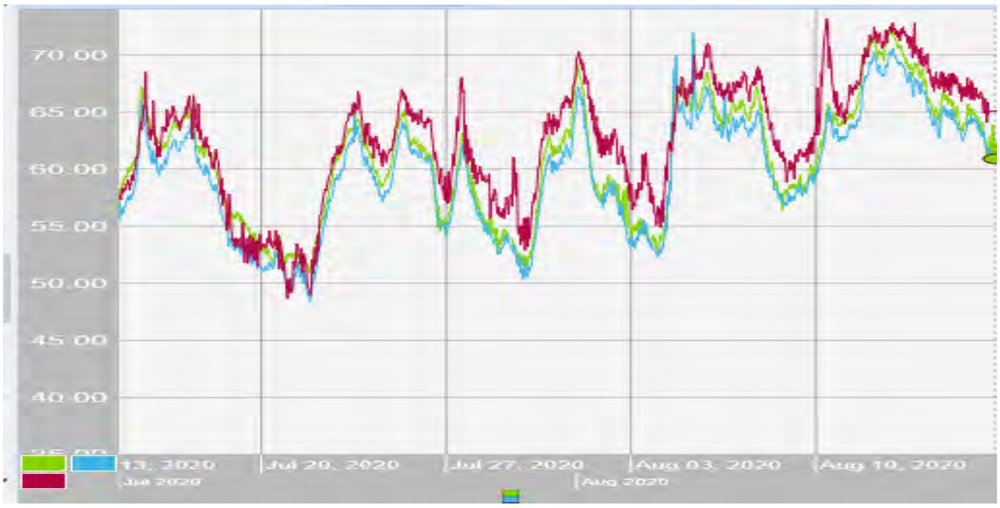
Additionally although 2.0mg/l is above normal drinking water limits, however would not be within taste of odour thresholds and is perfectly safe to work with.

Discussion took place at the meeting regarding the potential risk of higher levels of CL02 passing through the filter via the backwash. Scotomas indicated that this level is for the backwash going to drain. (*Note: happens every 57 minutes on each unit*) They also indicated that additionally even if the higher levels of CL02 got through the filters to the filtrate tanks, which themselves are dosed with CL02, the levels would not be identifiable due to dilution within the tanks.

This should be discussed at the Water Technical Group for approval.

Humidity Monitoring – QEUH Tank Room

13/06/20 – 17/08/20



PPM Update

Month	Water PPM's Complete %	Water PPM's Completed	Water PPM's Outstanding
April	100.00%	432	0
May	99.52%	617	3
June	99.63%	545	2
July	91.44%	801	75
August	56.73%	139	106

Other information

During routine checks two filters were found to be significantly dirty:-

- NICU Level 1 Blood Gas Room
- PICU Staff Room

In both cases, Infection Control, Facilities and the Ward have been informed.

NHS Greater Glasgow & Clyde	
Meeting:	**Acute Infection Control Committee**
Date of Meeting:	
Purpose of Paper:	**For Noting/Information**
Classification:	**Official Sensitive**
Sponsoring Director:	**Tom Steele**

Paper Title
Water/Ventilation Exceptions Update Operational Estates

Recommendation
The members of ICBEG are asked to:

- Note paper contents.

Purpose of Paper

Exception reporting on Water Systems within GG&C

Any Patient Safety /Patient Experience Issues

No direct impact identified.

Any Financial Implications from this Paper

None.

Any Staffing Implications from this Paper

None.

Any Equality Implications from this Paper

None.

Any Health Inequalities Implications from this Paper

None.
Has a Risk Assessment been carried out for this issue? If yes, please detail the outcome.

N/A.

Author: **Mark Riddell**
Tel No: [redacted]
Date: **8th December 2020**

The purpose of this paper is to report exceptions within the GG&C Water Systems

Royal Alexander Hospital (RAH)

CLO2 Plant RAH

A meeting was held with clinical representatives on Mon 9th November 2020 to outline the proposals and publish the timeline to the "go-live" date. All representatives were asked to cascade the information to their respective teams and return any areas of concern by Weds 18th November 2020 to allow the next steps of the project to progress. Any areas of concern can be addressed by the installation of localised RO filtration to remove CLO2 if required. None have so far been identified but a follow up request for information will be issued to clinical representatives. Final installation and commissioning of monitoring stations is progressing with a potential "go-live" date of early January 2021 TBC.

Foxbar HC

This HC has been closed since the commencement of COVID in March 2020. Regular outlet flushing has been carried out and recorded. We have received a request to put the HC back into use so as a pre-emptive measure it was decided to bring forward the CWST cleaning programme in order to minimise disruption at a later date. On completion of the CWST cleaning and disinfection, the water samples returned some out-of-spec results for TVC's As a result further cleaning and a system wide disinfection has also been carried out twice. Subsequent samples have still returned out-of-spec results. During further investigation some hidden Dead legs were found on the distribution pipework which are in the process of being removed. Once work is completed a further round of sampling will be carried out to ensure results are within spec before opening the HC to use.

VOL Water Supply

The CWST's at VOL are increasingly subject to entry and build-up of silt/debris from the incoming water main. Business Stream have been contacted and consulted, and have forwarded a proposal to replace a significant section of mains pipework within the VOL curtilage to improve the quality of the delivered water. (Circa £90k) It is thought that this may not fully address the issue as the ring main around site is in similar condition VOL estates are looking at options to install filtration plant on the incoming main to eliminate to ingress of silt/debris. Thus far water samples have not shown any significant cause for concern, although the debris could provide a nutrient source for water borne bacteria.

Glasgow Royal Infirmary

AHU replacement Endoscopy unit within the GRI is currently part of this year's capital projects. Due to the down time to the department if the project was to include the renewal of the existing ductwork which we are currently investigating. If we can deliver the AHU replacement /upgrade by using the existing duct work, this would reduce the downtime to the department as we should only require access to the department at weekends. We have not had this confirmed as possible to date but will continue to update as information becomes available.

Gartnavel General Campus

Ongoing issues with damaged and blocked cast iron drainage piped system on the upper ground floor of the main unit impacting into Nuclear medicine. Sections have been removed and replaced on a rolling programme as and when these blockages occur. Users have been advised on the continued miss use of wipes been discarded through the system. Future required action is for the complete renewal of this section of the drainage system.

QEUH Campus Ventilation Management Report Updated 20/11/20

Exceptions

Failure of the supply fan for the air handling unit that supplies Ward 61. The fan unit broke off of the mounting fixings within the unit. HEPA Scrubber units were temporally installed within the ward however these are only designed to supplement existing ventilation systems, they are by no means a replacement. The fan unit & components arrived back with a temporary repair to the casing and the AHU was re-built with the system being switched back on at approximately 15.30hrs. Also the AHU was re-verified before being put back into service. The new double inlet centrifugal fan has been ordered with an estimated 4 week lead time.

Theatre verifications completed

Three theatre validations carried out in October

- RHC Theatre 8
- Adult Theatre 9
- Adult Theatre 10

Critical Ventilation completed

Three critical verifications carried out

- PICU room 12
- PICU room 17
- PICU room 18

PPM Update

Month	Ventilation PPM's Complete %	Ventilation PPM's Completed	Ventilation PPM's Outstanding
April	89.05%	127	24
May	93.04%	119	18
June	89.05%	128	17
July	84.08%	143	39
August	64.94%	56	12
September	87.04%	56	**7**

Other information

We have identified that a number of PPM’s have not been issued to the Service Provider PDA. This is due to the PPM’s requiring the Service Provider added into each element (step) within the PPM. PPM’s without elements only require the service provider added to the PPM.

Estates have confirmed with the Service Provider that the PPM’s have been completed and the figures above reflect that. Estates are working with Corporate Estates to rectify this.

QEUH Campus Water Management Report Updated 13/10/20

Out of spec Summary for Retained Estates

DMA Sample Number	Re sample	Lab Reference	Date	Results Date	Analysis Required	Building	Department/Area	Unique Outlet Identification	Sample Point	Outlet Type (Tap Shower, CWST)	Hot, Cold, Mixed (TMV)	Sample Temp	Legionella cfu/L	Lp Sero Group	Summary of latest actions taken	Next Action	Legionella Range cfu/L
MAT0835	Y	20 1864288 A	24/09/20	05/10/20	Legionella	Old Maternity	Ground Floor	L8/159	Theatre 1 Anaesthetic Rm SSS	Tap	Cold	27.5	100	Species	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if little used requires to be put on their flushing register. (we will be checking to see if this has been complied with) WR2007140929	Note: this area was found to be out of use and used as a store with no evidence of flushing. Ward and Infection Control have been informed	21/07/20 – Not Detected Pre 21/07/20 – 150 Post 2-14 30/07/20 – 2600 Post 2-14 06/08/20 – 500 Post 2-14 12/08/20 – 450 Post 2-14 20/08/20 - 100 2-14 27/08/20 – 50 2-14 03/09/20 – 750 2-14 10/09/20 – Not Detected 17/09/20 – Not Detected 24/09/20 - 100 Species
MAT0837	5	20 1864290 H	24/09/20	05/10/20	Legionella	Old Maternity	Ground Floor	D 31	Ultrasound Room 10 WHB	Tap	Cold	27.1	50	Species	Incident TBC Carry out full clean and disinfection of tap. Inform nursing staff that this outlet if little used requires to be put on their flushing register. (we will be checking to see if this has been complied with)	Await further samples	24/08/20 – 250 Species 10/09/20 – Not Detected 17/09/20 – Not Detected 24/09/20 – 50 Species
ICE111	N	20 1864287 W	24/09/20	05/10/20	Legionella	ICE Building	Ground Floor	0	RHS Shower	Shower	Mixed	0	100	Species	Incident TBC DMA after they initially became aware that the showers had come back positive, both shower heads were disinfected using shower head plus (done to DMA-Canyon RAMS). Resampling were then done. Daily flushing for a minimum period of 3 minutes was also commenced, recorded and continues. Both of the shower heads that were originally fitted have now been changed out for Dupal fixed head showers and these will be exchanged on a 3 monthly basis going forward. The daily flushing and weekly resampling will continue until such time as the micro sampling results improve in line with SHTM guidelines." Shower filters also been chlorinated. 08/09/20 Further review to be carried out to identify source of issue (DMA/Estates)	Await further samples	04/08/20 – 2600 Species 20/08/20 – 300 Species 27/08/20 – Not Detected 03/09/20 – 50 Species 10/09/20 – Not Detected 16/09/20 – Not Detected Pre 16/09/20 – Not Detected Post 24/09/20 – 100 Species

A number of out of specs’ for Legionella are still apparent within with Old Maternity, although these have reduced from previous month. Both returned two clears however on the third sampling it returned and out of spec. Further maintenance of these taps and TMV’s is being arranged.

One shower with ICE Building has also returned an out of spec after two all clears. Further is being arranged.

Out of spec summary - Adults & Children's

DMA Sample Number	Re sample	Lab Reference	Date	Results Date	Analysis Required	Building	Department/Floor	Unique Outlet Identification	Sample Point	Outlet Type (Tap Shower, CWST)	Hot, Cold, Mixed (TMV)	Sample Taken Through Pall Filter (Yes/No)	Out of spec Sample	Summary of latest actions taken	Next Action	Checks carried out TVC @ 37C cfu/ml TVC @ 22C cfu/ml Coli form cfu/ 100ml e.coli cfu/ 100ml Legionella cfu/L Lp Sero Group Pseudo monas Species SAB @ 30C / Mould @ 25oC SAB @ 22C / Yeast @ 25oC Cupria vidus AMS cfu/ 100ml Other (Count only) Bacteria/Mould found
KID8853	Y	20.1847417.N	30/09/20	06/10/20	Potable	Adult	2nd Floor Adult Theatres	THE-117	Theatre 5 RHS WHB Nearest Door	Optitherm	Cold	No	TVC / Other	Incident TBC - Carry out thermal disinfection of tap and clean with alchohol. Speak to Facilities to review cleaning regime	Carry out resample	20/08/20 -TVC@22c 4500 21/09/20 - Sphingomonas Paucimobilis 1 Stenotrophomonas Maltophilia 1 23/09/20 – No sample taken 30/09/20 – TVC@37c 1
KID8874	Y	20.1847421.N	30/09/20	06/10/20	Potable	Children's	Ground Floor Concourse	ENT-022	Therapy	Optitherm	Cold	No	TVC / Other	Incident TBC - Carry out thermal disinfection of tap and clean with alchohol. Speak to Facilities to review cleaning regime	Carry out resample	15/07/20 – Not Detected 20/08/20 – TVC@22c 255 17/09/20 – Sphingomonas Paucimobilis 70 23/09/20 – No sample taken 30/09/20 – TVC@37c 44 TVC@22c 10
KID 8582	Y	20.1847041.W	21/09/20	24/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 173	Facilities	SSS	Hot	No	TVC	Incident TBC - Carry out full maintenance of tap and disinfection. Speak to Ward to ensure tap is flushed accordingly with SHTM04-01. Check with ward if this is identified on WS01 little used outlets. **Note** : Room also has wash hand basin and janitorial sink and results are still to be send from Lab. Tap has subsequently been filtered due to Clinical patient group.	Carry out resample	21/09/20 - TVC@37 1 Sphigomonas Paucimobilis 1
KID 8580	Y	20.1847039.C	21/09/20	24/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 173	Janitorial Sink	SSS	Hot	Yes	TVC	Incident TBC - Change filter and resample	Carry out resample	21/09/20 - TVC@37c 531 TVC@22c 26 Sphigomonas Paucimobilis 1
KID 8602	Y	20.1847061.P	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 1	OPD 027	WC Staff	Contour	Mixed	No	Other	Incident TBC - Carry out full maintenance of tap. Speak to Ward to ensure tap is flushed accordingly with SHTM04-01. Check with ward if this is identified on WS01 little used outlets	Carry out resample	21/09/20 - Stenotrophomonas Maltophilia 91
KID 8605	Y	20.1847064.M	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 1	OPD 031	Treatment Room A	Optitherm	Mixed	No	Other	Incident TBC - Carry out full maintenance of tap. Speak to Ward to ensure tap is flushed accordingly with SHTM04-01. Check with ward if this is identified on WS01 little used outlets	Carry out resample	21/09/20 - Acidovorax Delafieldii 16 Brevundimonas Diminuta > 100
KID8566	Y	20.1847025.M	21/09/20	29/09/20	Potable, Pseudomonas, GNB, AMS	Children's	1st Floor Ward 1D PICU	CCW-108	Bed 20 (with filter)	Optitherm	Mixed	Yes	Other	Incident TBC - Change filter and resample. Also introduced flushing by DMA. Discuss with Facilities flushing and cleaning regime	Carry out resample	17/08/20 – Not Detected 21/09/20 - TVC@37c 31 TVC@22c 3 Spigomonas Paucimobilis 2
KID8579	Y	20.1847034.Z	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 178	Consulting Room 14	Optitherm	Mixed	Yes	Other	Incident TBC - Change filter and resample. Also introduced flushing by DMA. Discuss with Facilities flushing and cleaning regime	Carry out resample	21/09/20 Spigomonas Paucimobilis >100
KID 8584	Y	20.1847043.C	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 171	Consulting Room 9	Optitherm	Mixed	Yes	Other	Incident TBC - Change filter and resample. Also introduced flushing by DMA. Discuss with Facilities flushing and cleaning regime	Carry out resample	21/09/20 Spigomonas Paucimobilis 2
KID 8587	Y	20.1847046.B	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 167	Consulting Room 11	Optitherm	Mixed	Yes	Other	Incident TBC - Change filter and resample. Also introduced flushing by DMA. Discuss with Facilities flushing and cleaning regime	Carry out resample	21/09/20 TVC@37c 99 TVC@22c 14Spigomonas Paucimobilis >100
KID 8591	Y	20.1847050.B	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 1	OPD 009	Public WC	Contour	Mixed	No	Other	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection. Close room however DMA to carry out flushing until all clear. Discuss with Facilities flushing and cleaning regime	Carry out resample	21/09/20 TVC@22c 20 Pseudomonas Auerugosis 2 Spigomonas Paucimobilis >100
KID 8596	Y	20.1847054.N	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 1	OPD 158	EEG Room 1	Optitherm	Mixed	No	Other	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection. DMA to carry out flushing until all clear.	Carry out resample	21/09/20 TVC@337c 95 Acidovorax Delafeldii 4
KID 8590	Y	20.1847055.E	21/09/20	25/09/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 1	OPD 022	EEG Room 2	Optitherm	Mixed	No	Other	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection. DMA to carry out flushing until all clear.	Carry out resample	21/09/20 Blastomonas Ursicola 31
INT3906	Y	WS10748584	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward A	GENW9-065	Bedroom 28	Optitherm	Cold	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	18/08/20 - Not Detected 15/09/20 - SAB@30c Mould at 25 c 15
INT3908	Y	WS10748587	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward A	GENW9-066	Facilities	Hot Tap	Hot	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@30c Mould@25c 10
INT3910	Y	WS10748589	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward A	GENW10-033	Bedroom 42	Optitherm	Mixed	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@22c Yeast@25c 151.5
INT3906	Y	WS10748599	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward B	GENW12-065	Bedroom 85	Optitherm	Mixed	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@30c Mould@25c 14
INT3901	Y	WS10748580	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward B	GENW12-066	Facilities	Cold Tap	Cold	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@22c Yeast@25c 50
INT 3918	N	WS10748588	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	8th Floor Ward C	GENW13-066	Facilities	Cold Tap	Cold	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@30c Mould@25c 15
INT 3921	N	WS10748600	15/09/20	-	Legionella Potable Pseudomonas Fungi	Adult	11th Floor Ward B	GENW24-035	Bedroom 97	Optitherm	Cold	No	Mould	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection.	Carry out resample	14/07/20 – Not Detected 18/08/20 – Not Detected 15/09/20 – SAB@30c Mould@25c 12
KID8638	Y	20.1847122.W	22/09/20	02/10/20	Potable, Pseudomonas, GNB	A&C	8th Floor Ward 6A	GENW1-019	Room 8 WHB (With filter)	Optitherm	Mixed	Yes	Other	Incident TBC - Change filter	Carry out resample	28/07/20 – Acinetobacter lwoffii 12/08/20 – Not Detected 21/08/20 – Not Detected 25/08/20 – Not Detected 26/08/20 – Not Detected 22/09/20 - Sphingomonas Paucimobilis 3 Brevundimonas Diminuta 2
KID 8807	N	20.1847411.K	30/09/20	05/10/20	Potable, Pseudomonas, GNB, AMS	Children's	Ground Floor Clinic 2	OPD 162	Clean Utility	SSS	Cold	No	TVC	Incident TBC - Carry out full maintenance of taps, carry out thermal disinfection. DMA to carry out flushing until all clear.		30/09/20 - TVC@37c 550 TVC@22c 194
KID 8815	N	20.1847379.F	30/09/20	06/10/20	Potable, Pseudomonas, GNB	A&C	8th Floor Ward 6A	GENW1-003	Room 1 En-Suite (With Filter)	Shower	Mixed	Yes	Other	Incident TBC - Change filter		05/07/20 – Not Detected 07/07/20 – Not Detected 07/07/20 – Not Detected 04/08/20 – Not Detected 31/08/20 – Not Detected 30/09/20 - Roseomonas Mucosa 1

A number of out specs have been identified:-

Ground Floor clinic – RHC

A number of outlets have indicated out of specs for TVC's and GNB's as noted above. Note a number of these were from filters. Filters are changed and resampled.

Note: Pseudomonas Auerugosis (result of 2 within spec) was found on public WC, full maintenance was carried out and tap disinfected. This will remain out of use and flushed by DMA until all a clear.

Confirmed with Facilities that flushing occurs in this area.

8th Floor – Adults

A number of outlets have returned out of specs for mould. Full maintenance and disinfection arranged for these outlets.

6A – RHC

Two **filtered** taps have returned out of specs. Filters changed.

Discussions have taken place with Infection Control, Microbiology regarding these. Additionally liaised with Facilities to review cleaning regime as per agreed procedures. Facilities Management are carrying out refresher training.

PAL have now reported that all 11 filters previously sent back from 6A, passed the integrity tests.

A meeting was held between Facilities, Infection Control and Microbiology to discuss the number of out of specs from filtered water to try and identify what is causing the retrograde contamination. Sampling was agreed to be taken from the drains.

Raw Tank Monitoring – QEUH Tank Room

A number of out of specs (16) have been identified in the **RAW** water tank over the month for TVC's, moulds and in some cases GNB's :-

10 – From Tank drain sample points.

3 – From Tank make up points.

3 – From Dip samples

Bulk Filtration Tanks

Two out of specs from bulk filtrate tank drains.

DMA Sample Number	Re sample	Lab Reference	Sample Date	Time Sample Taken	Results Date	Analysis Required	Sample Area (Adult, Childrens or Plantrooms)	Department/Floor	Unique ID (Door Code)	Sample Location	Asset Sampled (Tap, Shower, CWST, Cal)	Hot, Cold, Mixed (TMV)	1st Flush or Post Flush	Sample Taken Through Pall Filter (Yes/No)	Temp (°C)	ClO_2 (mg/l)	TVC @ 37C cfu/ml	TVC @ 22C cfu/ml	Coli form cfu/ 100ml	e.coli cfu/ 100ml	Legionella cfu/L	Lp Sero Group	Pseudo monas Species	SAB @ 30C Mould @ 25oC	SAB @ 22C Yeast @ 25oC	Cupria vidus	AMS cfu/ 100ml	Other (Count only)	Sepcies Info
KID 7813	N	20.1845861.H & 20.1863470.V	19/08/20	15:00	01/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 1B Drain	CWST Drain	Cold	Post	No	17.7	0.24	0	2	0	0	0	Not Detected	0	0	0	-	-	51	Delftia Acidovorans
KID 8007	N	20.1846222.D & 20.1863793.D	26/08/20	15:00	10/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 1B Drain	CWST Drain	Cold	Post	No	17.5	0.3	2	0	0	0	0	Not Detected	0	0	0	-	-	1 8	Acinetobacter lwoffii Delftia Acidovorans

Post Filtration units

A number of out of spec results for TVC's and gram negative bacteria have been found in the post filtration sample points. In one case Legionella LP1 (50 cfu/ml) from make-up filter 1.

DMA Sample Number	Re sample	Lab Reference	Sample Date	Time Sample Taken	Results Date	Analysis Required	Sample Area (Adult, Childrens or Plantrooms)	Department/Floor	Unique ID (Door Code)	Sample Location	Asset Sampled (Tap, Shower, CWST, Cal)	Hot, Cold, Mixed (TMV)	1st Flush or Post Flush	Sample Taken Through Pall Filter (Yes/No)	Temp (°C)	ClO_2 (mg/l)	TVC @ 37C cfu/ml	TVC @ 22C cfu/ml	Coli form cfu/ 100ml	e.coli cfu/ 100ml	Legionella cfu/L	Lp Sero Group	Pseudo monas Species	SAB @ 30C Mould @ 25oC	SAB @ 22C Yeast @ 25oC	Cupria vidus	AMS cfu/ 100ml	Other (Count only)	Sepcies Info
KID 7925	N	20.1845876.E & 20.1863481.J	19/08/20	15:35	01/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2A Make-up (Filter 1 Running) Start of Cycle	Filter Drain Point	Cold	Post	No	17.5	N/A	0	0	0	0	0	Not Detected	0	0	0	-	-	1	Acinetobacter lwoffii
KID 8022	N	20.1846252.F	26/08/20	00:00	10/09/20	Valve in Fully Closed Position Tank Not Making Up. No Sample	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 1B Make-up (Filter 1 Running) Start of Cycle	Filter Drain Point	Cold	Post	No	0	N/A	0	0	0	0	0	Not Detected	0	0	0	0	0	1	Sphingomonas Paucimobilis
KID 8036	N	20.1846250.Y & 20.1863825.P	26/08/20	14:56	11/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2A Make-up (Filter 1 Running) End of Cycle	Filter Drain Point	Cold	Post	No	16.5	N/A	1	1	0	0	50	1	0	0	0				GNB - Not Detected
KID 8050	N	20.1846398.G & 20.1863508.T	03/09/20	10:25	14/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2B Make-up (Filter 2 Running) Start of Cycle	Filter Drain Point	Cold	Post	No	16.7	N/A	0	344	0	0	0	Not Detected	0	0	0	-	-	3	Sphingomonas Paucimobilis
KID 8062	N	20.1846410.N & 20.1863820.D	03/09/20	11:05	14/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2A Make-up (Filter 2 Running) End of Cycle	Filter Drain Point	Cold	Post	No	16.5	N/A	0	0	0	0	0	Not Detected	0	0	0	-	-	4	Sphingomonas Paucimobilis
KID 8063	N	20.1846411.E & 20.1863821.S	03/09/20	11:30	14/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2B Make-up (Filter 2 Running) End of Cycle	Filter Drain Point	Cold	Post	No	16.4	N/A	67	53	0	0	0	Not Detected	0	0	1	-	-	>100	Sphingomonas Paucimobilis
KID 8275	N	20.1846271.Y & 20.1864032.P	07/09/20	10:17	18/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2A Make-up (Filter 2 Running) Start of Cycle	Filter Drain Point	Cold	Post	No	15.5	N/A	0	5	0	0	0	Not Detected	0	0	1	-	-	>100	Sphingomonas Paucimobilis
KID 8290	N	20.1846082.D & 20.1864043.S	07/09/20	10:45	21/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 1A Make-up (Filter 2 Running) End of Cycle	Filter Drain Point	Cold	Post	No	15.6	N/A	2	1	0	0	0	Not Detected	0	0	1	-	-	1	Cronobacter Sakazakii
KID 8301	N	20.1846085.J & 20.1864056.D	07/09/20	11:56	21/09/20	Legionella Potable Pseudomonas GNB SAB	A&C	Basement Tank Room	No Code	Bulk Filtrate CWST 2A Make-up (Filter 3 Running) Start of Cycle	Filter Drain Point	Cold	Post	No	15.5	N/A	0	0	0	0	0	Not Detected	0	2	0	-	-	1	Acinetobacter lwoffii

Following discussions at the Water Management Group it was agreed to increase the CL02 on the backwash for the filtration units from the 0.5mg/l ClO2 to 2.0mg/l CL02. This was increase in early October.

It was also agreed to wait a number of weeks and carry out full sampling of the post filtration unit sample points to gauge what impact this has had.

A meeting is planned for October with DMA, Estates and Microbiology to review the initial sampling of the filtration points.

Humidity Monitoring – QEUH Tank Room

PPM Update

Month	Water PPM's Complete %	Water PPM's Completed	Water PPM's Outstanding
April	100.00%	432	0
May	100.00%	620	0
June	100.00%	547	0
July	100.00%	871	0
August	100.00%	262	0
September	100.00%	521	0

Other Information

We have identified that a number of PPM's have not been issued to the Service Provider PDA. This is due to the PPM's requiring the Service Provider added into each element (step) within the PPM. PPM's without elements only require the service provider added to the PPM.
Estates have confirmed with the Service Provider that the PPM's have been completed and the figures above reflect that. Estates are working with Corporate Estates to rectify this.

A waiver has been completed for TMV/TMT maintenance and has been signed off by Estates Management and awaiting final approval.

Domestic Water Service Survey

Summary:

During this survey we are going to sample 40 randomly selected areas throughout the full hospital. Within these areas we have picked areas less likely to cause any disruption to the everyday running of the hospital. We are going to use a high powered magnet to investigate for any ferromagnetic particles that you dont find in stainless steel installs but would be found in mild steel. Below are the steps we would be carrying out to carry out this survey.

1. HAI-Scribe documentation will be submitted for each area we look to carry out this investigation.
2. Upon approval we will set up the area as per HAI-Scribe documentation.
3. We will then remove the ceiling tile within the set up area and inspect pipework using the high powered magnet. As it is high powered it will work through the lagging and mean we minimise the time within the area and reduce mess within area.
4. The inspection will be carried out by Mercury and witnessed by Brookfield and an NHS representative. Who will sign off upon completion of survey of that area.
5. Ceiling tiles will then be re-instated and any clean up will be within HAI-Scribe documentation specifications.
6. If any Mild Steel sections are found upon survey of these 40 areas we will look to carry out 40 more samples as a precautionary.

Attendances:

Mercury: Johnathan Dunnet

Brookfield: Micheal Haveron

NHS: TBA

Description of Above Ground Drainage

Overview

This description relates to the above ground drainage system serving the Adult and Children's Hospitals at the time it was handed over to GGHB by MPX.

The operational procedures, monitoring, control measures and preparedness are matters for GGHB.

Above ground foul (soil and waste) drainage is collected from sanitary fittings, equipment and outlets, by a system of vertical and horizontal pipework distributed within the building, to connect to the below ground drainage system.

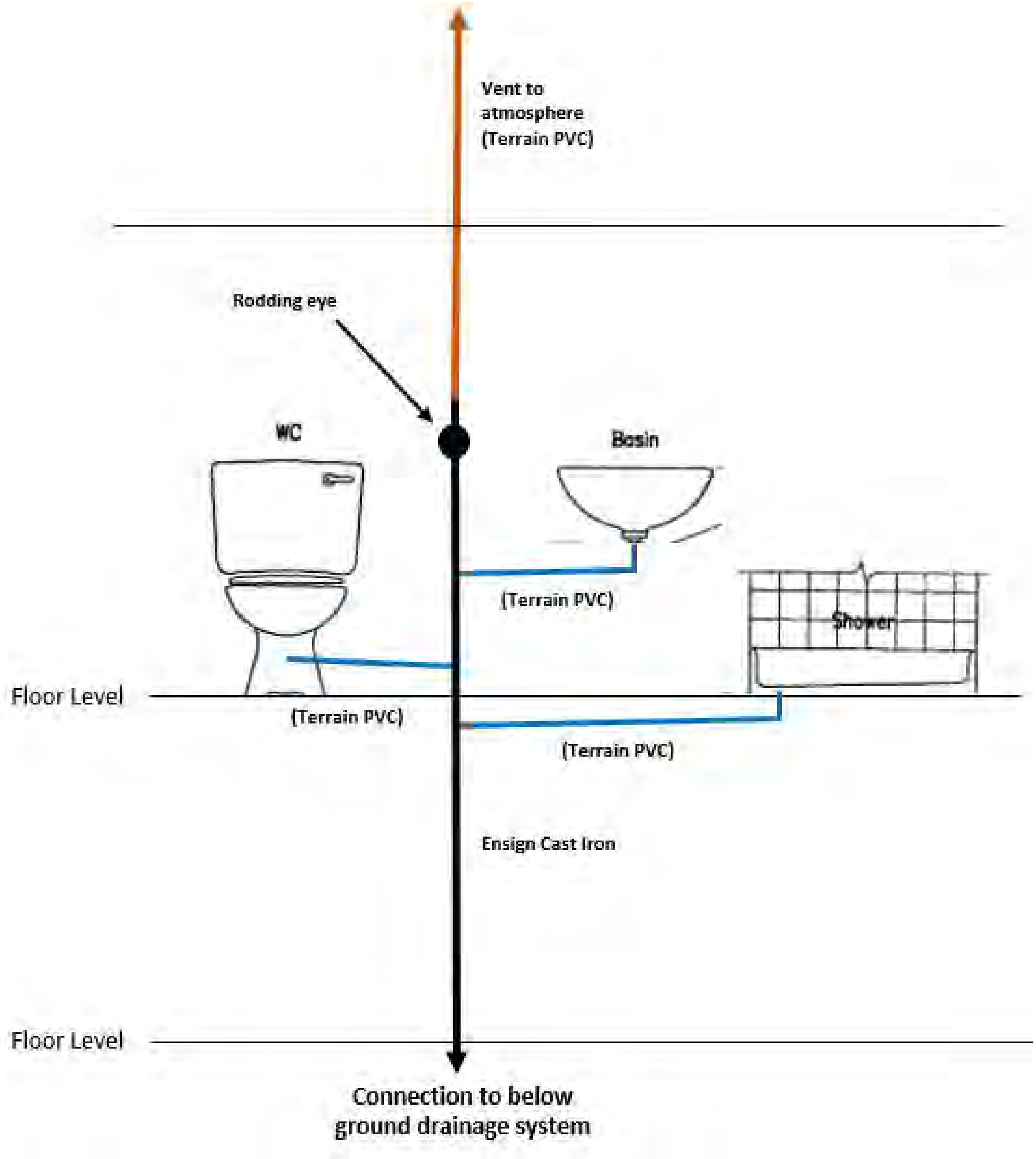
Below are some examples of pipework installation.

The drainage system operates under gravity with anti-siphon ventilation stacks to atmosphere for the ground floor upwards.

The pipework is generally concealed within modular sanitary panels and ceiling voids.

Rodding eyes are installed at 1.2m above floor level and are generally installed within modular sanitary panels.

The below diagram is a simplified representation of an above ground drainage system.



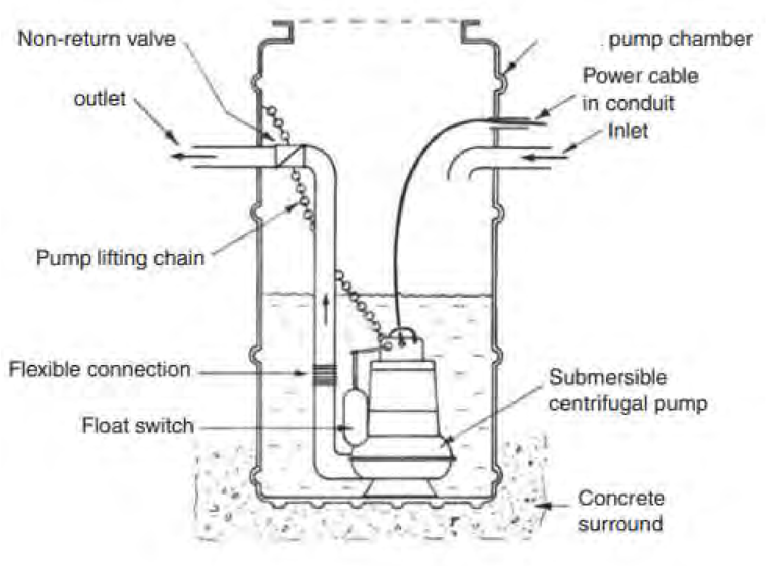
For the basement, the soil and waste feeds into a sump located in the pump room FMB-024 and is pumped into the ground floor and below ground drainage system.

There are several other sumps and pumps within the basement providing pumped drainage for,

- Water filtration backwash.
- Emergency overflows from the cold water storage tanks.
- Emergency overflows from the sprinkler system tanks.
- Emergency overflows from the renal concentrate storage tanks.
- Emergency drainage from Core G lift sump.

Also within the basement corridors there are several emergency sumps. These have the facility to allow a temporary sump pump to be installed if necessary.

The below is an image of a typical sump pump arrangement.



Pipework Materials

The following pipework materials have been used;

- Drainage stacks 100mm and above are Ensign cast iron.
- Pipework 50mm and below is Terrain plastic.
- All vent pipework is Terrain plastic.

Notes

The following are excluded from this description,

- Helipad drainage
- Rainwater

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Tank Report/Investigation

Our reference NPL-150652

Project:
GRP tanks, basement tank room, Adult & Children's Hospital, QEUH, Glasgow.

- **2no 10x5x2m Raw water tanks formed from 2 equal compartments each 5x5x2m**
- **2no 27.5x5x2m Bulk Filtrate tanks each tank formed from 2 unequal compartments 14x5x2m & 13.5x2m**
- **1no 2x2x1m Trade water services tank formed from 2 equal compartments each 2x1x1m**

Site visit carried out on behalf of and with DMA Canyon (David Watson)

Enquiry:
Customer (David Watson of DMA) contacted ourselves and we held discussion relating to corroding fasteners & strengthening tie bars along with resultant debris within tanks. Following discussion, it was agreed that this would be unusual after such a short period of time, tanks installed approximately 8 years ago, considering the expected life of a tank would expect to be well in excess of 15 years with normal operating conditions, regular inspection, cleaning & resultant maintenance.
A site visit was agreed to be carried out.

Findings from site visit:
Immediately on attendance it was evident corrosion is taking place on fasteners, strengthening tie bars and internal dividing wall supports. This occurs above and below the water line but is more prevalent above the water line where oxidisation occurs. Resultantly there is continual debris and contaminants from the corrosion entering the stored water either in solid or liquid form. Corrosion is more evident within crevices of threads on the strengthening tie bars and there is no consistency across the tanks as levels of corrosion vary.
Additionally, as well as with corrosion of internal stainless steel components there is within the tanks marking stamps on fasteners showing non-compliant use of sub-standard A2 stainless steel (grade 1.4301) instead of compliant A4 (grade 1.4401) which would be the expected minimum specification for a tank for use within a hospital property. was the specification.
There is also mesh openings on vent air intakes, which allow the tank to "breath", which are greater than the permitted standard 0.65mm. Under heavy draw off air containing contaminants and debris could be drawn into the tanks through these oversized vented areas. Damaged & misaligned lid cover panels may also add to this issue.

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Tank Report/Investigation

Corrosion of internal stainless steel image 001

Corrosion of internal stainless steel image 002

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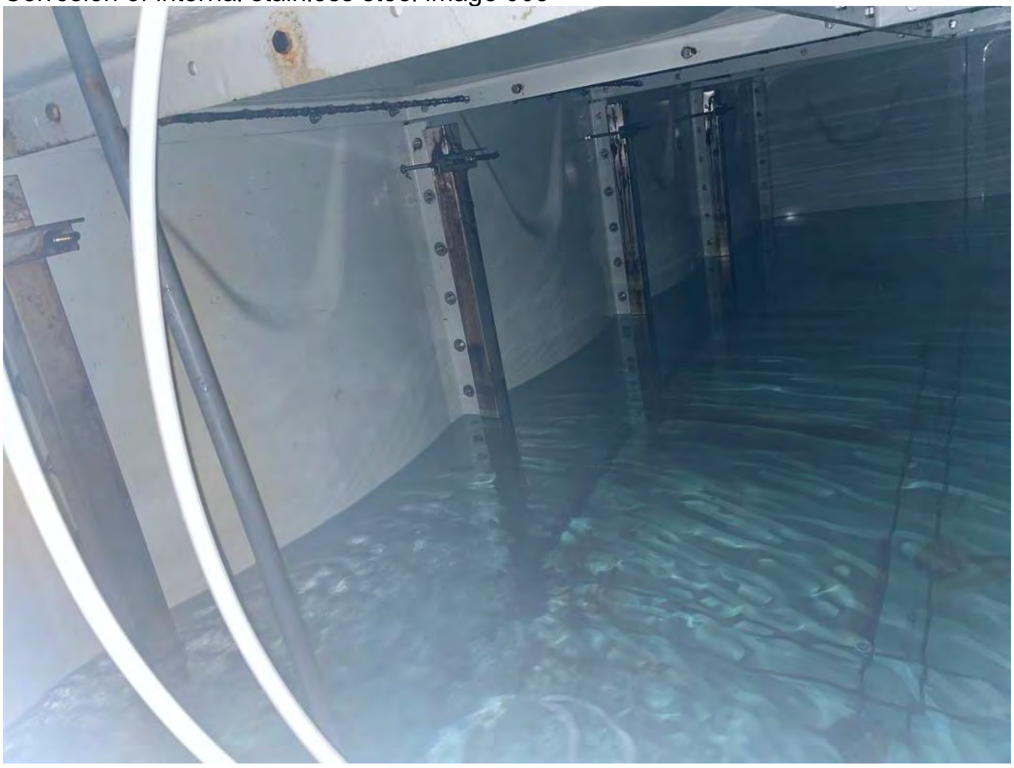
Tank Report/Investigation

Corrosion of internal stainless steel image 003



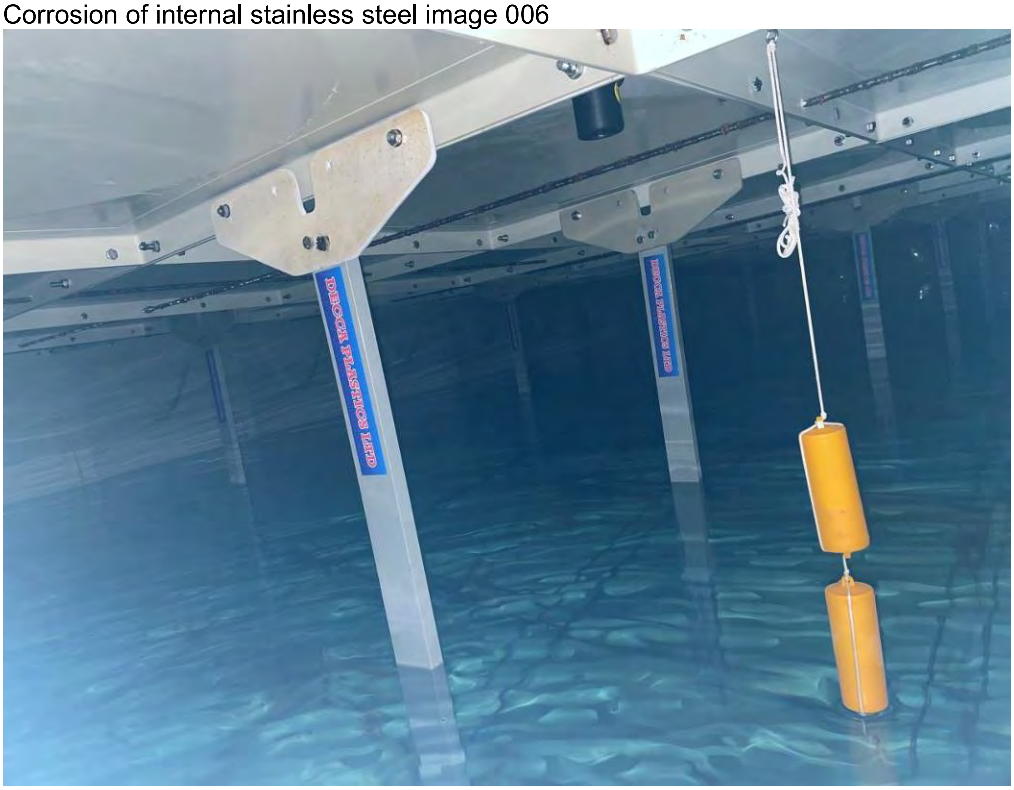
Corrosion of internal stainless steel image 004

NICHOLSON PLASTICS LTD

Tank Report/Investigation

Corrosion of internal stainless steel image 005

Corrosion of internal stainless steel image 006



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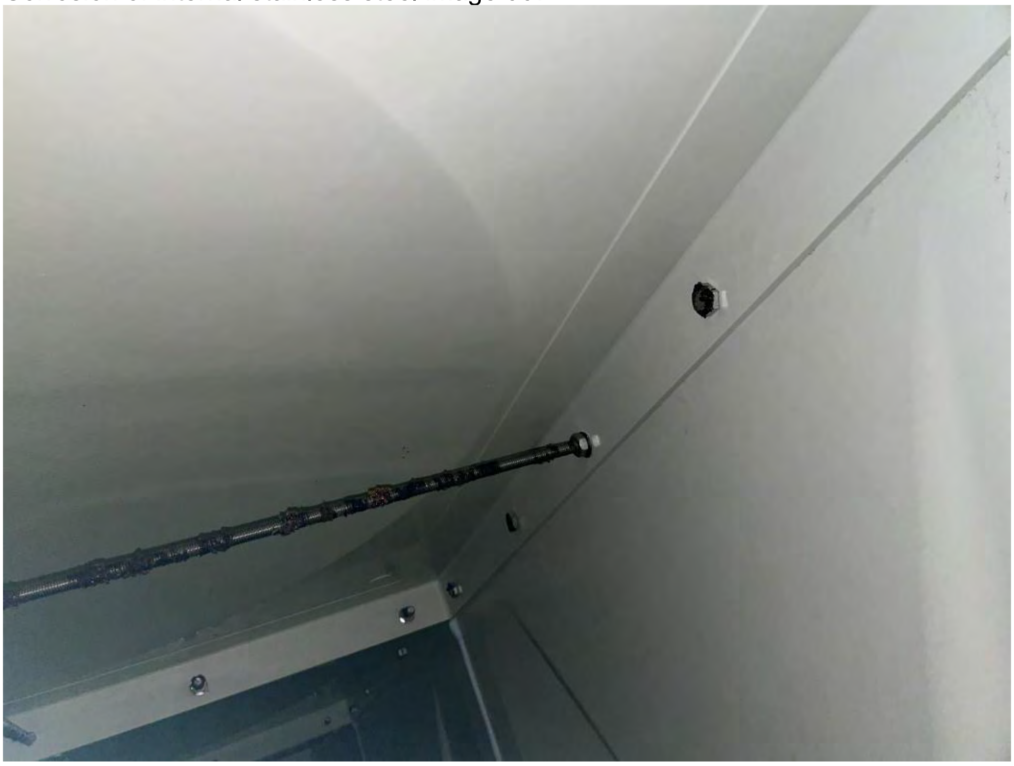
Tank Report/Investigation

Corrosion of internal stainless steel image 007



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Tank Report/Investigation

Corrosion of internal stainless steel fastener image 008

Corrosion of internal stainless steel fastener image 009

Tank Report/Investigation

A2 (1.4301) stainless steel grade stamp internally image 010

A2 (1.4301) stainless steel grade stamp internally image 011

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Tank Report/Investigation

A2 (1.4301) stainless steel grade stamp internally image 012

A2 (1.4301) stainless steel grade stamp externally image 013

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Tank Report/Investigation

A2 (1.4301) stainless steel grade stamp externally image 014

Tank Report/Investigation

Corrosion at inlet valve and surrounding stainless steel components image 015

Corrosion at inlet valve and surrounding stainless steel components image 016

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Tank Report/Investigation

Corrosion at inlet valve and surrounding stainless steel components image 017

Tank Report/Investigation

Air intake vent with screened mesh greater than 0.65mm image 018

Air intake vent with screened mesh greater than 0.65mm image 019

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Tank Report/Investigation

Misaligned poorly formed cover lid panels allowing debris to enter tank image 020

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Tank Report/Investigation

Summary Conclusion
As time passes the fasteners & more importantly retaining tie bars will weaken through further corrosion which will result in further contamination, potential weaknesses within the integrity of the seals on the tank panels as forces are lessened and may result in leaks and potentially catastrophic failure.

Sample steel components could be removed from the tank and sent for analysis for avoidance of doubt that the steel provided has not been a sub-standard batch rather than non-compliant.

As a hospital project the design parameters would be to SHTM/HTM 04-01 which within its section Construction of Cisterns clause 7.25 states "All storage cisterns should be constructed in accordance with manufacturers recommendations and should comply with Water Supply (Water Fittings) Regulations 1999, be WRAS-approved, and comply with BS6700: 1997. Glass reinforced plastic (GRP) tanks should comply with BS EN 13280:2001." It is stated within this latter document BS EN 13280:2001 section 6.10 Fasteners: "Fasteners used inside a cistern or tank shall be made from stainless steel in accordance with grade 1.4401 in EN 10088-3:1995" and also " section 6.11 Bracing system "Internal metallic bracing system members shall be manufactured from stainless steel in accordance with grade 1.4401". In this installation this is not the case.
References to stainless steel grades can be taken as follows with equivalents naming conventions
1.4401 also known as A4 stainless and 316 stainless
1.4301 also known as A2 stainless and 304 stainless.
The importance of the use of the correct compliant grade of stainless steel cannot be understated particularly when coming into contact with levels of free chlorine no matter how diluted.

Notes
It is assumed that the tanks should be installed to the legislation which was in place at the time of the project. This we have seen at the time of tender which indeed refers:
- SHTM/HTM 04-01
- BS EN 13280:2001
- WRAS compliance
- BS6700: 1997

Images in document have been compressed to reduce file size. Full HD files are retained & available for use with improved clarity.

Steven Dempster - Managing Director
[redacted]

WPS
Water & Pipeline Services Ltd

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FK2 7UY
Tel: 01324 611353

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To whom it may concern

Scottish Water Bylaw Inspection Rectification works at Queen Elizabeth University Hospital, Maternity at Hardgate Road Glasgow.

1.The emergency fire hydrant fill point must be installed above ground level and be in a lockable box.

Actions

Below ground pipework altered and moved to an above ground position in a kiosk.

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Installed in a kiosk

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FK2 7UY
Tel: 01324 611353

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2.Original double check valve at the mains inlet must be checked to confirm if working or replaced with new valves.

Actions

Replaced existing dcv in meter housing with new dcv.

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Both of these rectifications were completed by Friday 14th of June 2019.

Signed

John Graham

Director

Water and Pipeline Services

CAPITA SYMONDS

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

NEC 3 SUPERVISORS REPORT NO. 10

MARCH 2011

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**

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NEW SOUTH GLASGOW HOSPITAL LABOROTORIES

1.0 EXECUTIVE SUMMARY

Visits to the site during March indicate that the construction and procedures are progressing in a satisfactory manner in accordance with the Project Executive Plan.

We continue to monitor the construction drawings and specifications for compliance with the Contract Documentation in conjunction with our visual site inspections. Throughout, the standard of workmanship and quality is generally good and operations are being carried out in an acceptable manner with due regard to health and safety issues

Site visits and visual inspections have again continued during the period together with ad hoc meetings and discussions with the site teams. Information regarding drawings, quality issues and other technical matters has been supplied when requested generally via 'Aconex'.

A meeting was held with the QA Manager who explained and answered questions on the Contractor's Quality Assurance System. The system is based on a previously model and is appropriate for managing a project of this nature. However Brookfield is currently reviewing their Test and Inspection Plan to record the interface between construction packages. We will continue to monitor their procedures.

Structural steelwork is practically complete at roof level, as is the connecting structural steelwork between the pod and the laboratories. The walkway link bridge structural steelwork between the building wings has also now been erected. Blockwork is progressing and the works in general appear to be progressing in accordance with the Client's requirements.

Sub-station works have progressed out of the ground in the period with several concrete walls now cast.

Energy centre piling has been completed and foundation works have commenced.

Towards the end of the period piling commenced to the main hospital works in area K with Skanska/Cementation as piling sub-contractor.

The guarantee/warranty on the 'Caltite' concrete will be made available when the tunnel areas have been allowed to dry out and then a check will be made to determine if any remedial works are required.

The insulation to the Sto system has commenced, internal stud partitions continue to be erected and the Permaquik to the flat roof is progressing. The fitting of the external cladding is also progressing together with the installation of windows.

We were in attendance initially when the Integrity Tests were carried out on part of the roof and were satisfied with the procedures. We have had discussions with the Radmat representative, Brookfield Multplex and Prator on site concerning minor repairs cared out. The Radmat representative confirmed that he was satisfied with the method of repairs being carried out and we await a copy of the Integrity Tests.

In general all mechanical services first fix are well progressed and the standard is of a high quality. Protection of open ends of pipes and ductwork is being provided throughout the site.

Electrical works are well in hand on all levels, and being carried out to the same high standard as the mechanical systems. Cabling is being installed within the containment on throughout the floors and again is being carried out to a high standard. Extensive data cabling has now been installed on cable tray. Caution needs to be maintained where the cabling leaves the cable tray that damage does not occur on the cable until final connections have been made.

Overall the installation and co-ordination of services appear to be well organised.

Supervisor's Communication General Matters / Other Instructions (CI 13.1) No's 19, 20, 21 and 22 were issued to Brookfield during February. These included excessive joints at splayed corners of the Fermacell boards, damage to partition lintels and the use of thin infill pieces of boarding on the face of the partition at the corner of the window reveals. We also made a request for window manufacturers fixing details and surface rust on the steel plates fixed to the window openings in the stairwells in the west wing.

We have inspected the installation of the angle pieces to the unfixed section of boarding in the West Wing Level 1 Areas 1 and 2 as they were installed. We can confirm that they are being installed in Accordance with the Knauf detail.

Acoustic testing programme for all partitions in accordance with Section 7 of Health Technical Memorandum 08-01 is currently under review by Brookfield.

We continue to have discussions with Brookfield and are being assisted by the site teams in resolving various construction, mechanical, electrical, and quality issues which have been raised following our visits.

2.0 DESIGN COMPLIANCE CHECK

The drawing and specification information issued on Aconex indicates that the design is in accordance with the Project Executive Plan.

Drawing and Construction information continues to be provided by Brookfield.

3.0 PROCEDURES REVIEW

3.1 Performance

Workmanship generally again appears to be to a good standard.

Photographs included in the appendices illustrate works progress during the period.

Much information has been provided in relation to the Labs but information requested and still outstanding include:

- Caltite waterproofing - copy of guarantees/warranty when available
- Proprietary tunnel roof waterproofing details.
- Cube results from the w/c 21/02/2011 are awaited.
- Proposals for remedial work to steelwork surface finishes.
- Proposals for remedial repair to surface area of concrete on the second floor.

Adult and Children's Hospital

- Feedback on comments concerning Structural Design Philosophy at Appendix K stage.
- Pile test results for Energy Centre.
- Concrete cube results for the substation.
- Copy of building warrant for the main adult hospital.

3.2 Quality Assurance Procedures

Brookfield and their subcontractors have continued with their QA and checking procedures during the period.

A meeting was held with the QA Manager who explained and answered questions on their Contractor's Quality Assurance System. The system is based on a previously model and is appropriate for managing a project of this nature.

We also reviewed both Brookfield's Sub-Contractors Inspection and Test Plans and Quality Inspection Sheets copies of which are shown in Appendix 1. Brookfield is currently reviewing their Test and Inspection Plan to record the interface between construction packages.

3.3 Early Warning

Currently nothing to report.

3.4 Trust Equipment Installation, Testing and Commissioning

We have received Astins Test and Inspection Plan and QA check sheets and we shall continue to inspect their sheets. (Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 3 is closed out).

We await Brookfield's acoustic testing programme for all partitions in accordance with Section 7 of Health Technical Memorandum 08-01: Acoustics. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 4).

4.0 CONSTRUCTION REVIEW

4.1 Visits to the Works

Site inspections were carried out by the NEC 3 Supervisor on the 1st, 2nd , 3rd, 4th, 7th, 8th, 9th, 10th, 11th, 14th, 15th, 16th, 18th, 22nd, 24th, 25th 28th , 29th , 30th and 31st March 2011.

4.2 Elements of the Works available for inspection.

- Steelwork erection to roof areas, connecting steelwork between 'pod' and the main building and link bridge structural steelwork.
- Adult Hospital: piling matt placed and piling plant established.
- Linhouse Burn Diversion.
- Grouting up to steel column bases remains ongoing.
- Blockwork erection to the ground floor.
- Partitions.

- Metal Stud Infill's for External Insulated Render System.
- Permaquik application to flat roofs.
- Cladding.
- Window installation.
- Ductwork.
- Pipework Distribution.
- Piling Mat and Operations (ACH – Energy Centre).
- Reinforcing and Concreting (ACH – substation).

4.3 **Observations from March 2011 inspections.**

The visual inspections of the work packages carried out to date indicate that the works are being carried out to a satisfactory standard. Listed below are observations in relation to site visits in March.

4.3.1 Floor Slabs

Information has been made available regarding the cracks in certain concrete slab soffits and, with all props now removed, a plan provided showing the actual crack widths at the various locations. All of these are reported as being within the acceptable serviceability limit, and all are within the building in unexposed locations. Of the areas affected only that at the water tank area will have the concrete soffit visible.

We shall inspect the remedial work to the irregularity / 'laitance bossing' on the concrete slab on the second floor when it is complete. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 11 is closed out. However we are awaiting remedial proposals from Brookfield.

The guarantee/warranty on the 'Caltite' concrete will be made available when the tunnel areas have been allowed to dry out and a check made if any remedial works are required. This is anticipated in the next two months.

4.3.2 Steelwork

Structural steelwork is practically complete at roof level, as is the connecting structural steelwork between the pod and the laboratories. The walkway link bridge structural steelwork between the building wings has also now been erected.

Remedial action to the west wing roof steelwork surface finish has been ongoing during the period. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 2).

The broken handrail post in Area 5 has been satisfactorily repaired and we have carried out an inspection. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 18 is closed out.

Brookfield has confirmed that they have asked the Architect to advise on a solution for the potential health and safety issue at the access ladders raised in the last report.

Brookfield has confirmed that they are treating the rust areas to the external parapet steelwork at roof level on the east wing.

The steel plates fixed to the window openings in the stairwells in the west wing have surface rust. Confirm the proposed treatment of the steel and time sequence for carrying out the treatment. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 22).

4.3.3 Blockwork

Blockwork has continued in several areas during the period at ground floor level. The works in general appear to be progressing in accordance with the Client's requirements and with due regard to health and safety issues and to a good standard of workmanship.

There are other areas where lintels require to be built into the blockwork and due attention has been paid to the provision of lintels at appropriate locations where required.

Brookfield confirmed that they would determine the extent of service penetrations before placing lintels. We shall continue to monitor this work. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 15).

4.3.4 Partitions

We have reviewed the Fire Resistance Performance Report for the Fermacell Partitions Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 3d is closed out.

The moisture content of the Fermacell boarding and timber head pieces affected by water ingress is being monitored. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 7).

The internal wall lining located on Level 1, Areas 1 and 2 on the west elevation of the west wing does not have screw fixings to the boarding between the ducting and the underside of the concrete soffit (approximately 500mm). Knauf has provided a detail showing an angle piece fixed to the underside of the soffit and this was being fixed during a recent inspection. We shall continue to monitor this work. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 12)

We noted that the joint at the corner of the partition on Level 1 Area 4 has a filler which exceeds Fermacells recommended specification for joint filler for corners which is generally is 5-7mm. Brookfield has confirmed that a remedy was discussed with Fermacell and it was recommended that the joint is scratched back and an angle corner bead to be applied. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 19)

There are damaged lintels on the partitions located at doors D0/B/002, D0/B001 and D0/B033. Brookfield confirmed that areas like this are to be replaced at the 2nd fix. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 20)

We noted that a few windows on the west elevation of the west wing on level 1 have had the sheets cut short around the windows. Consequently the existing detail around the corner of the window reveals and the faces of the boarding have infill pieces. This does not comply with BS 8000-8:1994 Code of practice for plasterboard and is likely to cause cracking around the windows. Brookfield has confirmed that the boards around the window openings will be replaced. We shall continue to monitor the proposed remedial work. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 21).

4.3.5 Insulated Render System

The metal stud framing is progressing with insulation being fitted on the West Wing.

4.3.6 Sub-station

Sub-station works have progressed out of the ground in the period with several concrete walls now cast.

The reinforcement congestion in the foundations does not appear to be reflected in the wall reinforcement and these areas have progressed satisfactorily. Concrete cube results awaited.

4.3.7 Energy Centre

Energy centre piling has been completed and foundation works have commenced.

Piling was completed in the period and records and test results are awaited. Excavation and casting of foundations has commenced. Cage reinforcement has been used generally in this respect and no congestion issues have been apparent. To date no water ingress issues have arisen at this part of the site.

4.3.8 Temporary Road/Linhouse Burn Diversion

The temporary road works to facilitate the construction of the Linthouse Burn Diversion were completed during the period and this appears of good quality and appropriate for its function, and it appears to be dealing adequately with the present traffic flows.

The permanent works to this element of the project commenced during the period and appears to be progressing in accordance with the Client's requirements.

4.3.9 Flat Roof

Electronic roof integrity tests commenced on Monday 28th March and we witnessed part of the tests. We had discussions on site with the Radmat representative, Brookfield Multiplex and Prator concerning the appropriate repairs to indented areas. The Radmat representative was satisfied with the minor repair carried out. We await a copy of the report Integrity Test Report certifying the waterproof integrity of the roof. (See Supervisors tests and Inspections)

4.3.10 Windows

We have requested the window manufacturers fixing details for the windows on the east and west elevations Areas 1 and 2. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 21A has been issued.

4.3.11 Mechanical

Pipework

Installation of hot, cold, heating and chilled water pipework on all levels is progressing, and generally being installed to a good standard. A few open ends were still being left for extended periods. Brookfield to again be reminded to seal ends against ingress of dirt.

Initial hydraulic testing of installed pipework on some floors has been carried out, with final hydraulic tests being made available for witnessing in the coming weeks

Ventilation

The installation of ventilation ductwork was progressing well and being installed to a high standard. There are inconsistencies with the number and location of access doors being installed. We shall raise a Supervisor's Communication General Matters / Other Instructions (CI 13.1) in relation to this issue.

The problem with the ends of ducts being left uncovered has been addressed.

Brookfield to address the support arrangements in a limited number of areas where the spacing is out with the specified requirements and where two ducts are in contact with the building structure or adjacent services.

Insulation

Insulation to pipework and ducting has been damaged during the construction process in a limited number of areas and requires to be repaired / replaced.

Plant

One of the Chilled beams has sustained physical damage and should be replaced. We shall raise a Supervisor's Communication General Matters / Other Instructions (CI 13.1) in relation to this issue.

Brookfield has provided manufacturers QA in relation to the hydraulic testing of the pre-insulated pipework and we are currently reviewing this information (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 6).

Brookfield has provided thermal expansion calculations consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 6) is closed out.

4.3.12 Electrical

Trunking.

Trunking is progressing on all levels, sufficient to allow some cabling to be installed. The standard is good and installation of high quality.

Cable Tray.

Extensive cable tray is now well advanced on site to a high standard and level.

Conduit.

Solid conduit is being used at high level with flexible metal conduit in partition walls. Both installations are of a good standard and being well fitted.

Cabling.

Some circuit wiring is already being drawn into containment and down to final connection points. Work standard is good.
Fire Alarm.

First fix of fire alarm wiring is well under way and being installed to a high standard.

Data Cabling.

Extensive data cabling has been installed and run on all of levels. Care needs to be maintained to protect the cabling as it runs off, and through the cable tray supporting the cabling.

4.3.13 Fire Batts

Brookfield is in the process of fitting fire collar to the fire batts which had been previously saturated with rainwater. We inspected the work in progress with Brookfield’s representative and the work is being carried out in accordance with the detail. Consequently this Supervisor’s Communication General Matters / Other Instructions (CI 13.1) No 10 is closed out.

4.3.14 Cladding

Brookfield has confirmed that the basis of the curtain walling design is that the vertical dead load from the panels is supported by their top brackets only. The lower brackets are for wind suction only. Brookfield has also provided us with a drawing showing this information. Consequently Supervisor’s Communication General Matters / Other Instructions (CI 13.1) No 17 is closed out.

4.3.15 Acute Hospital

Towards the end of the period piling commenced to the main hospital works in area K with Skanska/Cementation as piling sub-contractor. These works appear generally to be progressing in accordance with the Client’s requirements and with due regard to quality.

Meetings have been held with Brookfield piling/geotechnical engineer with a discussion of subcontractor Skanska/Cementation methodology and QA procedures. These all appear to be satisfactory.

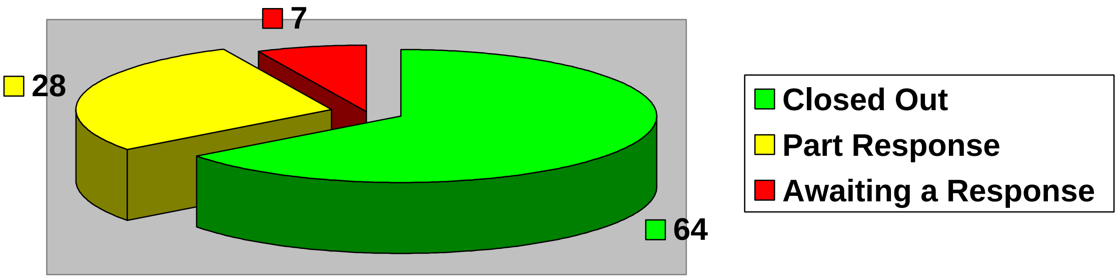
4.3.16 Linthouse Burn Diversion

The permanent works to this element of the project commenced during the period and appears to be progressing in accordance with the Client’s requirements.

4.4 Non Conformance Reports

One non conformance report has been issued by Brookfield in relation to drainage at the west wing.

5.0 INFORMATION REQUIRED



NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**

Item No.	Description	Date Requested	Comment	
01	We have requested the following information:	14.06.10		
01a	Dunne PEP or equivalent.		Closed out.	
01b	Current civil and structural drawings.		Closed out.	
01c	URS specification. Pile integrity and load test results.		Closed Out.	
01d	Cube results to date.		Ongoing	
01e	Caltite waterproofing additive details (and copy of guarantees).		Awaiting copy of guarantees.	
01f	Proprietary tunnel roof waterproofing details.		Details awaited.	
02	We have requested the following information:	25.11.10		
02a	Confirm when remedial measures will be undertaken to address the poor rust patches in the structural steel and notify us when the work is complete to allow us to carry out an inspection.		Brookfield confirmed remedial action to be undertaken. Awaiting notification that work is complete.	
02b	Confirm the approved remedial action to ensuring that there is a continuous DPM in accordance with the drawing.		Closed out.	
02c	Provide the QA Inspection and Test Plan for signing off the completion of the work prior to the commencement of the structural copper cladding.		To be reviewed at audit.	
03a	Provide full test results to BS 5234 for strength and stability for all partition types including impact damage and door slam tests for all door opening situations.	03.12.10	Closed out.	
03b	Please provide your written method statement/QA describing the erection procedures together with details of the quality checking and recording systems being implemented to ensure correct construction of partitions and correct location of partition types.		Information Provided. Closed out.	
03c	Confirm if timber inserts are being fitted within the horizontal section of partition forming the door opening to provide strength and robustness.		Confirmation received from Brookfield. Closed out.	
03d	Provide test results/certificates to BS 476 for all fire resistant partitions		Closed out.	

04a	There are gaps between the boarding at a few locations on Level 1 about 5mm wide. We are seeking confirmation if these gaps can be filled and that there will be no risk of cracks occurring in the future especially above door openings	03.12.10	Response received. Closed out.	
04b	Please confirm your acoustic testing programme for all partitions in accordance with Section 7 of Health Technical Memorandum 08-01: Acoustics.		Brookfield has this under review. Awaiting acoustic test programme.	
05	The boarding to the partition around the doors leading into the Genetic Freezer Store and the Block Slide Store on Level 2 has been exposed to water ingress. Please confirm when these are replaced to allow us to carry out an inspection.	21.12.10	Fermacell confirmed that boards will dry out. Closed out.	
06a	Check ends of pre-installed pipes and ducts are covered to prevent contamination.	06.01.11	Closed out.	
06b	Check to ensure that pre insulated pipe and ducting is affected by water ingress on level 2 is completely dry. Insulation to be removed and replace if required.		Closed out.	
06c	Access hatches for dampers etc on ventilation systems require to be positioned to allow adequate access to the item being serviced. Check existing installed hatches and future installed locations.		Closed out.	
06d	Fire dampers to be supported independent of the ducting		Closed out.	
06e	Confirm the strategy for hydraulic testing of the pre-insulated pipework. In the event of failure how is the actual point of failure indentified if covered by insulation.		Information received and under review.	
06f	Confirm the strategy for thermal expansion within the pipework systems.		Closed out.	
07	Confirm if Fermacell boarding, timber head piece and timber door frame affected by water ingress require to be replaced or provide evidence that the moisture contents in the timbers does not exceed the recommended moisture content.	07.01.11	Being monitored by Astins	
08	Please confirm when an electronic roof integrity test will be carried out to the Permaquik system prior to the application of any insulation or covering materials to the roof area.	13.01.11	Brookfield confirmed that 24hr notice would be given.	
09a	Fermacell Boarding adjacent to door D/2/B072 on Level 2 are not flush. Confirm remedial action.	14.01.11	Closed out.	
09b	The Fermacell Boarding at the window opening S/2/021 City Analysis 2 on Level 2 has not been fitted properly.		Remedial work as Fermacell Report. Closed out.	
09c	Boarding not fitted properly at window opening S/2/021 City Analysis 2.		Remedial work as Fermacell Report. Closed out.	
09d	Damaged header at door opening at B/2/B086.		To be replaced at 2nd fix	

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10	Fire batts around internal rainwater pipes in the west wing have been saturated with rainwater. Confirm when we can inspect the completed fire collars.	14.01.11	Detail of fire batt providided. Inspection carried out.	
11	The surface of the concrete floor is boss (spalling) on Level 2 Sequencing Lab L2/B/028. Investigate the extent and confirm when the appropriate remedial measures have been completed.	09.02.11	Repair to be carried out. See Inspection list	
12	The internal independent wall lining located on Level 1, Areas 1 and 2 on the west elevation of the west wing does not have screw fixings to the boarding from the underside of the ducting to the top of the partition (approximately 500mm). Confirm measures to ensure the boarding is fixed at the appropriate centers and provide notification to allow the partitions to be inspected	14.02.11	Response received. Being reviewed.	
13	Unsecured bolt confirm when this has been remedied so that an inspection can be carried out.	18.02.11	Brookfield confirmed bolt secured. Confirmed by inspections.	
14	There is restricted access to the upper section of some of the partitions in a number of locations throughout the site especially in corridors. Confirm that the boarding can be fitted in these locations in accordance with Fermacell's specifications. We are aware that in some locations the partitions are to be in shatfwall.	18.02.11	Shaftwall being used. Closed out.	
15	A lintel requires to be installed in the blockwork wall on the ground floor Area 4/5. There are also other openings elsewhere on the ground floor which require lintels. Confirm when these are complete so that an inspection can be carried out.	18.02.11	Extent of services to be ascertained before placing lintels in position.	
16	Attention should be given to the detailing of the reinforcing and pre fixing system which should be to the same standard as the Laboratory	18.02.11	Adjustments made to detailing.	
17	Lower Anchors on the panels fitted do not appear to be fit into the brackets properly. Confirm if the distribution of the load from the panels are equally taken by the upper and lower brackets/anchors. Provide a specification relating to drawing SUK-LAB-XX-DT-251-GA 020 and the numbered items on the drawing.	28.02.11	Briefed by Brookfield. Drawings to be provided.	
18	Handrail post to the feature in Area 5 is broken. Confirm when this will be repaired/replaced.	28.02.11	Closed out.	
19	The joint at the corner of the partition on Level 1 Area x has filler which exceeds Fermacells recommended specification for joint filler for corners which is generally is 5-7mm.	28.02.11	Remedy work in progress.	
20	There are damaged lintels on the partitions located at doors D0/B/002, D0/B001 and D0/B033.	04.03.11	Areas like this to be replaced at 2nd fix.	
21	Boarding has infill pieces. This does not comply with **B**S 8000-8:1994 Code of practice for plasterboard partitions and dry linings,	22.03.11	Awaiting Response.	
21A	Please provide the window manufacturers fixing details for the windows on the east and west elevations Areas 1 and 2	08.03.11	Awaiting Response.	
22	Rust affecting the steel plates in the stairwells in the west wing.	22.03.11	Awaiting Response.	

6.0 SUPERVISORS TESTS AND INSPECTIONS

Tests not required	N/A
Tests required but not tested	**Req**
Tests required which has passed tests	Pass

Tests				
Ref	**Title**	**To be Notified by**	**Status**	**Test Date**
1.	Flat Roof Integrity Test	Brookfield	**Req**	

Inspection not required	N/A
Inspection required	**Req**
Inspection complete	Pass

Inspections				
Ref	**Title**	**To be Notified by**	**Status**	**Inspection Date**
1.	Replace fire batts west wing	Brookfield	**Req**	
2.	Level 2 room L2/B/028 spalling concrete	Brookfield	**Req**	
3.	Special fixing of K nauf boarding internal wall lining located on Level 1, Areas 1 and 2	Brookfield	Req	

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**

John Redmond
Capita Symonds
Technical Advisory Services

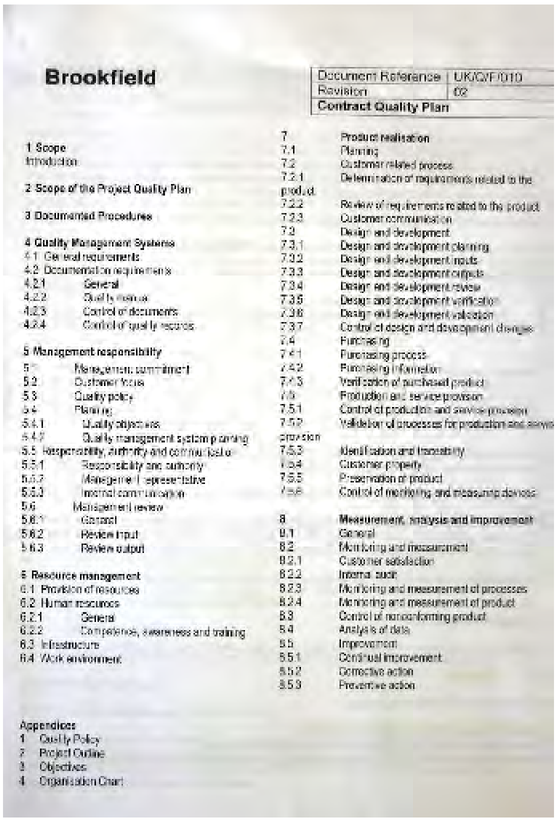
Skypark SP1, 8 Elliot Place, Glasgow, G3 8EP

	Signed	Date
Originated by	John Redmond	04 April 2011
Checked by	David Ramsay	04 April 2011

APPENDIX 1 Photographs

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**



Brookfield

Document Reference	UK/Q/F/010
Revision	02
Contract Quality Plan	

1. Brookfield's Contract Quality Plan.

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**

ASTINS LTD
INSPECTION AND TEST PLAN

astins

Inspection & Test Plan N°: AST-LB-XX-DC-252-005

Revision: P 03

PROJECT: New South Glasgow Hospital Laboratory

PROJECT N°: C 214

WORK ITEM: Plasterboard Drylinings/Partitions

LOCATION: Hospital Laboratory Building

SUB-CONTRACTOR: ASTINS LIMITED

INSPECTION AND TEST PLAN

REV	AMENDMENT	ORIGINAL	DATE	APPROVED	DATE
P 01	1st Issue	Ian Russell	26/11/2010		
P 02	2nd Issue K10 J - Plasterboard Drylining / Partitions NBS Specification 02/12/10	Jim Flynn	07/12/2010		
P 03	Handover ITP/AST/F/32	Ian Russell	12/01/2011		

AMENDMENT RECORD

LEGEND:

Inspection Authorities:

Architect	BMJ
Fermacell	FC
Building Control	BC
Brookfield	BF
Astins Ltd	AST

Inspection Code:

Hold Point	H
Notification Point	N
First Time Only	X
Approval Required	A
Information Only	I
Random 10% Inspection R10	
Random 20% Inspection R20	
Surveillance	S

2. Astins Ltd Inspection and Test Plan.

Level 1 Sheet 3 of 4

astins

QUALITY INSPECTION REPORT - 1st FIX

ASTINS LTD

Contract No: C214

Date: 9/02/11

1. Tick each box if works satisfactory
2. Sign & date room by room
3. If item is unsatisfactory, mark with X
4. Upon returning to office fill in ONE NUMBER non conformance sheet (ITP/AST/CA11) for each item
5. Highlight Drawings

No	Rm no	SETOUT Setting Out	FIRST FIX Wall type	Defl. Head	Junct. Details	Cupboard openings	Door Openings	Sliding Door	Services framed	Wall plumb/true	Comment	Astins Signed & Date	MC Signed & Date
1	[illegible]	[illegible]	[illegible]	[illegible]	✓	N/A	[illegible]	N/A		[illegible]			
2	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
3	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
4	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
5	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]		[redacted]	
6	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
7	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
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10	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
11	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
12	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
13	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
14	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
15	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
16	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
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18	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
19	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
20	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
21	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]	[redacted]		
22	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
23	[illegible]	[illegible]	[illegible]	[illegible]	✓		[illegible]			[illegible]			
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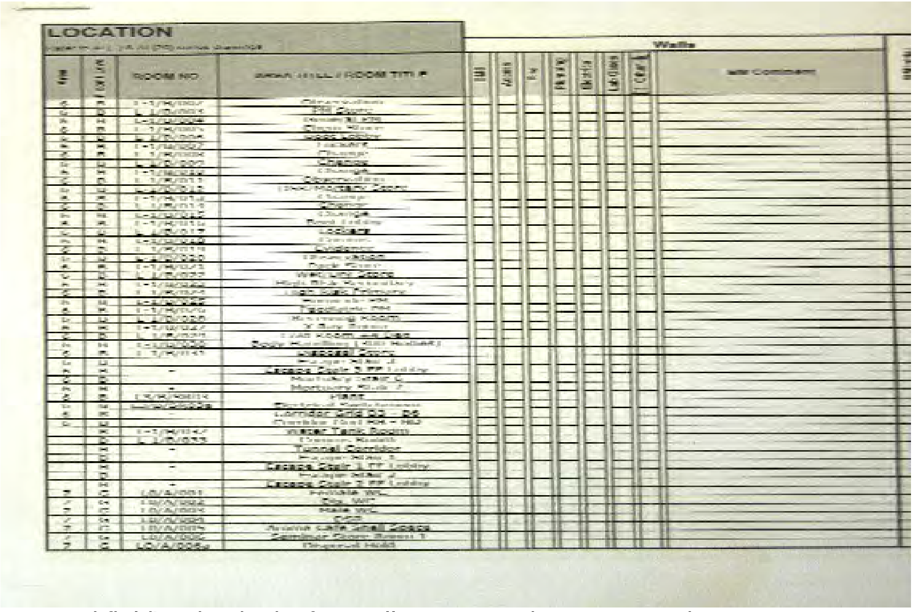
3. Astins Quality Inspection Report.

NEW SOUTH GLASGOW HOSPITAL LABORATORIES

SUPERVISOR'S REPORT NO. 10 **MARCH 2011**


LOCATION

ROOM NO

Walls

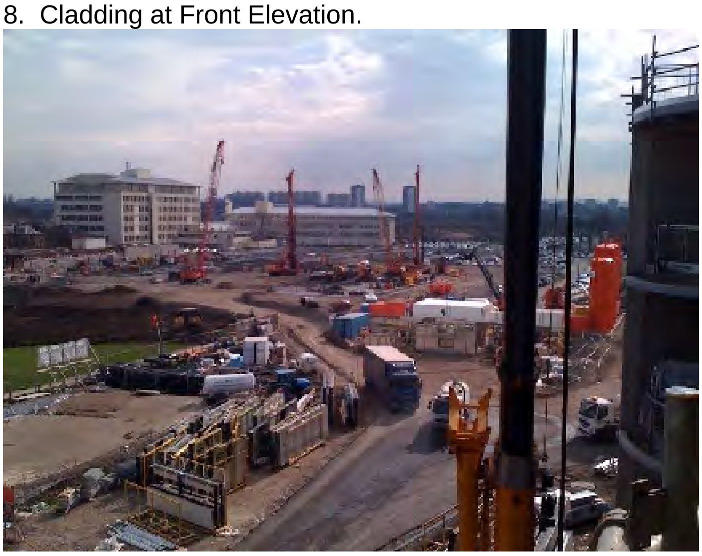
4. Brookfield's Check List for Walls on Room by Room Basis.

5. Insert pieces of boarding used as infills around the window reveals 23rd March 2011.

6. Example of Shaftwall installation.

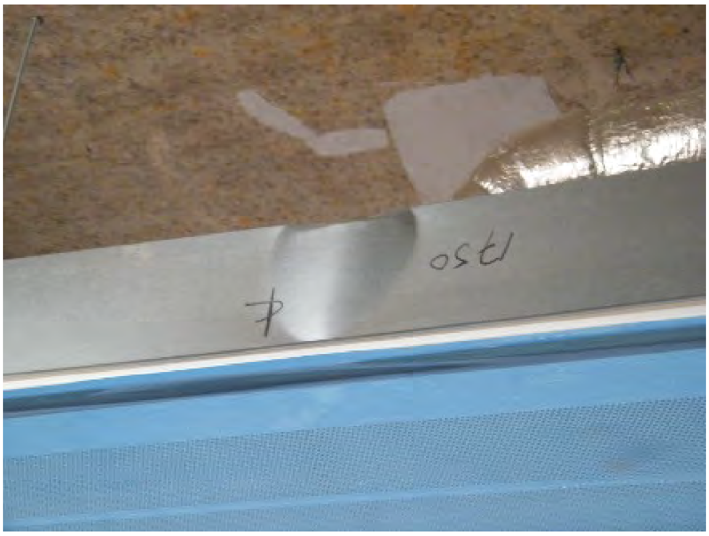
7. Rust on Steel Plate.

8. Cladding at Front Elevation.



9. Piling Plant.

10. Typical Access Door Problem. March 2011.



11. Damaged Chilled Beam Unit. March 2011.

CAPITA SYMONDS

NEW SOUTH GLASGOW HOSPITAL

ADULT AND CHILDREN'S HOSPITAL AND THE ENERGY CENTRE

NEC 3 SUPERVISORS REPORT NO. 30

SEPTEMBER 2013

SUPERVISOR'S REPORT NO. 30 SEPTEMBER 2013

CONTENTS

NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

SUPERVISOR'S REPORT NO. 30 SEPTEMBER 2013

1.0 EXECUTIVE SUMMARY: ADULT & CHILDREN'S HOSPITAL

Visits to the site during September 2013 continue to indicate that the construction and procedures are progressing in a satisfactory manner in accordance with the Employer's Requirements.

Throughout, the standard and quality of the workmanship is generally good and operations are being carried out in an acceptable manner.

Following our identification that smoke detectors had been sited to close to air supply grills in some locations by quality and compliance inspections last month we carried out inspections in Zone H, 1-529 and 1-530. We have raised a Supervisor's Communication highlighting the close proximity of smoke detector in relation to chilled beams throughout Zone H, 1-529 and 1-530. We have also asked if Scotshield will be continuing with their surveys and repositioning smoke detectors to their recommended distance of approximately > 950mm away from ceiling grilles.

Brookfield continues to undertake their Quality Assurance systems on site with inspection and checklist documentation available for the ongoing construction activities. Over the period, we have closely liaised with Brookfield and witnessed 85 point check to the partitions on Level 4 Zone E 4-143, Level 0 Area 1-515. The partitions were constructed in accordance with the specifications. However on Level 4 Zone E 4-143 there is a small step between the concrete upstand and the Unitised Panel which was filled with sealant. Brookfield is seeking advice in relation to this detail. An 85 point check was also carried out on Level 1 Area 1-506 and was constructed in accordance with the specification.

Civil and structural works continue to be to a generally high quality standard.

Piling as built drawings are still to be inserted on Zutec.

In the car park test results for the piling have now been received and these appear to be satisfactory. Foundation works are nearing completion and quality to date has been to an acceptable standard. Drainage, sub-base and tarmac have been placed to a significant area of the ground floor and quality here is also satisfactory. The 1st floor slab and part of the 2nd floor have been poured and post tensioning applied. Brookfield quality checks on this appear sound and the floor finish achieved appears to be satisfactory.

All pods to the Atrium Bridge have now been positioned and additional deflection checks to date have been further examined in respect of datum issues by the Brookfield team. Proposals in respect of final screeding and floor finish levels are still awaited.

Final elements of steelwork erection have continued to the roof of the Children's Hospital in Zones A and B. Communications have been raised with Brookfield and are listed on the following pages. These still remain outstanding and have been examined with Brookfield who will ensure that they are addressed at the appropriate time.

Steelwork erection has also continued on the roof of the ACH and now extends to all 4 arms. Some communications raised in respect of this steelwork are still being addressed. In addition steelwork erection is proceeding on the helipad structure, and queries have been raised in respect of some handling damage to the galvanised finish and how this will be addressed. A similar query has been raised re some, albeit limited, damage to paintwork finish to the main atrium roof steelwork (white).

The steel structures for the bridge link to the existing neuro-building have been assembled in sections on site in preparation for single day lifting into position. A query has been raised re the single column moment connection to the bridge structure.

The sample AHU21 in plant room PR21 was inspected and comments provided for action by Mercury. It was agreed that this unit will form the standard for all other AHU's, therefore any issues are to be fully closed out to ensure quality installation. We still await a response from Brookfield to allow close out of remaining issues. It should be noted however, that some items will only be closed out once full commissioning has been undertaken.

The M&E installation quality is being maintained to a good standard and we are generally satisfied that the installation is compliant with exception of the specific items raised under communication.

The M&E installations are progressing on all levels up to Level 12 and range from first fix module installation to completed and tested areas. Major works are now well underway within levels 2, 3 & 4 plantrooms.

The installations in the Energy Centre are well advanced with the advanced A-side systems commissioned and handed over. Commissioning programmes for the B Side have been presented and significant commissioning has been taking place from June and will continue through to December 2013.

Various witnessing of commissioning activities has been carried including air flow tests, duct pressure tests, gas soundness tests, electrical testing, oil line pressure tests, smoke damper tests, and fire alarm loops tests. All with the exception of one smoke damper test were tested satisfactory.

We are continuing to work with Brookfield during our inspections highlighting any items that have raised concern. Items identified in this manner are generally being addressed by the site team in advance of any defect notice being raised.

In general terms we are satisfied that the installations continue to be installed to a compliant standard, and are of a good quality. However we have noted that certain items this month have raised concern. These have been raised with the Contractor as follows:-

Supervisor's Communication General Matters / Other Instructions No 159, 160, 161, 162, 163, 164, 165, 166 and 167 were issued during September.

- Seeking confirmation that the gap between the internal partition and external unit has been filled to avoid flanking.

- Seeking confirmation that the appropriate action has been taken to address the shaded areas below the finished surface of the render on the east elevation.
- Seeking confirmation when all medical gas valves are covered.
- Seeking confirmation when legs to steel framework have been extended.
- Seeking details of the lead protection to the penetrations above ceilings within Radiology.
- Seeking confirmation when rodding eye inspection cover has been repositioned.
- Seeking confirmation of measures to improve the quality of finish to the blockwork.
- Seeking confirmation when the water damaged boards have been replaced.
- Seeking confirmation that smoke detectors in 1-529 & 1-530 will be surveyed and repositioned appropriatelly.

Supervisor's Notification of Defects No 65 and 66 were issued during September.

- Seeking confirmation when damaged medical gas pipes have been addressed. (Location1).
- Seeking confirmation when damaged medical gas pipe has been addressed. (Location 2).

We continue to be assisted by the site teams and the NHS Project Team who produce an internal weekly report which assists us in resolving various construction, mechanical, electrical and quality issues. We continue to close out our Supervisor's Notifications and Defects when we have received satisfactory responses.

2.0 DESIGN COMPLIANCE CHECK

Currently nothing to report.

3.0 PROCEDURES REVIEW

3.1 Contractor's QA Procedures / Compliance Inspections

Brookfield and their subcontractors have continued with their QA and checking and inspection procedures during this period. We are in discussion and liaise with Brookfield's Quality Manager on QA matters and we undertake regular reviews of their QA documentation.

We await further survey from Scotshield showing the smoke detectors which are too close to service grills and their new positions. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 152).

We undertook inspection with Brookfield on Level 0 Zones 0-522, 0-520, 0-523, 0-524 and 0-519 and noted that the works were progressing at varying stages in all Zones. The works are generally to a good industrial standard. However we brought to Brookfield's attention that fire putty was missing from two back boxes Brookfield confirmed that they would address this but we will monitor this during further visits.

Inspections were carried out with Brookfield on Level 1 Zones 1-534, 1-533, 1-530, 1-532, 1-539, 1-537 and 1-538. The quality of the work was to a good industrial standard. We have raised a Supervisor's Communication requesting details of the lead protection to ducts and penetrations passing through walls above the ceilings within Radiology. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 163).

We carried out a joint inspection with Brookfield on level 2 Zones 2-520, 2-521 and 2-521B. The quality of the work was to a good industrial standard. Permit access only is being initiated on Level 2 Zones 2-526 and 2-524 in advance of quality and compliance inspections.

The blockwork on the South Elevation of Area 9 is progressing with some areas finished up to the underside of the render. The quality was good with only a few localised vertical pointing which were too deep.


Blockwork at the Children's Hospital.


Reinforcing at window**.**

The works to Courtyard 1 is progressing with the quality good. The works to the intensive roof between the Children's and the Acute Hospital is progressing with the insulation being laid on the hotmelt. The quality of the work is good. The roof to the Atrium at the main entrance is progressing in readiness for the roof to be installed.

The Main Atrium roof is nearing completion.

<u>85 point Checks</u>

An 85 point inspection of the partition in room RENW-143 on Level 4 Zone E 4-143 and the partition was constructed in accordance with the specification. There was a small step between the concrete upstand and the Unitised Panel which was filled with sealant. This may allow flanking of sound and Brookfield is seeking advice from Nightingales.

An 85 point check was carried out to a partition in the Children's Hospital which has a 47db rating formed on Level 0 Area 1-515 in rooms OPD-769 and 133. The partition had been constructed in accordance with the specification. A check was also carried out to the junction with the external wall and the partition which was full insulated.

Insulation in partition.

Junction of partition with external wall

An 85 point check was carried out to a partition Level 1 Area 1-506 and the partition was constructed satisfactorily.

We asked Brookfield to provide us with the manufacturer's literature/guidelines or method statement for maintaining the refrigeration units on site keeping them closed off air tight and clean. The Cold/ Freezer rooms are not yet commissioned and still under construction. Brookfield has confirmed that there are no manufacturer's guidelines on keeping the units closed off and air tight until the system is commissioned and they are bringing the rooms down to design temperature. Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 158 is closed out.

Early in the month WSP carried out a visual inspection. They have confirmed that in accordance with Technical Report 68 the Class of Damage to be Class 1 and as such no further testing of the concrete is deemed necessary. We have been inspecting the reinstatement work in the fire damaged area and can confirm that the work is satisfactory.

3.2 Witness Testing and Commissioning

We witnessed a number of tests during September which were satisfactory and these were as follows:

- Electrical inspection within the Energy Centre.
- Gas strength and soundness test within the EnergyC.
- Proportional air flow tests of ventilation systems 21-AHU-28.
- Oil line pressure test in Energy Centre.
- Local fire alarm panel commissioning on Level 2 Zones 17 & 19.

We witnessed one smoke damper test which failed, consequently this requires to be retested.

- Smoke damper tests in L0, Zones D & G.

3.3 Board Equipment Installation,

Currently nothing to report.

3.4 Non Conformance Reports

We reviewed Brookfield's NCR Tracker and noted the issues raised by the Package Managers. The blockwork and pointing on the south and east elevations although improved by cleaning continues to be a concern with shading of the mortar evident. Prater has still to offer it up to Brookfield as complete reference NCR 156. We are also monitoring the issue in relation to water between the glass of the Structal Panels NCR reference 157 and 219. Brookfield an independent survey carried out by Cladtech Associates has been forwarded to Structal. Brookfield are reviewing all the infoprmation. NCR 237 was issued to Astins in relation to the lack of insulation at abutments between internal partitions and external walls.

4.0 CONSTRUCTION REVIEW

4.1 Visits to the Works

The following members of our team undertook site inspections, reviewed documentation, attended meetings and met with relevant Trust, Project Co and Contractor on-site personnel:- John Redmond (Lead NEC3 Supervisor) 2nd to 6th, 9th to 13th, 16th to 20th, 23rd to 26th September; Douglas Wilson (M&E NEC3 Supervisor) 2nd to 6th, 9th to 13th, 16th to 20th, 23rd to 27th and 30th September;Willie Roxburgh (Civils/Structural NEC3 Supervisor) part days on 4th, 9th, 11th, 16th and 18th, plus remote desk top input each day of the month until the 18th September. Capita Symonds Independent Tester team visited site a combined 44 person days.

4.2 Elements of the Works available for inspection

- Energy Centre – structurally complete. Civil works around.
- Main building – all concrete areas.
- External Drainage – specific sections of installation where access is possible.
- Tunnels between ACH and Labs, and Cores C to F.
- Structural steelwork to Atrium (limited due to access).
- Structural steelwork to all roof areas (limited due to access)
- Neuro bridge assembly area.
- Dual carriageway to Renfrew Road, turning area in front of the main entrance, and carriageway from Hardgate Road.
- Car park area.
- Internal Partitions.
- M&E modular units.
- Roofing.
- Cladding.
- Windows.
- Sto system.
- Brickwork Courtyard 5 and south east elevation.
- Brickwork/blockwork south east elevations.
- Basement blockwork.

4.3 Observations from September 2013 Inspections

The visual inspections of the work carried out to date indicate that the works are generally being carried out to a satisfactory standard. We continue to be assisted by the site teams and the NHS Project Team in resolving various construction, mechanical, electrical, and quality issues. We continue to close out our Supervisor's Notification and Defects when we have received satisfactory responses. Listed below are observations closed out, still to be closed and those raised following site visits in September 2013.

4.3.1 Structural

All pods to the Atrium Bridge have now been positioned and additional deflection checks to date have been further examined in respect of datum issues by the Brookfield team. Proposals in respect of final screeding and floor finish levels are still awaited.

Final elements of steelwork erection have continued to the roof of the Children's Hospital in Zones A and B. Communications have been raised with Brookfield and are listed on the following pages. These still remain outstanding and have been examined with Brookfield who will ensure that they are addressed at the appropriate time. This is also the case with a communication raised some months ago re connections to a support angle at the 1st floor level in Zone A.

Steelwork erection has also continued on the roof of the ACH and now extends to all 4 arms. Some communications raised in respect of this steelwork are still being addressed. In addition erection is proceeding on the helipad structure, and queries have been raised in respect of some handling damage to the galvanised finish and how this will be addressed. A similar query has been raised re some, albeit limited, damage to paintwork finish to the main atrium roof steelwork (white).

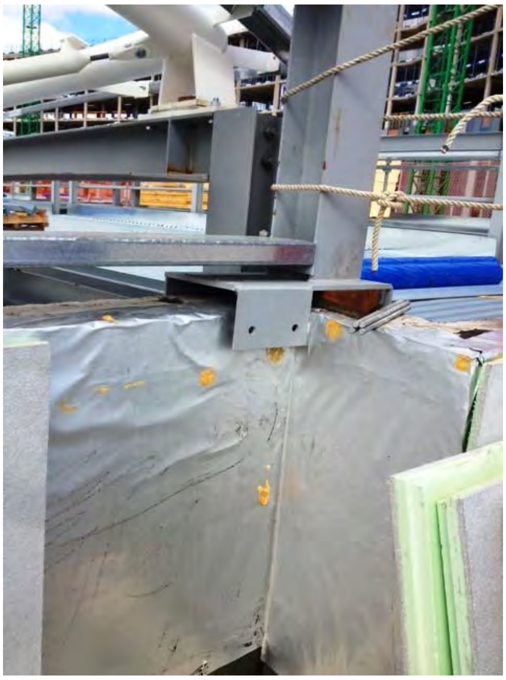
The steel structures for the bridge link to the existing neuro-building have been assembled in sections on site in preparation for single day lifting into position. A query has been raised re the single column moment connection to the bridge structure.

We brought to Brookfield attention the fixings of the steel angle to the wall at the 1st floor suspended composite deck in the atrium area of Zone A of the Children's hospital. We asked them to confirm they are in accordance with the Specification and relevant current codes of practice and standards. Resin anchors are the correct fixings as agreed with WSP, these will now be fitted. Larger washers were installed on the 17th September 2013. We will carry out a further inspection. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 111).

Two internal RHS columns in the Children's Hospital Zone B appear to be held up by adjoining steelwork. Brookfield has informed us that the final detail is a connection to concrete. The concrete works and subsequent bolting up will be undertaken prior to the installation of any cladding. The fitting of additional brackets has been agreed by WSP and we were informed that this would be completed by Monday 19th August. It was our intention to inspect on completion, however the work is still not complete. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 118).

The areas of steelwork in the Children's Hospital Zone B had significant paint damage is now completed and a joint inspection between Brookfield and Capita is to be arranged. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 119).

We asked Brookfield to provide proposals to meet the design intent for the Children's Hospital Roof Steelwork Zone A where bolts are missing at the parapet. Brookfield has had discussions with William McColgan WSP during a visit to site. Subsequent to this visit Dunne has provided a detailed sketch which has been approved by WSP. We shall inspect this on completion. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 128).



We have asked Brookfield to advise us of the remedial proposals for those column bases where there is at present insufficient nut connection to bolt thread. Brookfield has confirmed that W Mc Colgan of WSP has accepted of proposal from J&D Pierce. They have provided WSP with an isometric indicating the locations and JDP Sketch sheet BP1. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 131).

We asked Brookfield to provide technical solutions to various situations on the structural steelwork to the Children's roof where base plates are (floating), edge distances are minimal or miss the concrete base. Cladding rails also prevented HD bolt fixing. WSP has provided a detailed sketch to show remedial work to plinth. We shall inspect this on completion. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 141).

The steel framework in riser on Level 0 ZF Riser M30 has had the legs extended immediately in front of the entrance door. There are other legs which have not been extended yet and we asked Brookfield to confirm when the other legs will been extended. This work is in progress and they will advise when complete. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 162).

Extended legs

Leg still to be extended.

<u>Car Park 1</u>

In the car park test results for the piling have now been received and these appear to be satisfactory. Foundation works are nearing completion and quality to date has been to an acceptable standard. Drainage, sub-base and tarmac have been placed to a significant area of the ground floor and quality here is also satisfactory. The 1st floor slab and part of the 2nd floor have been poured and post tensioning applied. Brookfield quality checks on this appear sound and the floor finish achieved appears to be satisfactory.

4.3.2 Energy Centre

Steelwork snagging appears to have been addressed, but much tidying up remains outstanding in the eastern half of the building.

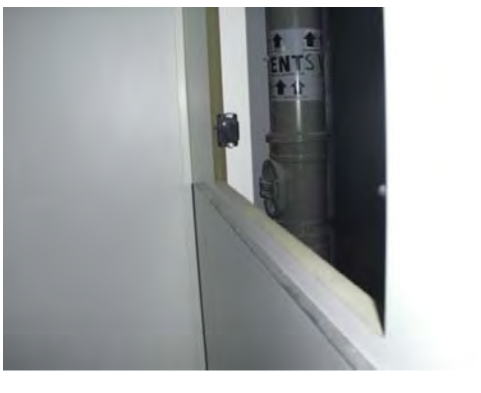
4.3.3 Drainage

We noted that the above ground storm drainage has a lack of ground floor access panel. Zone D. MH S4 in courtyard has a 100mm storm pipe running from inside the building. Brookfield is currently marking up drawings indicating the locations of access panels. We shall review these when complete.

With reference to the above ground storm drainage position of access panel.
Zone D. MH S5 has a 150mm storm pipe running from inside the building. Inside the building the pipe runs above slab level is insulated and an access panel at ground floor level is apparent, however this access panel is located in an unsuitable position, and would be very difficult to utilise if the requirement arose. We asked Brookfield to advise on their proposals in respect of this to comply with current standards. We also asked them to check all such locations throughout the building that they also comply and advise accordingly.

Brookfield is seeking clarification and would prefer to inspect this pipe on site. Brookfield has confirmed that all pipes have been installed in accordance with these construction issue approved drawings. The ME 581 series drawings provide detailed dimensioned locations for installation of the pipe work. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 116).

Rodding eye inspection cover facing wrong direction for access. We have asked Brookfield to confirm when this has to be addressed to allow access from behind removable panel within toilet MDU-011. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 164).



4.3.4 Dual Carriageway to Renfrew Road. (A&C)

The defects previously identified will be reviewed nearer to completion when they will be effectively rectified.

4.3.5 Pipework.

Installation of hot, cold, heating, & chilled water pipework in the A&C hospital is progressing and in general is being installed to a good standard.

We are continuing to monitor all pipework installations to identify possible dead legs. The quality checking by Brookfield would appear to be identifying these before our inspections. Open unprotected ends are also being identified in our weekly site inspection reports and these are notified to Brookfield. During September there has been a reduction in the number of open ends

We have asked Brookfield to confirm the flow of water from the sprinkler head highlighted is not restricted by the adjacent section of unistrut. We have recived a photograph from Brookfield which confirms that the sprinkler head deflector is under the unistrut. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 74 is closed out.

During our inspections in Plant Room 21, we noted that all AHU condensate discharges are routed to gullies via low level unprotected plastic pipework. This is a potential trip hazard. We have asked Brookfield to confirm that the CDM Coordinator has considered this problem and has asked if there are any measures to address this. There is also the risk of the pipes being broken. Refer to SHTM03-01 clause 4.25. Brookfield has confirmed that where appropriate, sheet metal guards will cover condensate discharges. However we have requested to see a typical detail of what they are proposing to allow further comment.

We have asked Brookfield to confirm if a ramp (up/down) will be installed over the low level pipework & be fixed in position. Also in some instances, where the pipework is particularly exposed, this ramp may need to extend further along the length of the pipe or additional protection provided. We have asked again if the CDM Coordinator has considered this problem and has taken cognisance of SHTM03-01 clause 4.25. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 122.

Following a visit to site we raised our concerns that there are some locations where there is insufficient space for maintainable, replacement building services and plant as per the Employers Requirement Section 5.13 Facilities Management.

We raised our concerns with Brookfield in relation with the following areas.

Level 2 Zone H. Pipework connections above line of unistrut. Access appears difficult. We have asked Brookfield to confirm that future access will be available.

Level 2 / Zone K. Current access to install chilled water riser pipework appears difficult. We have asked Brookfield to confirm that future access will be available once the walls are constructed.

Level 3 / Zone H. Pipe Racks in area shown below have multiple levels of pipe work. We have asked Brookfield to confirm that future access will be available. Brookfield confirmed that access to the 3 areas identified will be accessible for FM in compliance with ER Section 5.13. The access arrangements for this item will be recorded as part of the Access Strategy Tracker which is currently being developed by Brookfield and Mercury. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 126).

We noted that the unistrut pipework support had visibly bent under weight of pre-fabricated pipework module in Plant room PR31 adjacent sub-station 2A.
This will become more pronounced when pipework is filled with water. We asked Brookfield to confirm that the structural supports utilised are compliant with the design intent. Brookfield has replied that the frames are suitable for their intended function and have provided calculations. They have informed us that this appears to have been mechanical damage and not deformation due to weight of the services. We have not found any fitted modules with bowed frames in this manner. Further investigations are being carried out by Brookfield and Mercury. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 135).

We noted a clash between the cold water pipes and drainage connection in the corridor and room OPD-031. Brookfield has resolved this issue and consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 143) is closed out.

The waste pipes are uninsulated to the external soffit area on the underside of Level 4 Zone H and on the underside of Level 1 above the entrance to Accident and Emergency. We have asked Brookfield if insulation is required to these pipes. This Notification has been forwarded to the relative floor manager and is being investigated. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 156).

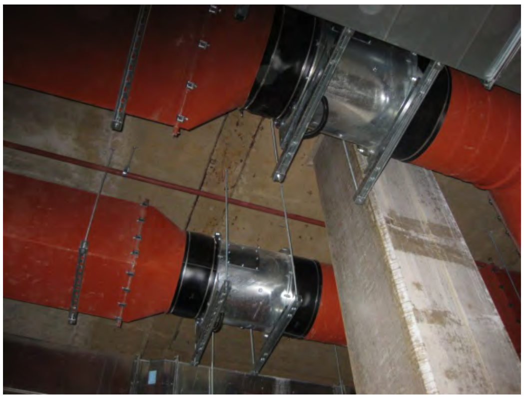
4.3.6 Ventilation

We were in attendance to witness the successful test of the supply and extract airflow testing of AHU's 24 & 25 within plant room 21 and levels 1 & 2 of zones D&G, and dirty extract fan 39.

We noted that the air handling unit 21AHU16 supply duct transition does not appear to comply with HVAC DW144 clause 11.6 & 11.7 which could result in high pressure loss.

Brookfield has confirmed that ductwork is not in compliance to drawing/specification and will be replaced. However we await the design philosophy in relation to the proposed remedial measures. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 121).

We asked Brookfield to confirm that the fire rating of the flexible connections and supporting system in Plant room PR31 is equivalent to the overall system requirements. The fan is located adjacent to atrium at the west side of building. We have also asked them to confirm fire rating of fans (observed as non-bifurcated type). ZBP has confirmed to Brookfield that fans require to be fire rated and are at technical submittal stage. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 133).



Following an inspection of Plant Room PR21 we raised a number of points which were clarified, however the items below are still awaiting coment from Brookfield.

- Confirmation received that diffuser plate will be fitted to alleviate fan discharge velocity issues raised (items 1a, b, d, e & f). We asked for details of the proposed diffuser plate to be fitted in front of supply AHU fan discharge. The diffuser plate already fitted to AHU 21 appears inadequate for its intended use. Brookfiled is awaiting a response from the Manufacturer.
- Item c - please confirm Coil 'off coil' conditions. Brookfield has confirmed that this is as per ZBO Schedule ZBP-XX-XXSH-600-323.
- Please confirm grade of filtration. Do the bag filter grades vary depending on application? Brookfield has confirmed that standard throughout and as per ZBP Schedule ZBP-XX-XX-SH-600-323. We will monitor this during commissioning.
- We asked for confirmination that the AHU is compliant with SHTM03-01, or state any agreed derogation. Some aspects stated do not comply with the SHTM & will require agreement from the Board. Brookfield has confirmed that all All units are SHTM compliant and inline with ZBPs design. There are a few cases where the specific fan powers could not be achieved as the manufacturers' limiting velocity of 2m/s across components would not have been achieved, this has been brought to ZBP's attention. All units are approved and supplied to ZBP's design schedules.

(See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 137).

There is an unsupported ventilation pipe passing through rooms above the ceiling line of Rooms RCG-067 Cleaner, RCG-068 Baby Sleep and RCG 070 Change. The duct is currently supported across vertical stud members. Brookfield have resolved this issue consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 138) is closed out.

We noted that the access hatches were located within the line of the partition wall on Level 2 room DMW-040. Brookfield confirmed that two access doors will be installed. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 142 is closed out

During our inspections on Level 2 we noted that the duct inspection hatch is located above the partition dividing rooms DMW-037 & 038. We have received confirmation that the duct access hatch will be repositioned to allow access to the duct. We have asked Brookfield to confirm when the hatch will be accessible. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 150).

A ductwork inspection hatch has been installed in middle of the partition in room HOW-301 Level 4. We have asked Brookfield to confirm when the inspection hatch will be fully accessible. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 153).

We have asked Brookfield if the Isolation ductwork hatch to the fire rated ductwork in Plant Room 21 needs a double seal. This Notification has been forwarded to the relative floor manager and is being investigated. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 154).

There are multiple types of Isolation ductwork flexible connections used in Plant Room 21, all secured with single jubilee clip at either end. We have asked Brookfield to confirm if these provide an adequate seal against air leakage especially to spiral ductwork.

We have asked Brookfield to confirm if fire integrity is maintained with all types of flexible connection used? This Notification has been forwarded to the relative floor manager and is being investigated. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 155).

We noted that the smoke detectors on Level 1 Zone H, 1-529 and 1-530 are too close to the chilled beams. Please confirm if Scotshield will be surveying the rooms in these areas and relocating the detectors to approximately > 950mm away from ceiling grilles as per their previous report. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 167).

4.3.7 Insulation

The thermal insulation installation to the pre-fabricated sections of pipework is being completed off site, before delivery and completed after installation.

4.3.8 Pressure testing

Pressure testing of the modular pipework sections on a zone by zone or area by area basis has been programmed through the commissioning meetings.

4.3.9 Medical Gases

Medical Gas pipework in being installed in all areas and independent tests are being witnessed by Ian Sandford of Hulley and Kirkwood.

We noted that there were a number of medical gas valves on all floors which were not covered. Some rooms in the same zone have covers and other do not. Brookfield has confirm that the "do not use labels" do not form part of any type of seal or cover. Labels are to make the medical practitioners aware of outlets should not be used. We shall continue to monitor the installation to ensure that any valves are protected in construction areas. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 161 is closed out.

4.3.10 Energy Centre

The installations in the Energy Centre are well advanced with the A-side systems commissioned and handed over and ground floor pipework being prepared for the CHP installation. Commissioning programmes for the B Side have been presented and significant commissioning will be taking place from June to December 2013.

4.3.11 Trunking

Cable trunking is being installed as part of the offsite fabricated sections that are being installed in the A&C hospital and in general the installation is to a good industry standard.

4.3.12 Cable Trays

Cable trays are being installed as part of the offsite fabricated sections that are being installed in the A&C hospital and in general the installation is to a good industry standard.

4.3.13 Cabling

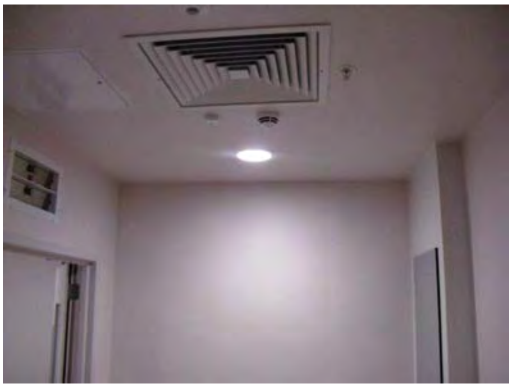
Modular wiring looms are now being installed as part of the offsite fabricated assemblies and carefully tied up for protection and installation is of a good standard.

4.3.14 Conduit

Solid conduit installations are well progressed in the areas being fitted out and are to a good industry standard.

4.3.15 Void Detection

The smoke detector within the lobby on Level 1 Room CCW-049 is within 300mm of the supply grille. We asked Brookfield to confirm when this has been repositioned to the minimum distance of 1metre. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 146).



4.3.16 Intake Sub Station

Brookfield has confirmed that the communication cables are still to be pulled into the Substation. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 30 & 45).

4.3.17 Partitions

The partition between the east side of the atrium and plant room 41 has been damaged by water ingress. Brookfield to confirm they are aware there has been some damage, and will replace the boards after they have completed the resin flooring works. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 166).



Water damaged boards.

4.3.18 Roofs

A&C Roofs

Courtyard 2, 3, 4 and 5 on Level 1 and 2 are progressing to completion with Brookfield awaiting the final snagging by Praters.

Level 4 Zone E&H Structal to remove materials to allow work to recommence.

The roof covering zones G and D on Level 3 is progressing to completion with Brookfield to carry out final checks.

The remaining roofs on Levels 2, 3 and 4 including the Green Roofs are progressing.

The hot melt roof on Level 12 is nearing completion.

Generally the quality of the workmanship throughout is to a good industrial standard.

The Sarna Roof covering is progressing above Plant Room 121.The photo below shows the membrane sealed at all laps.

Children's Roofs

The Sarna roof on Level 5 is nearing completion and the quality is to a good industrial standard.

Below is the QA check list for the Sarna Roof.

CONTRACT: 1204………………………………………………PACKAGE NO:………………………

Building/ Roof Area Inspected: Zone A Level 5 R5-001 ………………………..…………….

Inspection By: **Jay Campbell………..** Contract no:…………………………

Activity to inspect **(Refer to** Inspection and Test Plan **for details of hold points and joint inspections)**	**Conform** Y/N	**Date of inspection**	**Comment**
MATERIALS **1. AS ORDERED** **2. CONDITION OF MATERIALS OK** **3. STORAGE ON GROUND & ROOF OK** ***PRIOR TO START*** **1. HANDOVER NOTE RECEIVED** **2. ACCESS** **3. ROOF AREA READY TO START** **4. SUITABILITY OF CONCRETE SLAB SUBSTRATE (if appropriate)** **5. CHECK STEEL ARRANGEMENT (if appropriate)** **6. FALLS, SKIRTING HEIGHTS** **7. HOISTING/ CRANEAGE** **8. SAFETY ARRANGEMENTS IN PLACE** ***WORKMANSHIP*** **1. METAL DECK INSTALLED & FIXED OK** **2. VAPOUR BARRIER LAPS SEALED, DAMAGE REPAIRED OK** **3. INSULATION BONDED OR**	**Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes** **Yes**	**17/02/13** **17/02/13** **17/02/13** **25/03/13** **25/03/13** **25/03/13** **25/03/13** **25/03/13** **25/03/13** **25/03/13** **25/03/13** **19/04/13** **03/05/13** **10/05/13** **10/05/13**	**8. Safety Nets in place**

MECHANICALLY FIXED OK	Yes	28/05/13	
4. SINGLE PLY FIXINGS AS DRAWING	Yes	28/05/13	
(check fixing and/ or bar centres, peel stops OK)	No	28/05/13	
	Yes	28/05/13	
5. END AND SIDE LAPS OK	Yes	28/05/13	
6. PERIMETER DETAILS OK	Yes	28/05/13	
7. NIGHT JOINT DETAIL APPROPRIATE	Yes	28/05/13	
8. OUTLETS FITTED OK	N/A		
9. SINGLE PLY FINISH OK	N/A		2. No damage
10. ELECTRONIC TESTING OK	Yes	03/06/13	
11. FINISHED WORK INSPECTED	Yes	03/06/13	
	Yes	05/07/13	
PRIOR TO HANDOVER			
1. FINISHED WORK PROTECTED			
2. DAMAGE RECORDED			
3. WASTE & SURPLUS MATERIALS REMOVED			
4. ROOF CLEANED DOWN			
5. HANDOVER TO CLIENT WITH HANDOVER FORM – (date and number)			

A47392376

JHH Engineering Ltd
Independent Consultancy to the Construction Industry
UKAS Accredited to ISO/IEC 17025:2005

- Electronic Integrity testing of roof system and building envelope membranes
- Watertightness testing of glazing systems and building envelope components (to AAMA 501.2.03 / BS EN 13051)
- Airtightness testing of building envelopes (to ATTMA TS1)
- Thermography inspections – eg insulation integrity, electrical systems, predictive maintenance
- "Long Reach" camera inspections
- Roofing System / Building Envelope / Dilapidation surveys and leak detection (inc moisture build-up / retention within insulation, etc)
- Concrete moisture/hardness testing; noise/vibration testing; environmental monitoring
- Design calculations for roofing systems.

Mr Stuart Hay
Prater Ltd
Perrywood Business Park
Honeycrock Lane
REDHILL
Surrey
RH1 5JQ

JHH/07111n/6468
07 August 2013

Reference:

A. Your Purchase Order No EC1204/PS004, dated 05 Sep 12
B. Your Oral Instruction, dated 31 Jul 13

Dear Mr Hay

NEW SOUTH GLASGOW HOSPITALS - VISIT 14

Further to the References, *JHH Engineering* carried out Electronic Integrity testing to the *PERMAQUIK / SARNAFIL* membranes, at the Title property. Testing was completed on Wednesday 7th August 2013

The report is enclosed.

Should you have queries, or seek clarification, please do not hesitate to contact me. In the meantime, we at *JHH Engineering* look forward with pleasure to our being of Service in the future.

Yours sincerely

[redacted]

Malcolm E D Gamble
BEng (Hons) CEng CMarEng MIMarE MInstNDT
Director, JHH Engineering Ltd

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VAT Registration N°: 814 3663 36 • Registered in Scotland N°: SC 174 529
Registered Address 1 Hope Street, Lanark ML11 7LZ

Hot melt application is progressing on level 2 balconies and Level 3 roof and the quality is to a good industrial standard.

ETFE roof above the Atrium is nearing completion.

4.3.19 Cladding/Courtyards

A&C

Cladding is substantially complete in courtyards 2, 3, 4, & 8 and plant room 21 & 31. The "STO" system is substantially complete in courtyard 2, 3, 4 and 7. Brookfield is to carry out their final quality inspections and sign off. The STO is in progress in

Courtyards 9, 10 and 11 with the standard and quality generally to a good industrial standard.

The stone rainscreen has progressed on the east elevation and the quality is good.

Repairs and painting was carried out to two damaged panels and these were acceptable to the client. Brookfield instructed Prater to repair and repaint damaged cladding panels. They are awaiting confirmation from Rukki that their Warranty is not compromised as a result of the repair/repaint. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 103).

The STO render to the upper panel on the east facing elevation nearest Core E has shaded areas visible below the finished surface. Confirm the appropriate action to ensure that there is a uniform covering to the panel and when this is completed. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 160).

<u>Children's Hospital</u>

The STO is in progress progressed around the external façade of the Children's Hospital.

4.3.20 Windows

Windows are progressing on the external elevations and courtyards in accordance with the specifications.

4.3.21 Equipment

Extract fan on Level L3 PR31 extract fan unit Number 30EF1 has been installed on the floor of the plantroom with the service access on the underside of the unit making servicing impossible. We asked Brookfield confirm that extract fan will be installed in a manner which will allow unrestricted maintenance. We have received a response that access is via the top and sides however the unit fitted does not allow access as described. We asked Brookfield to provide the manufacturers information in relation to maintenance access but received information for a different model. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 151).

4.3.22 Ducting

We have asked Brookfield to confirm that the fire damper actuator highlights in room EMC-011 can be accessed on completion of the cold water and ceiling installation. Brookfield has confirmed that the damper actuator will be accessible. The access arrangements for this item will be recorded as part of the Access Strategy Tracker which is being developed. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 92).

4.3.23 Floors

We have asked Brookfield to confirm their proposals to achieve level floors to the Atrium Bridge Corridors at door openings to offices/rooms and adjacent levels within these rooms. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 145).

4.3.24 Blockwork

We have reported since April that the quality and standard of workmanship of the blockwork on the east elevations was not to a good industrial standard.

Some of the blockwork panels are taken to have 10mm joints and other 14mmin accordance with the construction approved drawing NA-XX-XX-EL-251-500. The panel at drawing reference 8 has joint ranging from 8mm to 15mm but is taken for 10mm in accordance with the construction approved drawing.

The panel at drawing reference 6 and 7 has generally 10mm joints below the window sill and 14mm to the left and above the window.

The blockwork panel between drawing reference 5 and 6 is taken for 10mm but is generally 14mm.

The panel next to the block curve is taken for 10mm but is generally 14mm

Other panels have also a variety of joint widths.

Shading of joints are present in most panels. There are also localised vertical hairline cracking to vertical joint especially below window sills. The depth of the pointing is deeper at wide joints and narrower at narrow joints.

We have asked Brookfield to confirm their measures to improve the quality of finish. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 165).

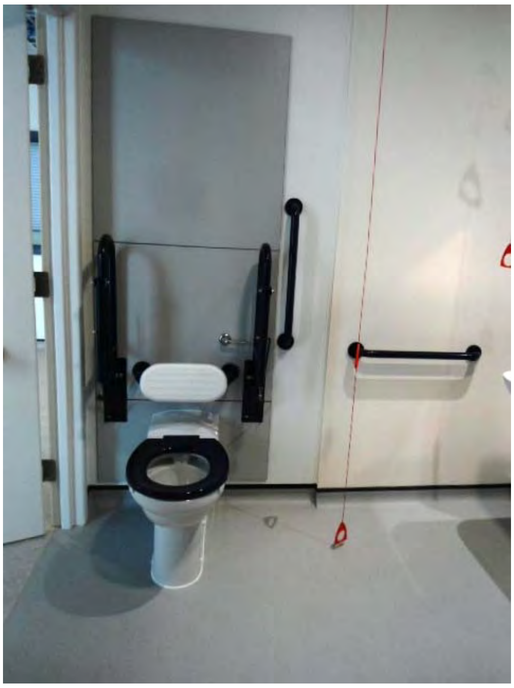
4.3.25 Pneumatic Tube

Currently nothing to report.

4.3.27 Electrical Fittings & Fixtures

The en-suite circular boxes in Level 0 OBW-023 appears to be recessed too far back and the opening is not cut out properly. This occurs in the en-suites on level 3. We asked Brookfield to confirm that there is an adequate seal between the boxes, the inner face of the boards and around the perimeter. This is especially important in any fire walls. Brookfield has confirmed that this is being investigated and a formal response will be issued in the next reporting period. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 139).

With the exception of room CCU-065 on level 1 1-521 all of the pull cords next to the WC bowels in the en-suites are not in their correct positions. We have asked Brookfield to confirm when they have been relocated. Brookfield has instructed Mercury Floor/Package managers to investigate and advise. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 140).



4.3.28 Sprinklers

We asked Brookfield to confirm the access arrangements to high level sprinkler heads. They have provided us with a copy of the sprinkler standards BS EN 12845. This states that a sample number of heads are tested every 25 years. They have also informed us that sprinklers are designed to last 100 years. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 75).

4.3.29 Lighting

The quality of the general and emergency lighting installed to date is of a good standard.

4.3.30 Power

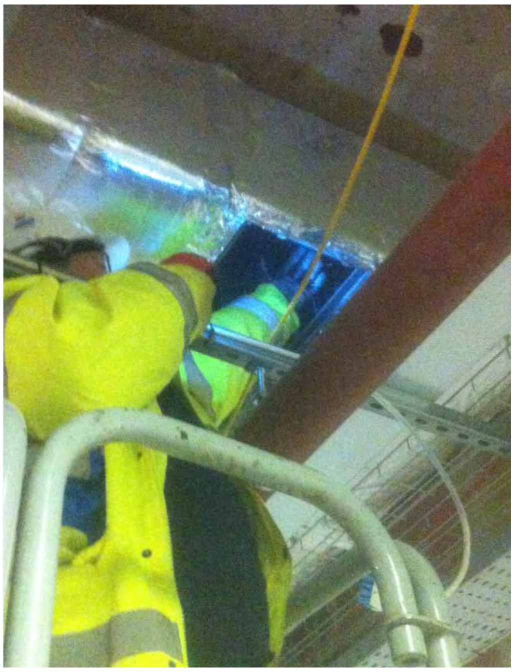
The quality of the small power installation installed to date is generally good with only minor defects noted which have been rectified.

4.3.31 Glazing

Brookfield has confirmed that the glazings to the Pods are to the design requirements and have provided us with a copy of the specification and fire certificate for the glass. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 149 is closed out.

4.4 Current Defects.

Restricted access to ductwork access hatch in corridor adjacent to Zone H near Stair Core F. Brookfield has confirmed that this issue will be added to an Access Tracker forming part of the Brookfield/Mercury Above Ceiling Access Strategy which is being developed. This will highlight the Method of access required for Maintenance or replacement. (See Supervisor's Notification of Defect (CI 42.2) No 13).



There are partitions on Level 0 Area 529 which have screw fixings that have been fixed too close to the edge of the board. The Knuaf/NBS Specification states that screws to be not less than 10mm from edge of board and this is not being achieved in many locations. Brookfield has confirmed that this has been raised at a progress meeting with Astins. The Sub Contractor is currently seeking information from Knauf on this issue. When Brookfield has feedback from Astins they will issue a further response. Brookfield has confirmed however at this stage the integrity and fixing of the boards should not be compromised. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 51).

Trace visited the site on Wednesday 19/06/13 and carried out repairs to the Highline blinds on level 1. There are still 6No blinds to be replaced this will be carried out by TRACE. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 54).

We noted that some smoke detectors were too near to supply grilles in all rooms in area 0-528 with the exception of rooms AAW-260, AAW-263 & AAW-366 which were locked at the time of the inspection. The smoke detectors are recommended to be no less than 1000mm from the supply grille in accordance with BS5839-1:2002+A2: 2008 Clause 22.3 Sub Clause (M). We have received confirmation that this system is designed to this standard.

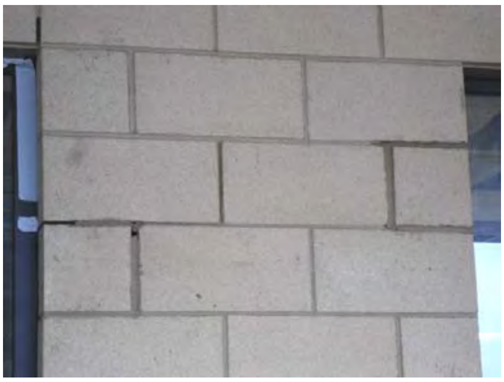
The recommendation is that any detector sighted next to a forced air inlet should be 1000mm away from the grille unit. At present Scotshield have installed detectors in uniformed positions throughout the project with a measured distance of approximately > 950mm away from ceiling grilles.

In terms of the short fall of approximately 50mm, they have confirmed that this will have no detrimental effect on how the system operates. The technologies used within present day systems are more advanced to monitor all situations therefore reducing the level of false alarms created by previous developed systems. This may require to be recorded as a minor derogation. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 59 is closed out.

The Pod on the North East corner of the 4th floor Atrium Bridge has sustained damage. We have asked Brookfield to confirm when this has been addressed. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 60).

The partition in Room ARU-034 on Level 2 has been cut to allow the sprinkler pipe to pass between rooms resulting in the partition being weakened.
Brookfield has passed this to Astins to investigate. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 63).

The quality of the workmanship to the blockwork on the West Facing Elevation is poor and requires to be addressed. The widths of perpends varying at various locations on this elevation. This is particularly evident between the windows on the right hand side of the entrance to A&E. See photo below. We have asked Brookfield to confirm when this issue has been addressed. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 64).



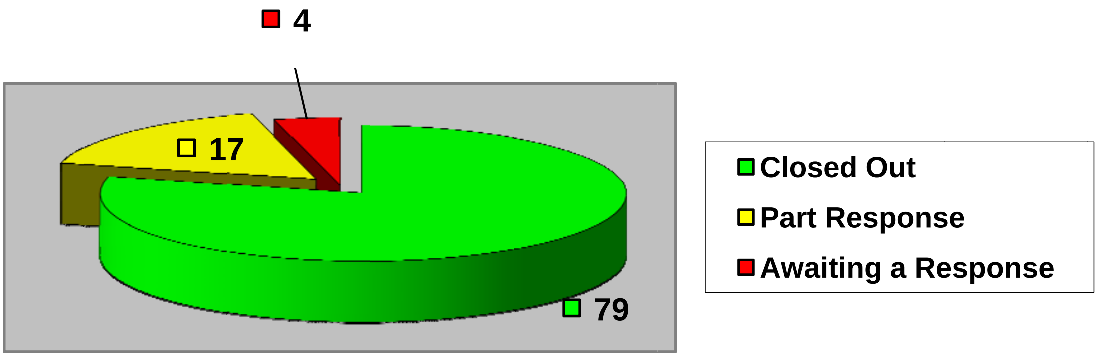
We noted that there were indentations/penetrations through the protective layer of the Level 12 roof and we have asked Brookfield to confirm when these have been addressed to allow for a further inspection. (See Supervisor's notification of Defects (Cl 42.2) No 61).

We noted that there were indentations/penetrations through the protective layer of the Level 12 roof and we have asked Brookfield to confirm when these have been addressed to allow for a further inspection. (See Supervisor's notification of Defects (CI 42.2) No 62).

There is a damaged medical gas pipe on Level 1 room MDU 051 above the ceiling. We have asked Brookfield to confirm when this has been addressed. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 65).

There are damaged medical gas pipes on Level 1 room MDU 012 above the ceiling. We have asked Brookfield to confirm when this has been addressed. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 66).

5.0 INFORMATION REQUIRED



Item No.	*Description*	*Date Requested*	*Comment*
Items 1 to 29have been closed out			
30	Confirm when cabling is complete, water pumped out and batteries removed.	10/08/12	Response received.
Items 31 to 44 have been closed out			
45	See Supervisor's Communication No 30.	18/09/12	Response received.
Items 46 to 73 have been closed out			
74	Confirm flow of water from the sprinkler head is not restricted.	30/11/12	Closed out.
75	Confirm the access regime for sprinkler head maintenance / replacement.	30/11/12	Response received.
Items 76 to 91 have been closed out			
92	Confirm that fire damper actuators highlights can be accessed on completion of the cold water and ceiling installation.	14/01/13	Response received.
Items 93 to 102 have been closed out			
103	Confirm on site painting of panels has the same life expectancy as the factory applied finish.	15/02/13	Response received.
Items 104 to 110 have been closed out			
111	Please check and confirm that the fixings to the steel angles to the wall at the 1st floor suspended composite deck are in accordance with the specifications/codes of practice.	28.03.13	Response received.
Items 112 to 115 have been closed out.			
116	Confirm that there are sufficient access panels in Zone D MH S4 and MH S5. Confirm that 50 mm waste pipes connecting to 100mm pipes at floor level without rodding points are compliant with Building Control.	03.05.13	Response received.
117	Confirm procedures to ensure the work to the incomplete concrete base has sufficient structural integrity.	15.05.13	Closed out.
118	Confirm the final detailing to internal RHS columns which appear to be held up by adjoining steelwork.	15.05.13	Response received.
119	Confirm measures to address areas of steelwork in the Children's Hospital Zone B which have significant paint damage.	15.05.13	Response received.
120	Confirm flatness and levelness (including floor specification and finishes) to achieve tolerances.	16.05.13	Closed out
121	Confirm the design philosophy in relation to air handling unit 21AHU16 supply duct transition does not would appear to comply with HVAC DW144 clause 11.6 & 11.7.	16.05.13	Response received.
122	Condensate discharges are routed to gullies are a potential trip hazard. Confirm that the CDM Coordinator has considered this problem and confirm if there are any measures to address this.	16.05.13	Response received.
123	LTHW pumps are mounted on inertia bases however, there are no pump flexes. Vibration will transmit through pipework as a result. Please confirm if this has been considered and if there any measures are proposed to address this.	28.05.13	Closed out
124	Confirm when remedial measures have been completed in relation to the damaged duct.	28.05.13	Closed out
125	Confirm proposed remedial actions to the non-compliant steelwork/concrete bases on the roof of the SE section.	20.06.13	Closed out
126	Confirm areas identified in the Communication can be accessed in accordance with the Employers Requirements.	24.06.13	Response received.

127	Confirm when exposed heater battery coil has been covered.	25.06.13	Closed out	
128	Children's Hospital Roof Steelwork Zone A - please provide proposals to meet the design intent at the locations where bolts are missing at the parapet location.	25.06.13	Response received.	
129	Insulation has not been fitted inside the vertical SFS forming the window openings of the ground floor Children's Hospital. Confirm measures to address this.	26.06.13	Closed out	
130	Pneumatic tube box at CCW 073 Bay 1 has an open end. Please confirm when this is blanked off.	02.07.13	Closed out	
131	Advise the remedial proposals for those column bases where there is at present insufficient nut connection to bolt thread.	03.07.13	Response received.	
132	investigate cracks and confirm that the specification requirements are met or provide details of proposed remedial action.	03.07.13	Closed out	
133	Plant room PR31. Confirm that fire rating of flexible connections and supporting system is equivalent to overall system requirements. Confirm fire rating of fans (observed as non-bifurcated type).	03.07.13	Response received.	
134	PR31 adjacent sub-station 2A. Confirm methodology for structural support of pre-fabricated pipework modules.	03.07.13	Closed out	
135	Unistrut pipework support visibly bent under weight of pre-fabricated pipework module. Confirm that structural supports utilised are compliant with the design intent.	03.07.13	Response received.	
136	Level 3 Zones G/H. Confirm method for re-coating painted finishes, integrity test procedure to meet compliance and identification.	03.07.13	Closed out	
137	Various points requiring clarification in relation to the AHU 21.	08.07.13	Response received.	
138	Confirm when ventilation pipe in RCG-067 AND RCG-068 has adequate support.	09.07.13	Closed out	
139	Confirm that there is adequate seal between back boxes and the board especially in fire walls.	17.07.13	Response received.	
140	Pull cords in 1-521 too far from wc.	18.07.13	Response received.	
141	Please provide technical solutions to various issues to the steelwork to the Children's Roof.	23.07.13	Response received.	
142	Confirm measures to address access hatches in line with the head of the partition.	25.07.13	Closed out	
143	Confirm measures to address clash between the cold water pipes and drainage connection.	25.07.13	Closed out	
144	Confirm when damaged parts to AHU AH10 on Level 5 are replaced.	25.07.13	Closed out	
145	Confirm proposals to achieve level floors to the Atrium Bridge Corridors at door openings to offices/rooms.	25.07.13	Open	
146	Confirm when smoke detector is repositioned to the required distance from the supply grille.	25.07.13	Response received.	
147	Confirm when insulation will be fitted to SFS LEVEL 2 Zone J.	31.07.13	Closed out	
148	Provide us with a copy of your proposals / method statement for the flushing of the LTHW and CW and re-use of flushed water.	13.08.13	Closed out	
149	The gazing to the Pods are to BS EN 14179-3. Please confirm that this is the design requirements and provide a copy of the specification.	15.08.13	Closed out	
150	Hatch clashes with partition in DMW-037. Confirm when accessible.	15.08.13	Response received.	
151	Confirm when extract fan in Plant Room 31 is installed to allow unrestricted access for maintenance.	15.08.13	Response received.	
152	Provide marked up drawing from Scotshield showing smoke detectors not in accordance with BS 5839-1.	15.08.13	Response received	
153	Confirm when inspection hatch in room HOW-031 on level 4 fully accessible.	26.08.13	Response received.	
154	Confirm if isolation ductwork hatch in Plant Room 21 needs a double seal.	26.08.13	Response received.	

155	Plant room 21. Confirm if the multiple types of Isolation ductwork flexible connections used in Plant Room 21 provide an adequate seal against air leakage especially to spiral ductwork? Confirm if fire integrity is maintained with all types of flexible connection used.	26.08.13	Response received.	
156	Confirm if the waste pipes are to be insulated at the external soffit area on the underside of Level 4 Zone H and on the underside of Level 1 above the entrance to Accident and Emergency.	26.08.13	Response received.	
157	Provide a copy your proposals / method statement for the flushing of Water Tanks within the hospital.	29.08.13	Closed out	
158	Provide us with the manufacturer's literature/guidelines or method statement for maintaining the refrigeration units	29.08.13	Closed out	
159	Confirm when the gap between the junction of the internal partition and external units in room AAW-093 & 094.	10.09.13	Closed out	
160	Confirm the appropriate action to ensure that there is a uniform covering of the shaded STO panel on the east elevation adjacent Core E.	10.09.13	Open	
161	Confirm when all medical gas valves are covered al floors.	12.09.13	Closed out	
162	Confirm when the other legs have been extended to the steel framework in riser on Level 0 ZF Riser M30.	16.09.13	Response received.	
163	Provide details of the lead protection to ducts and penetrations passing through walls above the ceilings within Radiology.	16.09.13	Open	
164	Confirm when rodding eye inspection cover has been repositioned to allow access within toilet MDU-011.	17.09.13	Open	
165	Confirm measures to improve the poor quality finish to the blockwork on the east elevation.	20.09.13	Open	
166	Confirm when water damaged boards in Plant Roon 41 are replaced.	20.09.13	Response received.	
167	Confirm that smoke detectors on Level 1 Zone H, 1-529 and 1-530 are repositioned approximately > 950mm away from ceiling grilles.	24.09.13	Open	

SUPERVISOR'S REPORT NO. 30 SEPTEMBER 2013

6.0 SUPERVISORS TESTS AND INSPECTIONS

Tests not required	**N/A**
Tests required but not tested	**Fail**
Tests required which has passed tests	**Pass**

14/06/13 on Level 1 area 507

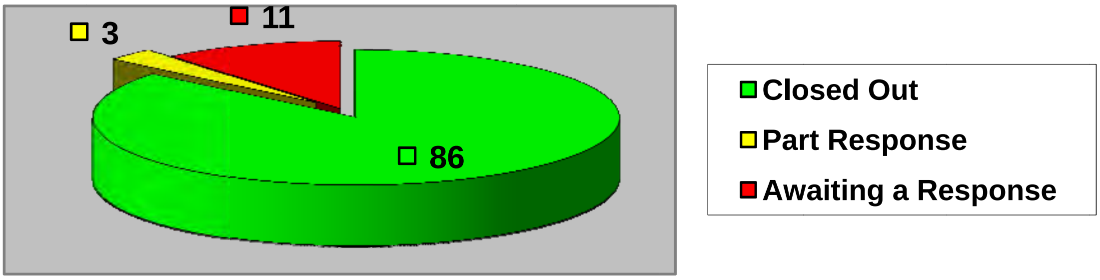
Tests				
Ref	Title	To be Notified by	Status	Test Date
01-80	Various tests undertaken from the 9/07/2012 to the 30/06/2013.			
81	85 Point Check Level 4-143.	Brookfield	Fail	04/09/2013
82	85 Point Check Level 1-515.	Brookfield	**Pass**	11/09/2013
83	Electrical testing in Energy Centre. DB's 8a & 8B.	Brookfield	**Pass**	03.09.2013
84	Gas soundness test in Energy centre.	Brookfield	**Pass**	05.09.2013
85	Witnessed air flow readings being verified within PR21 and Level 0 for AHU-28.	Brookfield	**Pass**	19.09.2013
86	Oil line pressure test in Energy Centre.	Brookfield	**Pass**	20.09.2013
87	Smoke damper test verification - Level 0, zones D & G.	Brookfield	**Fail**	24.09.2013
88	Local fire alarm commissioning at panels 17 & b19.	Brookfield	**Pass**	26.09.2013

Inspection not required	**N/A**
Inspection required	**Req**
Inspection complete	**Pass**

Inspections				
Ref	Title	To be Notified by	Status	Inspection Date
Inspections July 2013				
1	Zone 1-521	Brookfield	Pass	17/07/2013
2	Zone 1-528	Brookfield	Pass	30/07/2013

SUPERVISOR'S REPORT NO. 30 **SEPTEMBER 2013**

7.0 DEFECTS NOTIFICATIONS ISSUED



NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

SUPERVISOR'S REPORT NO. 30 **SEPTEMBER 2013**

	Description	Date Requested	Comment	
Items 1 to 12 have been closed out.				
13	Restricted access to ductwork access hatch in corridor adjacent to Zone H near Stair Core F.	02.10.12	Response received.	
Items 14 o 50 have been closed out.				
51	Knauf boards not fixed in accordance with NBS Specifications. Boards fixed too close to edge of board.	14.05.13	Open	
52	Confirm when penetrations through roof protection membrane have been repaired.	16.05.13	Closed	
53	Confirm when appropriate access to hatches in level 3 Zone A are provided.	16.05.13	Closed	
54	Faulty internal blinds. Confirm when remedial action has been completed.	30.05.13	Response received.	
55	Confirm when damaged fire coating has been renewed and provide dry film test results.	30.05.13	Closed	
56	Confirm when restriction to access hatch has been addressed.	03.06.13	Closed	
57	Missing insulation above ceiling level confirm when this has been addressed.	10.07.13	Closed	
58	Head track did not have sealant. Provide drawings showing the partitions constructed by the operative/s and confirm when the floor tracks identified on the drawings will be opened up and checked.	10.07.13	Closed	
59	Confirm when smoke detectors have been repositioned to the minimum regulation distance.	13.07.13	Closed	
60	Confirm when damaged Pod has been addressed.	15.07.13	Open	
61	Confirm when penetrations through the protective area level 12.	15.07.13	Open	
62	Confirm when penetrations through the protective area level 12.	15.07.13	Open	
63	Confirm when partition has been constructed properly to allow the sprinkler pipe to pass through wall.	20.07.13	Response received.	
64	Confirm when poor quality blockwork / perpends are addressed.	29.07.13	Open	
65	Confirm when damaged medical gas pipe on Level 1 room MDU 051 above the ceiling have been addressed.	17.09.13	Open	
66	Confirm when damaged medical gas pipes on Level 1 room MDU 012 above the ceiling have been addressed.	17.09.13	Open	

NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

SUPERVISOR'S REPORT NO. 30 **SEPTEMBER 2013**

John Redmond
Capita Symonds
Technical Advisory Services

The Beacon, 8th Floor, 176 St Vincent Street, Glasgow G2 5SG

	Signed	Date
Originated by	John Redmond	26th September 2013
Completed by	Douglas Wilson	26th September 2013

CAPITA

NEW SOUTH GLASGOW HOSPITAL

ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

NEC 3 SUPERVISORS REPORT NO. 36

APRIL 2014

SUPERVISOR'S REPORT NO. 36 **APRIL 2014**

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NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

SUPERVISOR'S REPORT NO. 36 **APRIL 2014**

1.0 EXECUTIVE SUMMARY: ADULT & CHILDREN'S HOSPITAL

Visits to the site during April 2014 continue to indicate that the construction and procedures are progressing in a satisfactory manner in accordance with the Employer's Requirements.

Throughout, the standard and quality of the workmanship is generally good and operations are being carried out in an acceptable manner.

Quality and compliance inspections were carried out on Ground floor Zones 0-506, 0-532, 0-533, 0-534, 0-535, Level 1 Zone 1-536, Level 2 Zones 2-514, 2-513, 2-512, 2-510, 2-529 and 2-530, Level 2 Area 2-529 and 2-530 The quality of the work was to a good industrial standard

Brookfield provided us with their QA documentation including a list of their defects which had been logged on their IDMS system. The areas inspected were generally to a good industrial standard and the defects captured by Brookfield were generally of a minor nature. We did however identify a number of minor defects which Brookfield recorded on to their IDMS system. On Level 2, Areas 2-513, 2-514 we noted that many of the drop down grab rails did not stay in the upright position. There were also two doors leading onto the flat roof which had been hung on the wrong side. We noted on Level 2, Areas 2-512 and 2- 510 and Level 0 Area 0-533 and 0-534 that a couple of rooms had base units with doors which were hung on the wrong side.

Acoustic Tests were carried out during the period and they have provided us with a report of tests carried out in six locations. The results were ambiguous and we have asked Brookfield for clarification. One partition between rooms THE 326 Recovery Bay to THE 327 Recovery Bay did not achieve the performance criteria.

A connection at one end of one of the circular hollow steel members of the main atrium roof failed during the previous period. Brookfield has initiated a detailed investigation into the causes of this incident and a report is awaited in respect of this. A remedial connection detail is understood to have been developed which will be installed at all similar joints in this proprietary roof structure.

Zutec entries continue to be under review.

The car park structural works are virtually complete with only the SW stairwell to be completed. Steelwork column foundation at the NE stairwell is still in need of remediation. Facing stonework is almost completed on the south and east faces and is of very good quality to date. Work is almost completed on the link road from the car park to Hardgate Road and quality to date is satisfactory other than for some minor snagging. Ground floor asphalt surfacing has been placed to the ground floor and is of a good quality standard. Some remedial work to concrete finishes, including at post tensioning positions, remains outstanding.

The final screed to the Atrium Bridge on the 4th floor will be used as a benchmark for all the Atrium Bridge Floors and completion of this is expected shortly.

Final elements of steelwork connections are still to be completed to the roof of the Children's Hospital in Zones A and B. Communications have been raised **with** Brookfield and they are addressing these, but some still remain outstanding. Other trades, particularly M&E, are progressing apace in these areas which may result in the completion of these details being awkward.

Roadway issues on the dual carriageway leading to Renfrew Road remain outstanding. Brookfield is aware of this and will rectify at an appropriate time in line with their programme for this area.

Light civil work to landscaping areas in courtyards has progressed and quality to date appears to be satisfactory. Work to drainage and an underground retention system at the south end of the site is almost complete with quality to date satisfactory.

The M&E installation quality is being maintained to a good industrial standard and we are generally satisfied that the installation is compliant with exception of the specific items raised under communication.

The M&E installations are progressing on all levels up to Level 12 and range from first fix module installation to completed and tested areas. Work is progressing within levels 2, 3 & 4 plantrooms. On Level 12 the ductwork and sprinkler installation is well in advance, together with the positioning and installation of plant and pipework. Positioning of electrical switch boards and the wiring of sub mains and BMS controls are in progress.

The installation of the CHP in the Energy Centre is in progress.

During April, we were in attendance during sprinkler pipework pressure tests in four areas, lighting control, computer room chilled water flow rates, ventilation plant, wireless access, dry riser pressure test and fire damper drop tests. Two of the tests witnessed were unsuccessful and these will be re-tested.

We are continuing to work with Brookfield during our inspections highlighting any items that have raised concern. Items identified in this manner are generally being addressed by the site team in advance of any defect notice being raised.

In general terms we are satisfied that the installations continue to be installed to a compliant standard, and are of a good quality. However we have noted that certain items this month have raised concern. These have been raised with the Contractor as follows:-

Supervisor's Communication General Matters / Other Instructions 204 and 205 were issued during April.

- Seeking confirmation that drop down grab rails will be adjusted to stay in the upright position.
- Seeking confirmation when finishing works to areas of the external slab will be completed.

Supervisor's Notification of Defect No 77 was issued during April.

- Seeking the method of treatment to prevent further rusting to the sprinkler pipes and when this will be carried out.

2.0 DESIGN COMPLIANCE CHECK

Currently nothing to report.

3.0 PROCEDURES REVIEW

3.1 Contractor's QA Procedures / Compliance Inspections

Quality and Compliance inspections

Brookfield and their subcontractors have continued with their QA and checking and inspection procedures during this period. We are in discussion and liaise with Brookfield's Quality Manager on QA matters and we undertake regular reviews of their QA documentation.

Quality and compliance inspections were carried out with Brookfield in a number of areas. Brookfield provided us with their quality packs which included a list of their outstanding works, defects recorded on to their IDMS system quality sign off sheets and drawings.

Together with Brookfield we carried out quality and compliance inspections on Level 0 Areas 0-506 and Level 1 1-506. The areas inspected were to a good standard and the defects captured by Brookfield were generally of a minor nature.

Quality & Compliance inspections were also carried out on Level 2, Areas 2-513 and 2- 514. The areas inspected were to a good standard and the defects captured by Brookfield were generally of a minor nature. However in on Level 2, Areas 2-513, 2-514 we noted that many of the drop down grab rails did not stay in the upright position. This was evident in all locations. There were also two doors leading onto the small flat roof area which had been hung on the wrong side.

We have asked Brookfield to confirm when the problem with the drop down grab rails have been addressed and any remedial work completed and other areas checked in the hospital for the same problem. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 204).

Quality & Compliance inspections were also carried out on Level 2, Areas 2-512 and 2- 510 and Level 0 Area 0-533 and 0-534. The areas inspected were to a good standard and the defects captured by Brookfield were generally of a minor nature. We did note that in a couple of rooms room base unit doors were hung in the wrong side and drop down grab rails did not stay in the upright position. In area 0-533 and 0-534 drop down grab rails were not fitted.

Quality & Compliance inspections were carried on Level 0 area 0-535 and the quality of the work is being maintained. However in one room doors to base units were hung in the wrong side of the unit. There was also another room which had less units fitted than was shown on the drawing Brookfield are reviewing this.

We carried out a Quality & Compliance Inspection of Level 2, Areas 2- 529 and 2-530 with Brookfield and the area inspected were to a good standard. We did however note a few defects which Brookfield recorded on their IDMS. These included unit doors hung on the wrong side, sink unit fitted as specified but a base unit fitted which was not specified. Brookfield is looking into this issue.

We carried out a Quality & Compliance Inspection of Level 0 Areas 0-536 with Brookfield and the area inspected were generally to a good standard. We did however note a few minor defects which Brookfield recorded on their IDMS. These included unit doors hung on the wrong side and walls. The General x-Ray Rooms RCG-053, RCG-077 and RCG-082 require partitions to be constructed and Brookfield await information from the client.

We have raised a Supervisor's Communication No 191 in relation to the Nurse call points not installed in these rooms and asked Brookfield to confirm when these works have been completed. Brookfield has confirmed that they are awaiting confirmation from Mercury when they will be fitted. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 191).

The recessed area on the right hand side of the wash hand basin in room OPD1-004 Level 1 Area 1-539 is congested. There is a nurse call, dispenser and grab rail to be fitted. We asked Brookfield to confirm how the fittings can be fitted within the present space or if there are any proposals to reposition fittings. Brookfield has confirmed that the OPD1-005 – nurse call is to be located to correct location as per 400series drawing and the grab rail may be situated on side panel but this has to be investigated. The OPD1-004 – IPS trespar location to be investigated on potential move to allow space for grab rail. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 194).

General Inspections

We carried out an inspection of the blockwork with Brookfield on the south and east elevation. The pointing in some areas is darker than the specified pointing. Brookfield intends to tint a sample area to demonstrate that a uniform colour can be attained to the pointing.

Zutec Review

We continue reviewed testing information on Zutec.

Acoustic Tests

Acoustic tests were carried out to partitions dividing the following rooms:

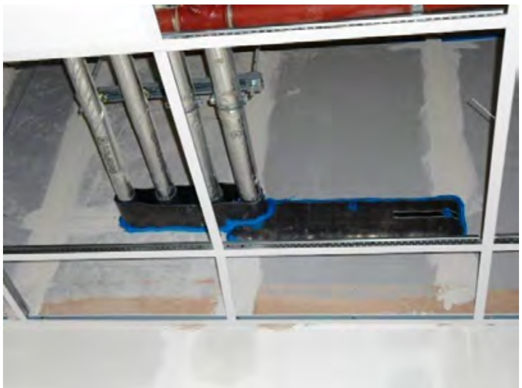
- THE 054 Cardiac Theatre to RCG 023 Image Analysis Laboratory.
- THE 103 General Theatre to STW 046 Single Bed.
- THE 103 General Theatre to STW 044 Single Bed.

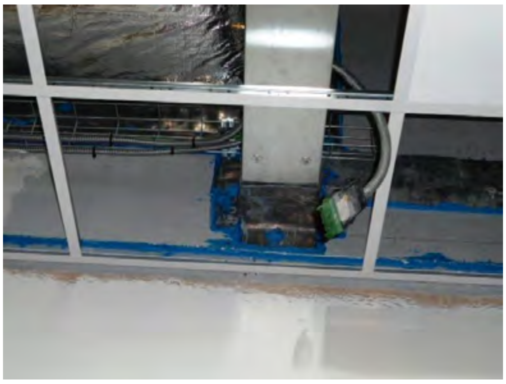
- THE 326 Recovery Bay to THE 327 Recovery Bay.
- THE 281 Reg Nurse Office to THE 282 Recovery Bay.
- RAF 035 Ultrasound to RAF 033 Mammogram.
- RCI 002 Anaesthetic to RCI 001 Dirty Utility.

The results were ambiguous and we have asked Brookfield for clarification. Only one partition did not achieve the performance criteria and that was the partition between THE 326 Recovery Bay to THE 327 Recovery Bay.

We await retest results for the partition between CCW 015 Relatives to CCW 014 Relatives.

We await details of the lead protection to ducts and penetrations passing through walls above the ceilings within Radiology. Brookfield has confirmed that drawing No AST-XX-XX-DT-252-112 from Astins has been given status B by both NHS and Brookfield with over marked comments. Brookfield discussed this with Astins and a test of rooms is planned for 1st May in specific areas on the ground floor. The results of these tests will confirm if the detail is satisfactory. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 163.





<u>85 point Checks</u>

No 85 point checks were carried out during the period.

<u>Above Ceiling Inspections</u>

We carried out above ceiling inspections of the partition walls with Brookfield on Level 1 Zones H and G and Level 0 Zones H. We identified defects such as missing or dislodged fire pillow at penetrations a few areas of missing fire stopping/acoustic sealant collar missing, incomplete fire stopping and fire damper bulb covered. The defects were recorded on a drawing and will be addressed. Below is a copy of the signed off "Pre- Ceiling Closure above Ceiling Sign Off Sheet" and a marked up drawing for part of the area inspected.

Other above ceiling inspections of the partition walls was carried out on Level 0 Zone G and level 2 Zone E. A few minor fire stopping defects were identified and recorded on a marked up drawings to be remedied later. These included missing or displaced fire pillows fire stopping incomplete and missing sleeve to vent. These were addressed and the area signed off by Building Control.

Brookfield Multiplex | BM

Pre-Ceiling Closure above Ceiling Sign Off Sheet.

Floor : 2 Zone : 2E NA Drawing No. : NA-XX-02-PL-572-104

PFP – Cavity Barrier Inspection.

*Note: Any defects found are to be notated in the comment box supplied and logged on the IDMS system / highlighted on the referenced drawing and attached to this sign off sheet.

Defect Free: ☐ Defect Found: ☑

Comments: VARIOUS DAMAGE MADE GOOD TO CAVITY BARRIERS

Acceptable: ☑ Defect Remediated: ☑

PFP Manager (Print): N.M^cPHEE Signature: [redacted] BMCE Manager (Print): C.WILSON Signature: [redacted]

Astins – Fire Compartment / Sub Compartment Inspection.

*Note: Any defects found are to be notated in the comment box supplied and logged on the IDMS system / highlighted on the referenced drawing and attached to this sign off sheet.

Defect Free: ☐ Defect Found: ☐

Comments: VARIOUS SEE ATTACHED DRAWING No. 1

Acceptable: ☐ Defect Remediated: ☐

Astins Manager (Print): TOM RUSS[illegible] Signature [redacted] E Manager (Print): C.WILSON Signature: [redacted]

BMCE Quality Manager – Fire Compartment / Sub Compartment / Cavity Barrier Inspection.

*Note: Any defects found are to be notated in the comment box supplied and logged on the IDMS system / highlighted on the referenced drawing and attached to this sign off sheet.

Defect Free: ☐ Defect Found: ☑

Comments: SEE ATTACHED DRAWING No 2. DO NOT CLOSE HIGHLIGHTED HASHED RED ROOMS.

Acceptable: ☑ Defect Remediated: ☐

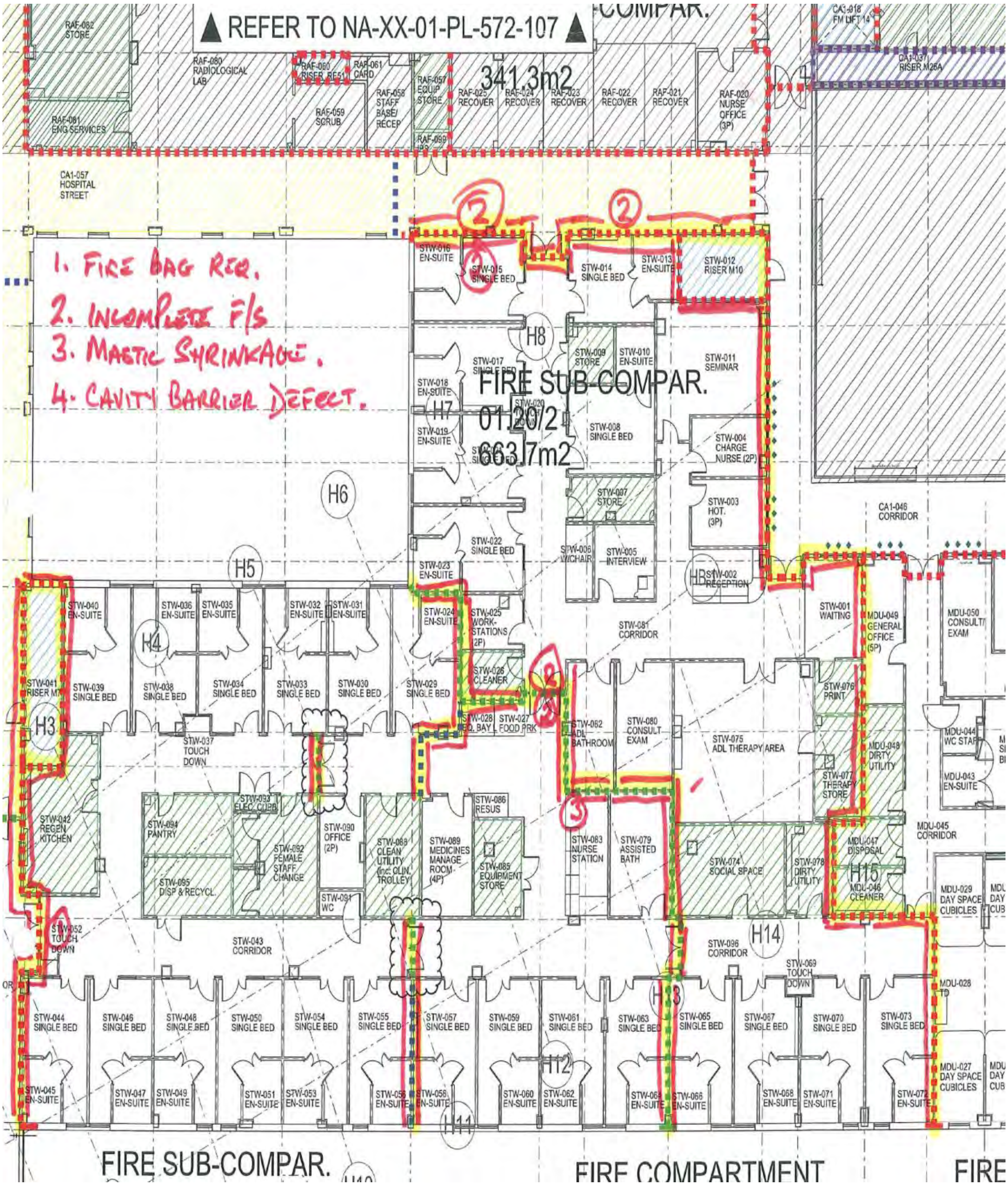
BM Quality Assurance MGR (Print): ____ Signature: ____ BM Manager (Print): ____ Signature: ____

Glasgow City Council Building Control – Fire Compartment / Sub Compartment / Cavity Barrier Inspection.

BCO Available at time off inspection Y/N. ☑ Acceptable at time of inspection in so far as can be reasonably ascertained ☑ Unacceptable Remediation Work Required. ☑

GCBC (Print): J. MUNRO 06/05/14 Signature: [redacted] BMCE Manager (Print): P. NORTON Signature: [redacted]

Comments: SEE ATTACHED DRAWING No. 3 DO NOT CLOSE HIGHLIGHTED HASHED RED ROOMS UNTIL REINSPECTED.



3.2 Witness Testing and Commissioning

We witnessed a number of tests during April 2014 which was satisfactory and these were as follows:

- Sprinkler pipework pressure testing. L2 riser 25a branches 211, 212 & 213.
- Lighting control in Level 4 & 5 zone H.

- Ground floor computer room chilled water witnessing.
- Ventilation plant witnessing in PR21 & PR31, on levels 0, 1 & 2.
- Vent plant witnessing. PR31 48 EF01 & AHU 48, 04 & 05.
- Sprinkler hydraulic test, Zone 201 M38 L2ZA, Zone 202 M38 L2ZA, Zone 203 M32 L2ZC & Zone 4 M32 L2ZC.
- Wireless access system.
- Sprinkler pressure test:
- Zone E & F, Sprinkler Zone 107 Riser M25 Area 507.
- Zone F & K, Sprinkler Zone 111 Riser M25 Area 501, 502, 503 & 504.
- Zone J, Sprinkler Zone 114, Riser M25, Area 537, 538 & 539.
- Dry Riser Pressure test at Core L.
- Fire damper drop tests in L4ZH, L5ZH and L6ZH.
- Twelve dampers tested, one failed. (VPI missing.
- Fire damper drop tests in L2ZJ, L2ZE, L2ZF, L2ZC and L3ZB.
- Sprinkler pressure test Zone 101 Riser CCB-007, Area 516, 517, 518, Zone 102 Riser CCB-007, Area 519, 520, Zone 103, Riser CCB-019, Area 506, 513, 514, Zone 104, Riser CCB-019, Area 511, 512.
- Sprinkler pipework pressure test in zone G12 riser M25A area 0 529 & 0 530 & zone G07 riser M25A areas 0 534, 0 507 & 0 508.
- PR31 Ventilation witnessing of AHU's 02, 06, 09 & 61.

We witnessed tests during April 2014 which were unsatisfactory. See below

- Pressure gauge at dry riser inlet inspected and confirmed reading 10 bar at start of test. The dry riser route was followed and all outlets inspected.
  Two of the outlets were found to be weeping slightly, which was put down to sludge and required further flushing. One air eliminator which was found to be closed on inspection was opened and found to be passing water. The eliminator was designated faulty. Brookfield drawing showed an outlet on the fourth floor which had not been installed. It was agreed that the riser outlets be flushed and cleaned, a new air eliminator be fitted and that checks made to see if an outlet should have been fitted on the fourth floor.
- VPI missing from Level 6 Zone H fire damper FD 6 511 001.
- VPI missing from Level 6 Zone H fire damper FD 0 530 013.

Previously witnessed tests which failed and has been re-tested successfully:

- PR31 AHU 16 - Airflows within theatre THE 354 to be retested.
  Retested satisfactorily 09.04.2014.
- Ventilation duct pressure test between Riser M25 Core D between Levels 4 and 12. This test passed. The issue was a lack of understanding of the duct fitter in what happens when the air is released.
- Fire alarm loop tests were carried out within L2ZA, L2ZE, and L1ZE, L1ZB and L1ZC panel 28 & L0ZE panel 11.
- Witnessing of fire damper drop tests Level 0 zone H:
  1. FD-0-527 002.
  2. FD-0-530-008.
  3. FD-0-530-013
- Witnessing of PR31 AHU 56, air flow below design at two grilles.

Previously witnessed tests which require to be retaken.

- Fire panel No 13 Level 0, 0-526 was tested and several smoke detectors and one call point activated satisfactorily. The test was aborted when on call point failed. New test date to be confirmed.
- FD-1-539-002 – The fire damper test lever was fouling adjacent ductwork. The fire damper is to be repositioned and retested.
- FD-1-518-001 - Difficult to access and activate damper link due to type of hatch fitted, and damper status indicator was obscured. A new hatch is to be installed and status indicator to be exposed.
- FD-1-539-003, Unable to access fire damper inspection hatch. A new inspection hatch to be fitted on opposite side of wall.
- Smoke damper verification and operational tests were carried out in Level 0 zones D & G which was aborted for the following reasons - One actuator not being connected, new hatch required in plaster board to gain access to one actuator and duplicate addresses being discovered on several other actuators tested. New test date 05.05.2014.
- Smoke dampers were tested in plantroom 31 and there were some which failed.

3.3 Board Equipment Installation,

Currently nothing to report.

3.4 Non Conformance Reports

We reviewed Brookfield's NCR Tracker and noted the issues raised by the Package Managers. The blockwork and pointing on the south and east elevations although improved by cleaning continues to be a concern with shading of the mortar evident. Prater has still to offer it up to Brookfield as complete reference NCR 156. We are also monitoring the issue in relation to water between the glass of the Structal Panels NCR reference 157 and 219. Brookfield has had an independent survey carried out by Cladtech Associates which has been forwarded to Structal. Brookfield has reviewing all the information and instructed the rectification of all of the outstanding issues. NCR 237 was issued to Astins in relation to the lack of insulation at abutments between internal partitions and external walls. This work is complete and an acoustic test is to be carried out.

4.0 CONSTRUCTION REVIEW

4.1 Visits to the Works

The following members of our team undertook site inspections, reviewed documentation, attended meetings and met with relevant Contractors representatives on-site personnel:- John Redmond (Lead NEC3 Supervisor) 1st to 4rd, 7th to 11th, 14th to 16th, 23rd to 25th and 28th to 30th. Douglas Wilson (M&E NEC3 Supervisor) 1st to 3rd, 7th to 11th, 14th to 17th, 22nd to 25th and 28th to 30th April. Willie Roxburgh (Civils/Structural NEC3 Supervisor) part days on 4th, 14th, 17th, 22nd, 24th and 30th April, plus remote desk top input most days of the month. Capita's NEC3 Supervisor's team visited site a combined 45 person days.

4.2 Elements of the Works available for inspection

- Energy Centre – structurally complete.
- Main building – all concrete areas. (becoming very limited due to access and partitions)
- Tunnels between ACH and Labs, and Cores C to F.
- Structural steelwork to all roof areas (partly limited due to access and partitions).
- Neuro bridge (partly limited due to access).
- Dual carriageway to Renfrew Road, turning area in front of the main entrance, and carriageway from Hardgate Road.
- South site drainage areas.
- Car park area.
- Internal partitions.
- M&E modular units.
- Roofing.
- Cladding.
- Windows.
- Sto system.
- Brickwork Courtyard 8, and 10.
- Brickwork/blockwork: Zone J North, East elevation and Basement Blockwork.
- Rainscreen: Zone F & C**.**

4.3 Current Observations

The visual inspections of the work carried out to date indicate that the works are generally being carried out to a satisfactory standard. We continue to be assisted by the site teams and the NHS Project Team in resolving various construction, mechanical, electrical, and quality issues. We continue to close out our Supervisor's Notification and Defects when we have received satisfactory responses. Listed below are observations closed out, still to be closed and those raised following site visits in March 2014.

4.3.1 Structural

At the Atrium Bridge in respect of final screeding the floor finish on the 4th floor will be used as a benchmark for all the other Atrium Bridge Floors. Floor screeding is completed and it is expected that the vinyl will commence in June.

Final elements of steelwork connections are still to be completed to the roof of the Children's Hospital in Zones A and B. Communications have been raised with Brookfield and are listed on the following pages. These still remain outstanding and have been examined with Brookfield who has indicated that these will be addressed at the appropriate time. However other trades, particularly M&E, are progressing apace in these areas which may result in completion of the above details being difficult. This has remained outstanding for approximately 6 months.

Roadway issues on the dual carriageway leading to Renfrew Road remain outstanding. Brookfield is aware of this and will rectify at an appropriate time in line with their programme for this area.

We asked Brookfield to provide technical solutions to various situations on the structural steelwork to the Children's roof where base plates are "floating"; edge distances are minimal or miss the concrete base. Cladding rails also prevented HD bolt fixing. The base plate details have been addressed other than at the north east door set on the fifth floor which Brookfield has indicated will be adjusted once the final door arrangement is known. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 141.

The steel framework in riser on Level 0 ZF Riser M30 has had the legs extended immediately in front of the entrance door. There are other legs which have not been extended yet and we asked Brookfield to confirm when the other legs will been extended. Brookfield has confirmed that these legs are not weight bearing and the weight bearing supports are on Level 01. They also confirmed that the extended legs will be cut back to be completely clear of the ground floor to finish flush with the frame. We asked for confirmation that the justification for this is based on an analytical assessment, and that the details provided are in accordance with this. We have received a further response but not an analytical assessment. We await a further response. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 162).

Extended legs

Leg still to be extended.

One of the base plates Level 4 Zone B has 2 out of 4 HD bolts either missing or not protruding through the baseplate. Brookfield has confirmed that post fixed anchors were installed and we will inspect this during our next site visit. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 182).

Several fixings to the underside of the roof slab for prefabricated framework supporting services on Level 3 zones E, K & F Zone 3-501 are not as originally intended. We asked Brookfield to confirm that what has been provided has been designed and that the installation is in accordance with that design. They have confirmed that the notification has been forwarded to the Mercury subcontractor for action. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 201).

The floor to the link bridge to the neuro-science block was cast during the previous period. The localised protruding top reinforcement from this reported in the last period has been addressed.

We are aware that Brookfield has instigated a report into the causes of the recent failure of one of the connections to one of the steel sections on the atrium roof support arrangement. We asked them to provide a copy of this to the NHS and ourselves when available. We have also asked them to confirm that all necessary safety precautions have been taken with respect to the overall atrium steelwork. We asked them to provide us with details of the proposed remedial actions when these are available and an early indication of timescale for these elements would be appreciated. Brookfield has confirmed that the report into the recent failure of a connection has been carried out and was issued by aconex 02/05/14. The report by David Dexter Associates, dated 15th April was issued to P Moir, D Hall and J Redmond. We confirm the report has been reviewed by WSP in advance of issue. See attached copy. Brookfield confirmed all necessary safety precautions were taken in respect of the atrium steelwork. The remedial actions are contained in sections 3 and 4 of the attached report. The remedial works will commence within a week or so. Approx during w/c 12/05/14. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 203 is closed out.

Car Park 1

The car park structural works are virtually complete with only the SW stairwell to be completed. Steelwork column foundation at the NE stairwell is still in need of remediation. Facing stonework is almost completed on the south and east faces and is of very good quality to date. Work is almost completed on the link road from the car park to Hardgate Road and quality is satisfactory, other than for minor snagging. Ground floor asphalt surfacing has been placed to the ground floor to a good quality standard to date. Some remedial work to concrete finishes, including at post tensioning positions, remains outstanding.

We have asked Brookfield to advise on their proposals to ensure that the column fixings to the foundations comply with the design intent. We have also asked them to confirm that grouting to the baseplates is in accordance with the specification. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 198).

Several areas of the external slab still require some finishing attention, particularly at the prestressing positions. See attached photograph. We asked Brookfield to advise how and when these areas will be addressed. They have informed us that Dunnes currently have operatives working on the inside of the ramps (photo 1) and should be complete by 9th May. They will access the areas above the car park access road using the cladding scissor lift which is due once the tower crane comes down. They expect this to be completed by 16th May. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 205).

4.3.2 Energy Centre

Steelwork snagging appears to have been addressed, but much tidying up remains outstanding in the eastern half of the building.

4.3.3 Above Ground Drainage

Work to drainage and an underground retention system at the south end of the site is nearing completion with quality to date satisfactory.

4.3.4 Dual Carriageway to Renfrew Road. (A&C)

The defects previously identified will be reviewed nearer to completion when they will be effectively rectified. This will also now include the significantly damaged kerb lines affected by the storage and lifting of the neuro-bridge sections.

4.3.5 Pipework.

Installation of hot, cold, heating, & chilled water pipework in the A&C hospital is progressing and in general is being installed to a good standard.

We are continuing to monitor all pipework installations to identify possible dead legs. The quality checking by Brookfield would appear to be identifying these before our inspections. Open unprotected ends are being monitored during our site inspections and there has been a marked improvement in all areas.

During our inspections in Plant Room 21, we noted that all AHU condensate discharges are routed to gullies via low level unprotected plastic pipework. This is a potential trip hazard. Below are photographs which show the solution to the problem and Brookfield has reported that this has been agreed to by NHS Board. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 122 is closed out.

Over the past few weeks there have been failures of crimped joints on Level 1 Area 1-533 and Level 0 Area 0-531. We asked Brookfield to confirm if they propose to carry out a percentage quality inspection of the crimped joints to identify if it is operative error. Brookfield has been informed by Mercury that a percentage quality inspection of crimped joints in the areas where the leaks have occurred have been conducted. They were able to trace operatives to the joints they formed. The cause being that a single operator in each leak did not adequately crimp a fitting. Tool box talks and refresher training have taken place; a pre-test check sheet to be completed by the relevant supervisor prior, during and after test has been produced along with an emergency procedure for all test personnel. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 202 is closed out.

4.3.6 Ventilation

We asked Brookfield to confirm that the fire rating of the flexible connections and supporting system in Plant room PR31 is equivalent to the overall system requirements. The fan is located adjacent to atrium at the west side of building. We also asked them to confirm fire rating of fans (observed as non-bifurcated type). ZBP has confirmed to Brookfield that fans require to be fire rated and are at technical submittal stage. Brookfield has issued an instruction to have the fans replaced. Brookfield has confirmed that the neck pieces are flame retardant to BS 7837:1996 Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 133 is closed out.

Following an inspection of Plant Room PR21 we raised a number of points all of which were clarified. These includeded difuser plate details and clarification on the specific fan power and the assocoiated design process. W4e shall continue to monitor the performance of the AHU's during final commisioning. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 137 is closed out.

We have asked Brookfield if the Isolation ductwork hatch to the fire rated ductwork in Plant Room 21 needs a double seal. This Notification has been forwarded to the relative floor manager and is being investigated. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 154).

We have brought to Brookfield's attention that materials are being stored within Plantroom 32 AHU 02 which can cause damage to the heating and cooling coil aluminium fins in plantroom 32 AHU 02. We have asked Brookfield to confirm their measures to address this bad practise. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 200).

4.3.7 Insulation

The thermal insulation installation to the pre-fabricated sections of pipework is being completed off site, before delivery and completed after installation. During our joint inspections with Brookfield we noted some damaged insulation within the plant rooms and these are being addressed. The ducting is currently being overclad with VentureClad Jacketing.

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4.3.8 Pressure testing

Pressure testing of the modular pipework sections on a zone by zone or area by area basis has been programmed through the commissioning meetings.

4.3.9 Medical Gases

Medical Gas pipework in being installed in all areas and independent tests are being witnessed by Ian Sandford of Hulley and Kirkwood.

4.3.10 Energy Centre

The installations in the Energy Centre are well advanced with the A-side systems commissioned and handed over. The installation of the CHP's is in progress.

4.3.11 Trunking

Cable trunking is being installed as part of the offsite fabricated sections that are being installed in the A&C hospital and in general the installation is to a good industry standard.

4.3.12 Cable Trays

Cable trays are being installed as part of the offsite fabricated sections that are being installed in the A&C hospital and in general the installation is to a good industry standard.

4.3.13 Cabling

Modular wiring looms are now being installed as part of the offsite fabricated assemblies and carefully tied up for protection and installation is of a good standard.

4.3.14 Conduit

Solid conduit installations are well progressed in the areas being fitted out and are to a good industry standard.

4.3.15 Void Detection

Nothing to report

4.3.16 Intake Sub Station

The Installation of the new transformer for Car Park 1 will coincide with all HV cables being pulled through to the Substation. It is anticipated that all cables will be pulled through during May 2014 to coincide with other work associated with the completion of the Car Park. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 30 & 45).

4.3.17 Partitions

The partition between the Snoozelum Room GW3-049 and the Medi Cinema has 50mm insulation fitted in the cavity. The Acoustic Logic Report ALC-SZ-SL-DC-660-001 reviewed by the client on 6/5/13 and by Brookfield on 16/05/13 specifies 100mm thick insulation. This supersedes a previous drawing AST-XX0XXDT-252-006 reviewed by Brookfield on 1/2/13 which shows no insulation. We asked Brookfield to confirm which specification is to be used to provide the required Rw 52dB. Brookfield has confirmed that they have issued the Communication to Astins together with the relevant drawings. They have asked Astins to issue the partition detail to comply with the required Db rating required at this location. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 192).

The partition between the east side of the atrium and plant room 41 has been damaged by water ingress. Brookfield to confirm they are aware there has been some damage, and will replace the boards after they have completed the resin flooring works. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 166).


Water damaged boards.

4.3.18 Roofs

A&C Roofs

Children's play area R3005 insulation has been completed and planters are being filled and planted.

Hotmelt work still to commence on Roof R3-004.

Roof R12-003 nearing completion.

Roof R3-003 work progressing to completion.

Roof R3-006 roof complete with landscape in progress.

Roof R4-008 work progressing to completion.

Roof R12-002 work progressing to completion.

Roof R12-001 work progressing to completion.

Podium roofs are nearing completion.

Roofs R4-010 hotmelt is complete.

R3-004 hotmelt still to commence.

R2-008 Hotmelt planned to commence this month.

The West Link Roof R12 between zones F and E have been retested and a number of repairs have been carried out.

Generally the quality of the workmanship throughout is to a good industrial standard and we have reviewed the QA documentation.

All the Sarna Roof covering is progressing to completion.

<u>Children's Roofs</u>

Hot melt is complete on level 2 balconies and Level 3 roof and the quality is to a good industrial standard.

R4-005, R6-002 and R1-007 hotmelt complete.

R5-005 hotmelt nearing completion.

4.3.19 Cladding/Courtyards

<u>A&C</u>

See comments under 3.1 Quality and Compliance Inspections.

The STO render to the upper panel on the east facing elevation nearest Core E has shaded areas visible below the finished surface. We asked Brookfield to confirm the appropriate action to ensure that there is a uniform covering to the panel and when completed. The panel has been recoated and the shaded areas are no longer visible consequently. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 160 is closed out.

<u>Children's Hospital</u>

The STO is in progressing in Core 2 and the West Elevation and the quality is to a good industrial standard.

<u>Blockwork</u>

Blockwork is nearing completion on the west elevation and is to a good industrial standard.

Cladding

Cladding is nearing completion at plantroom 41 A and is to a god industrial standard.

4.3.20 Windows

Windows are progressing on the external elevations and courtyards in accordance with the specifications.

4.3.21 Equipment

Nothing to report.

4.3.22 Ducting

Nothing to report.

4.3.23 Floors

We asked Brookfield to confirm their proposals to achieve level floors to the Atrium Bridge Corridors at door openings to offices/rooms and adjacent levels within these rooms. The atrium Bridge Floor on Level 4 has been screeded and we await confirmation when the vinyl will be fitted. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 145).

4.3.24 Blockwork

We have reported since April 2013 that the quality and standard of workmanship of the blockwork on the east elevations was not to a good industrial standard.

This was discussed on site with Peter Moir, John Redmond and Alasdair Fernie. It was agreed that the joint variance is as per the block sizes and no amount of remedial works would eliminate this. The repairs to damaged block and the cracks are to be addressed with a further visit required in around 6 weeks (Mid November) to allow the mortar colour to blend in. Brookfield has confirmed that they are awaiting the handover of the blockwork from Prater. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 165).

4.3.25 Security

No witnessing took place during the period.

4.3.26 Pneumatic Tube

Currently nothing to report.

4.3.27 Electrical Fittings & Fixtures

The pull cords in room CCU-065 on level 1 1-521 has been repositioned consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 140 is closed out.

4.3.28 Sprinklers

Nothing to report

4.3.29 Lighting

The quality of the general and emergency lighting installed to date is of a good standard.

4.3.30 Power

The quality of the small power installation installed to date is generally good with only minor defects noted which have been rectified.

4.3.31 Solar Panels

Nothing to report.

4.3.32 Fire Dampers

During the mechanical fire damper drop tests and the Quality and Compliance Inspections, several damper positional indicators have been found to be obscured by sealant. This is being addressed by Brookfield.

4.3.33 Heating

There are gaps in the thermal insulation in the back box of the remote TRV's mounted on external walls controlling the radiant panel heater in Level 0, ZA ward OBW 009. There is the likelihood that this will cause the TRV to be affected by the lower temperature in the partition void causing the Radiant panel to emit heat unnecessarily wasting energy. This applies to other similar TRV's on outside walls. We have asked Brookfield to confirm if this has been considered and if remedial action will be taken to address this. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 199).

4.4 Current Defects.

The smoke detector within the lobby on Level 1 Room CCW-049 is within 300mm of the supply grille. We asked Brookfield to confirm when this has been repositioned to the minimum distance of one metre. Mercury's specialist contractor has confirmed that In terms of BS5839-1 Clause 22.3 Paragraph M minimum spacing cannot be achieved. They cannot see how they are able to demonstrate the recommendation without infringing on

the minimum distance required to be away from the finished wall surfaces. They state further that due to third party equipment on the ceiling this restricts the position on the smoke detector. They state that it can remain in position. However this will mean that this is not compliant in terms of BS5839-1 Clause 22.3. Mercury together with their specialist fire systems installers is currently reviewing the position of the detectors. (See Supervisor's Notification of Defect (Cl 42.2) No 74).

The quality of the workmanship to the blockwork on the West Facing Elevation is poor and requires to be addressed. The widths of perpends varying at various locations on this elevation. This is particularly evident between the windows on the right hand side of the entrance to A&E. See photo. Brookfield has confirmed that the issue has been addressed. We carried out a further inspection and noted that the pointing was still darker that the surrounding joints. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 64.

Smoke detectors on Level 1 Areas 1-517 and 1-518 have been fitted too close to the walls in rooms CCW-100 Isolation Ward Lobby and CCW-147 Recess. Consequently these are not compliant with BS5839-1 Clause 22.3 which states that smoke detectors should not be within 500mm of any walls, partitions or obstructions to flow of hot gases. We asked Brookfield to confirm when the above smoke detectors have been repositioned. Brookfield has informed us that following a response from their specialist fire system installers the

CCW-100

positions of the detectors have been reviewed. They have informed us that the detector positions in room CCW-100 will remain unchanged. They claim they are in the best positions. This still remains a defect.

CCW-047

In room CCW-047 Brookfield's Sub Contractor Mercury together with their specialist fire systems installers is currently reviewing the position of the detectors. (See Supervisor's Notification of Defect (Cl 42.2) No 70).

MP-017

Smoke detectors have been fitted too close to the walls in rooms MP-018 Staff WC, MP-017 Staff WC, MP-002 Reception and MP-013 Cleaners. They are not compliant with BS5839-1 Clause 22.3 which states that smoke detectors should not be within 500mm of any walls, partitions or obstructions to flow of hot gases. We asked Brookfield to confirm when the above smoke detectors have been repositioned. Brookfield's Sub Contractor Mercury together with their specialist fire systems installers is currently reviewing the position of the detectors. (See Supervisor's Notification of Defect (Cl 42.2) No 71).

Smoke detectors have been fitted too close to the walls in rooms THE-268, 270, 271, 272, 273 and 274. Staff WC. They are not compliant with BS5839-1 Clause 22.3 which states that smoke detectors should not be within 500mm of any walls, partitions or obstructions to flow of hot gases. We asked Brookfield to confirm when the above smoke detectors have been repositioned and they have confirmed that they have passed the Defect notification to the installation team for further investigation and they are currently reviewing the position of the detectors. (See Supervisor's Notification of Defect (Cl 42.2) No 72).

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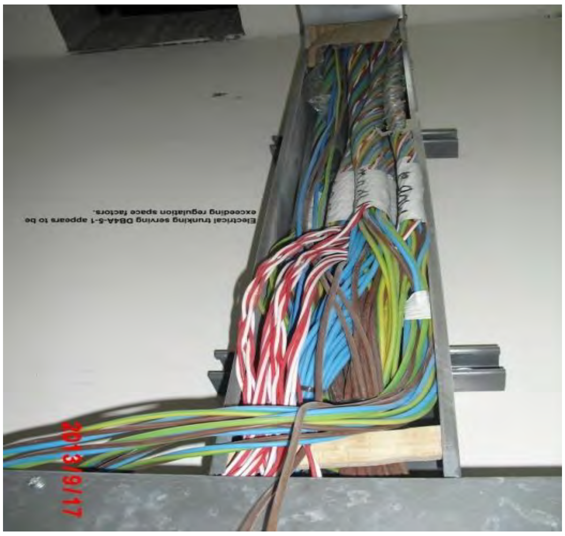
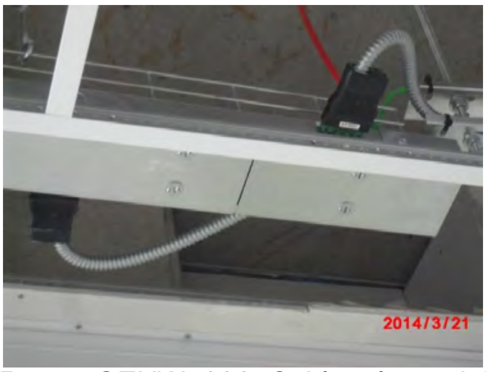
The wiring installed within the trunking at DB 4A-5-1 exceeds the regulated space factor for wiring installations as per section 4.5.3 of the 17th Edition of the IEE Regulations concerning cable capacities in conduits and trunkings. Confirm when this has been addressed. We have revisited the completed installation and are satisfied that the cables have now been posited properly within the trunking. Consequently Supervisor's Notification of Defect (Cl 42.2) No 73 is closed out.

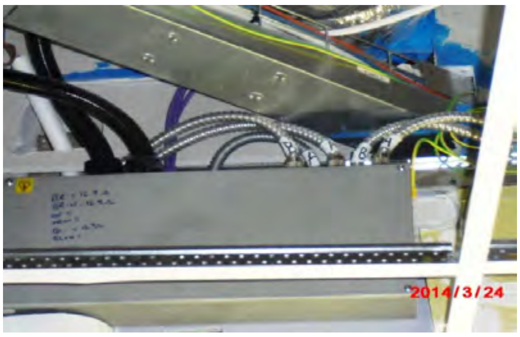


On Level 5 Zone J ward No GENW 006 a Metaflex type wiring system is being used to serve the power outlets in the bed head units. See photos. The cable is plugged into the Wago trunking in the ceiling void via a manufactured plug and drops down the vertical bed head trunking to the socket outlets. In other parts of the hospital installation (Level 1) the Metaflex cable is glanded into a metal box above the bed head dropper and then run within the trunking to the outlets.

In GENW 006 the Metaflex cables enters the trunking via an open end and run down the inside of the trunking with the end of the Metaflex cable bound with PVC tape. This is not a recognised practice for terminating this type of cable as it leaves a sharp ragged edge which can cause damage to either the cable conductors themselves or neighbouring cables. This practice is not confined to this area alone and is evident on other floors. We asked Brookfield to confirm when the cables are installed correctly in this and other locations where this is evident. Mercury has consulted with the manufacturer and has fitted an anti shorting bush to prevent damage. We have reviewed a sample and the modification appears to resolve the issue. Supervisor's Notification of Defect (Cl 42.2) No 76 is closed out but we will continue to monitor the installation.



Room GENW 006 Cable plugged into Wago power outlet.

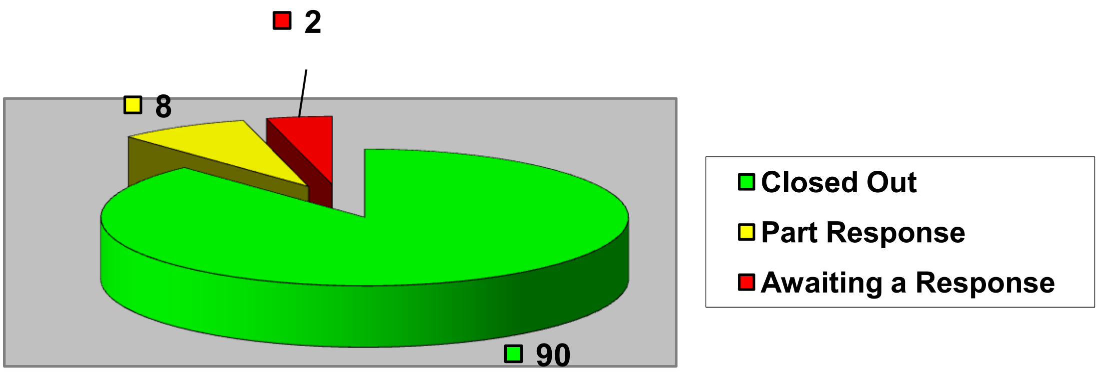


Level 1 Cable glanded properly into bedhead box trunking.

Metaflex cable incorrectly installed with PVC tape**.**

The sprinkler pipes on Level 2, Zone J, Area 2-532 are rusty. We asked Brookfield to confirm the treatment to prevent further rusting of these pipes and confirm when this will be carried out and completed. They have informed us that the defect notification has been forwarded to sprinkler specialist for their action. (See Supervisor's Notification of Defect (Cl 42.2) No 77).

5.0 INFORMATION REQUIRED



Item No.	Description	Date Requested	Comment	
Items 1 to 29 have been closed out				
30	Confirm when cabling is complete, water pumped out and batteries removed.	10.08.12	Response received.	
Items 31 to 44 have been closed out				
45	See Supervisor's Communication No 30.	18.09.12	Response received.	
Items 46 to 139 have been closed out				
140	Pull cords in 1-521 too far from wc.	18.07.13	Closed out.	
141	Please provide technical solutions to various issues to the steelwork to the Children's Roof.	23.07.13	Response received.	
Items 142 to 144 have been closed out				
145	Confirm proposals to achieve level floors to the Atrium Bridge Corridors at door openings to offices/rooms.	25.07.13	Response received.	
146	Confirm when smoke detector is repositioned to the required distance from the supply grille.	25.07.13	Closed out.	
Items 147 to 153 have been closed out				
154	Confirm if isolation ductwork hatch in Plant Room 21 needs a double seal.	26.08.13	Response received.	
Items 155 to 159 have been closed out				
160	Confirm the appropriate action to ensure that there is a uniform covering of the shaded STO panel on the east elevation adjacent Core E.	10.09.13	Closed out.	
161	Confirm when all medical gas valves are covered al floors.	12.09.13	Closed out.	
162	Confirm when the other legs have been extended to the steel framework in riser on Level 0 ZF Riser M30.	16.09.13	Response received.	
163	Provide details of the lead protection to ducts and penetrations passing through walls above the ceilings within Radiology.	16.09.13	Response received.	
164	Confirm when rodding eye inspection cover has been repositioned to allow access within toilet MDU-011.	17.09.13	Closed out.	
165	Confirm measures to improve the poor quality finish to the blockwork on the east elevation.	20.09.13	Response received.	
166	Confirm when water damaged boards in Plant Room 41 are replaced.	20.09.13	Response received.	
Items 167 to 174 have been closed out				
175	Confirm when the hotmelt areas damaged by temporary supports to Atrium Roof have been repaired and provide the accompanying QA information.	16.10.13	Closed out.	
Items 176 to 181 have been closed out				
182	Confirm that the 2 out of 4 HD bolts either missing or not protruding through the baseplate satisfies the design and specification intent or provide a remedial solution	30.10.13	Response received.	
Items 183 to 190 have been closed out				
191	Confirm that the nurse call points will be fitted in 1-537 Room OPD1-122 and 1-539 Room OPD1-097.	10.02.14	Response received.	
192	Confirm appropriate specification for the partition between the Medi Cinema and the Snoozelum Room.	12.02.14	Response received.	
193	Confirm if the mastic sealants which have been applied to junction of the horizontal beadheads and the vertical sections replace the specified preformed gaskets.	13.02.14	Closed out.	
194	Seeking confirmation how the fittings can be fitted within the present space or congested.	17.02.14	Response received.	

195	Confirm when suspended ceiling supports ar fitted on Level 0 Area 0-535.	27.02.14	Closed out.	
196	Confirm the procedures for accessing the valves in accordance with SHTM 2035 Section 5 on Level 0 Zone C in corridor OPD 024 adjacent OPD 025.	28.02.14	Closed out.	
197	Provide a copy of the Acoustic Test Report.	06.02.14	Closed out.	
198	Advise on proposals to ensure that the column fixings to the foundations comply with the design intent and that grouting to the baseplates is in accordance with the specification.	06.02.14	Open	
199	There are gaps in the thermal insulation in back box of remote TVR's. Confirm remedial action.	20.03.14	Open	
200	Materials being stored in AHU in plantroom 32	20.03.14	Open	
201	Confirm supports to services in Level 3 Zones E, K & F Zone 3-501 are in accordance with that design.	21.03.14	Response received.	
202	Confirm if quality inspections will be carried out to crimped joints.	21.03.14	Closed out.	
203	Provide report in relation to the failure of the steel connection, remedial measures and confirm that all necessary safety precautions have been taken.	26.03.14	Closed out.	
204	Confirm the remedial measures to address the issue of drop down handrail not being able to remain in the upright position. and confirm when complete	11.04.14	Open	
205	Finishing attention required to concrete slab confirm. Confirm when addressed.	30.04.14	Response received.	

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6.0 SUPERVISORS TESTS AND INSPECTIONS

Tests not required	**N/A**
Tests required but not tested	**Fail**
Tests required which has passed tests	**Pass**

Tests				
Ref	Title	To be Notified by	Status	Test Date
01-86	Various tests undertaken from the 9/07/2012 to the 30/06/2013.			
87	Smoke damper test verification - Level 0, zones D & G.	Brookfield	**Fail To be re-witnessed**	24.09.2013
88-100	Tests 28.09.2013 & 09.10.2013			
101	Fire alarm loop tests were carried out on L2ZA, L2ZE, L1ZE, L1ZB, L1ZC & L0ZE.	Brookfield	PASS	29.10.2013
102-113	Various tests undertaken from the 30/10/2013 to the 27/11/2013.			
114	L2 – 2-519 Fire dampers	Brookfield	PASS	12.02.2014
115	L1 1-539 Fire dampers	Brookfield	Fail	22.11.2013
115A	Fire panel No13 Level 0, 0-526 tested. On call point failed.	Brookfield	Fail	22.11.2013
116-119	Various tests undertaken from the 22/11/2012 to the 28/11/2013.			
120	1A & 1J - Fire damper drop tests. See 123 & 124 below.	Brookfield	N/A	29.11.2013
121-122	Various tests undertaken from the 28/11/2012 to the 29/11/2013.			
123	FD 1-518 001 Fire damper drop test.	Brookfield	Fail	29.11.2013
124	FD 1-539 002 Fire damper drop test.	Brookfield	Fail	29.11.2013
125	High voltage cable test between the main intake substation and substation 4A.	Brookfield	Pass	04.12.2013
126	Ventilation duct pressure test between Riser M25 Core D between Levels 4 and 12.	Brookfield	Pass	18.12.2013
127-138	Various tests undertaken from the 10/01/2012 to the 29/1/2014.			
139	Smoke damper tests in plantroom 31. Some fails.		FAIL	
140-150	Various tests undertaken from the 03/02/2014 to the 21/021/2014.			
151	Witnessing of ventilation balancing within PR31 AHU 16. Results within Plant room 31 satisfactorily, but airflows within THE 354 erratic and require be reviewing and retesting.	Brookfield	Pass	21.02.2014
152-159	Various tests undertaken from the 28/02/2014 to the18/03/2014.			
160	Fire Damper drop tests L0.	Brookfield	Pass	19.03.2014
161	Ventilation witnessing in PR31 and	Brookfield	Pass	24.03.2014

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	L0.			
162	Sprinkler pipework pressure testing. L2 riser 25a branches 211, 212 & 213.	Brookfield	PASS	01.04.2014
163	Lighting control in Level 4 & 5 zone H.	Brookfield	PASS	01.04.2014
164	Ground floor computer room chilled water witnessing.	Brookfield	PASS	09.04.2014
165	Ventilation plant witnessing in PR21 & PR31, on levels 0, 1 & 2.	Brookfield	PASS	09.04.2014
166	Vent plant witnessing. PR31 48 EF01 & AHU 48, 04 & 05.	Brookfield	PASS	
167	Sprinkler hydraulic test, Zone 201 M38 L2ZA, Zone 202 M38 L2ZA, Zone 203 M32 L2ZC & Zone 4 M32 L2ZC.	Brookfield	PASS	11.04.2014
168	Wireless access system.	Brookfield	PASS	14.04.2014
169	Sprinkler pressure test: Zone E & F, Sprinkler Zone 107 Riser M25 Area 507 Zone F & K, Sprinkler Zone 111 Riser M25 Area 501, 502, 503 & 504 Zone J, Sprinkler Zone 114, Riser M25, Area 537, 538 & 539.	Brookfield	PASS	16.04.2014
170	Dry Riser Pressure test at Core L	Brookfield	FAILED	17.04.2014
171	Fire damper drop tests in L4ZH, L5ZH and L6ZH. Twelve dampers tested, one failed. (VPI missing)	Brookfield	One damper failed	24.04.2014
172	Fire damper drop tests in L2ZJ, L2ZE, L2ZF, L2ZC and L3ZB.	Brookfield	PASS	25.04.2014
173	Sprinkler pressure test Zone 101 Riser CCB-007, Area 516, 517, 518, Zone 102 Riser CCB-007, Area 519, 520, Zone 103, Riser CCB-019, Area 506, 513, 514, Zone 104, Riser CCB-019, Area 511, 512	Brookfield	PASS	25.04.2014
174	Sprinkler pipework pressure test in zone G12 riser M25A area 0 529 & 0 530 & zone G07 riser M25A areas 0 534, 0 507 & 0 508.	Brookfield	PASS	29.04.2014
175	PR31 Ventilation witnessing of AHU's 02, 06, 09 & 61.	Brookfield	PASS	29.04.2014
176	VPI missing from FD 0-530 013	Brookfield	FAILED	29.04.2014

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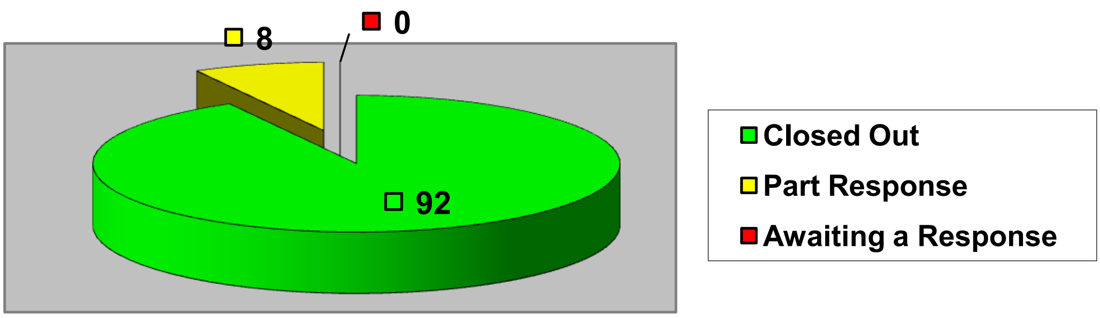
7.0 DEFECTS NOTIFICATIONS ISSUED



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	Description	Date Requested	Comment	
Items 1 to 63 have been closed out.				
64	Confirm when poor quality blockwork / perpends are addressed.	29.07.13	Response received.	
Items 65 to 68 have been closed out.				
69	Confirm that ducts are to the required fire rating or if dampers are required to ensure the appropriate fire integrity of the partitions in rooms CCW-032, CCW-034 and CCW-033.	19.02.14	Closed Out	
70	Confirm when smoke detectors fitted too close to wall have been repositioned	11.03.14	Response received.	
71	Smoke detectors have been fitted too close to the walls in rooms MP-018 Staff WC, MP-017 Staff WC, MP-002 Reception & MP-013 Cleaners. Confirm when addressed.	29.03.14	Response received.	
72	Smoke detectors have been fitted too close to the walls in rooms THE-268, 270, 271, 272, 273 and 274. Staff WC. Confirm when addressed.	29.03.14	Response received.	
73	The wiring installed within the trunking at DB 4A-5-1 exceeds the regulated space factor for wiring Confirm when this has been addressed.	21.03.14	Closed Out	
74	Confirm when the smoke detector in room CCW-049 which is too close to a supply grill will be repositioned.	24.03.14	Response received.	
75	Confirm when sprinkler elbows and tee pieces are painted.	25.03.14	Closed Out	
76	Confirm when metaflex cables are installed correctly level 5 Zone J.	26.03.14	Closed Out	
77	Confirm the treatment to prevent further rusting of sprinkler pipes and confirm when this will be carried out and completed.	30.04.14	Response received.	

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John Redmond, Technical Advisory Services

Property and infrastructure
Capita, The Beacon, 8th Floor, 176 St Vincent Street, Glasgow G2 5SG

	Signed	Date
Originated by	John Redmond	6th May 2014
Completed by	David Ramsay	6th May 2014

NEW SOUTH GLASGOW HOSPITALS

SPECIFICATION

CHP SYSTEMS

Ref: ZBP-EC-XX-SP-532-263

Rev: F

Date: Sept 2014

Wallace Whittle

Wallace Whittle

Specification Check / Revision Sheet

Project	**New South Glasgow Hospitals**	Project Number	**2900**
Service (s)	**Mechanical & Electrical**	Sheet	**1 of 1**
Performance Specification Title	**CHP Systems**	Date	**September 2010**
Prepared By	**MP**	Checked By	**NR**

Revision Ref.	Date of Revision	Page N$^{o(s).}$	Revision Details	Checked By
01	23 August 2010	All	Draft issue	NR
02	21 Sept 2010	6,7	CHP sizes added & Issued for Comment	EP
03	18 April 2011	-	Revised for discussion in Stage 3	EP
04	15 September 2011	-	Revised for discussion in Stage 3	SP
05	January 2012	-	Revised for T1, for comment	EP
A	July 2012	various	Carbon target paragraph added, drawing list amended and schedules updated	AP
B	August 2012	15	Minor amendment to clause 9.1	AP
C	November 2012	-	Appendix C added Section 10.8 added Section 1.0 amended as indicated	SP
D	December 2012	various	Amendments following client comments	AP
E	February 2013	Various	Amendments following RDD review	SP
F	September 2014	N/A	RDD Comments response sheet added	

TUV SUD WALLACE WHITTLE
RDD COMMENT/RESPONSES

Document Revision Reviewed	**E**
RDD COMMENTS	**RESPONSE**
This specification has been reviewed & agreed as suitable for tender issue via low carbon workshops & whilst some detailed reservations exist (refer to L.C.tracker) the detail, as agreed, will be developed with the selected supplier.	Noted

NEW SOUTH GLASGOW HOSPITALS
CHP SYSTEMS

OVERALL FRAMEWORK OF TENDER DOCUMENTATION

CONTRACT DOCUMENTATION-PRELIMINARIES

General Preliminaries relating to the BMS (By others as separate document)

CHP SPECIFICATION

PARTICULAR SPECIFICATION
General Description of Requirements.

MATERIALS AND WORKMANSHIP CLAUSES

APPENDICES
Specification Appendices and Technical Schedules

DRAWINGS

REFER TO APPENDIX B

NEW SOUTH GLASGOW HOSPITALS SPECIFICATION

COMBINED HEAT & POWER SYSTEM

CONTENTS

APPENDICES

1.0 GENERAL INTRODUCTION

Purpose of Document

The development of the scheme, manufacture, supply, installation, wiring, setting to work and commissioning of the works described in this document shall be undertaken by the Sub-contractor.

The Sub-contractor shall obtain the necessary supporting documentation including but not limited to that listed in Appendix A.

This specification relates to the CHP installation to be provided as part of the Energy Centre works. It shall be read in conjunction with the other specifications issued as part of the overall works.

This specification shall be read in conjunction with all other mechanical and electrical engineering services specifications and the architectural drawings.

The Sub-contractor shall, provide with their return tender, a statement confirming that their offer meets the specification in full, or advise of any areas where their offer does not comply.

The sub-contractor shall provide the information as defined in Appendix C with the returned tenders for the CHP systems to allow the Client to determine the best over life cycle option for selection of an appropriate supplier of the system.

The design of the CHP system and integration into the mechanical and electrical systems is based upon discussions held with one particular supplier. The sub-contractor may offer alternative manufacturers who are able to meet or improve upon the design criteria as stated in this specification. However, should any modification be required to the system to accommodate an alternative supplier the sub-contractor shall be fully responsible for any redesign necessary or design costs arising therein.

Drawings

As part of the development of the scheme the Sub-contractor shall prepare co-ordinated working drawings which shall include general arrangement drawing sections, elevations and schematics, of the works to be provided. These shall be based on the Architect’s base drawings and coordinated with other services and building elements.

Carbon Target

The hospitals have a stringent carbon target of 80kg/m^2 per annum and the engineering services have been designed with this strictly in mind. The Sub-contractor shall not deviate from the proposed designs without consulting with the Contractor and providing evidence on how the deviation impact on energy usage and hence the carbon target.

2.0 SCOPE

The scope of work covered by this specification is for three CHP generating systems each including but not limited to the following:-

- Gas fired reciprocating engine
- 11000V alternator/generator

- The provision of Medium Temperature Hot Water
- Connections to the HV switch panels
- Controls with computer supervision backed up by UPS c/w standby
- Full communication interface with the on-site Building Management System and Electric Network Management System
- Metering equipment to assess heat and electricity output
- Metering equipment to assess heat dumped
- Metering equipment to assess gas intake
- Metering software in the controls strategy to determine the CHP quality index as defined by Inland Revenue and carry out energy efficiency evaluations
- Mains synchronising equipment
- Connection to HV system in accordance with G 59.2
- Electric motor starting system
- Power isolator
- Fuel handling system
- Fuel cut-out system
- Neutral Earthing Resistors and associated controls
- Acoustic enclosure
- Acoustic equipment
- Forced air ventilation system for the enclosure
- Flue exhaust system with support structure
- Acoustic measures including inlet and outlet attenuation
- Lighting, emergency lighting and small power in the enclosure to facilitate maintenance operations
- Fire and gas detection activated safety fuel shut-off valves
- Site mechanical and electrical installations including all connections between the components in the scope of this contract and interfaces to the site systems
- Testing
- Setting to work
- Commissioning
- Demonstration that the system meets good quality CHP as defined by Inland Revenue, either making sufficient heat demand available at the secondary heat exchanger or via use of the heat dump unit as a simulating facility. This shall include the provision of all necessary meters, including for each unit:
    - Heat
    - Power
    - Gas

The foregoing summary is intended for the general guidance of the Sub-contractor in the preparation of his Tender. Any omission from it shall not relieve them of their obligation to carry out the whole of the works herein described and/or indicated on the drawings.

3.0 SPECIFIC EXCLUSIONS

Fire alarm systems, and telecommunications systems requirements that do not form part of the CHP installation are generally covered in separate documentation, for the provision by others.

4.0 APPLICABLE STANDARDS

All elements of the works shall be designed and installed in accordance with the requirements of SHTM 06-01, IEE Wiring Regulations BS 7671 (17^{th} Ed.), current legislation, regulations and industry standards, including British Standards unless otherwise stated.

The complete installation shall comply with the requirements of CHPQA (Department of Energy and Climate Change Quality Assurance Programme).

5.0 DESIGN CRITERIA

The attached CHP schedules in appendix B are to be referred to for the design criteria.

Under normal conditions the CHP units are to run to meet the MTHW demands of the heating system. The electrical power generated from the production of the Medium Temperature Hot Water demand shall be used to serve the Hospital's electrical power system. With this in mind, the switching on, off and stepping up/down of the CHP units shall be matched to the requirements of the MTHW system.

The CHP systems shall however be controlled so they do not export power from the NSGH electrical systems to the SPEN supply network. This shall be achieved by providing an integral power monitor and ensuring that under lower NSGH Electrical site load conditions one or more, as appropriate, of the CHP units are automatically ramped down or isolated.

6.0 LIAISON

The Sub-contractor shall include for liaison with:-

SPEN. The Sub-contractor shall include for liaison with SPEN to ensure the requirements for parallel operation of the CHP units and the mains incoming supplies are met.

Health and Safety Professionals. As well as the Health and Safety requirements of this specification, the Sub-contractor shall include for close liaison with Health and Safety professionals including the Hospital's Health and Safety Advisors and the CDM Co-ordinator and shall comply with the CDM Regulations and all Health and Safety Regulations.

The Contractor. The Sub-contractor shall liaise with the Contractor through whom all communications must flow. Drawings and other documentation will be available via the Contractor. The Sub-contractor shall include for liaison with members of the Contractor's team with an interest in the planning and administration of the systems. This shall include liaison with the supplier/manufacturer of the louvres, the provider of the flue exhaust system, the BMS specialist and the ENMS specialist.

The Sub-contractor shall satisfy themselves of the suitability of the products and installation details being provided by other specialists.

The Hospital. The Sub-contractor shall include for liaison in conjunction with the Contractor with members of the Hospital's team with an interest in the planning and administration of the Systems.

Building Control. The Sub-contractor shall liaise, with and adhere to, the requirements of the Building Control Officer.

Any other member of the Project and Hospital teams concerned with the planning and administration of the installations.

7.0 MECHANICAL

7.1 Air for Combustion & Cooling

A fan assisted ventilation system shall be provided for combustion, to dissipate heat build up within the CHP enclosure and the rejection of waste heat (e.g. from any low grade water).

Incoming ventilation air shall be ducted from louvres located on the south elevation to inside the CHP enclosure. The exhaust from the CHP enclosure shall be fan assisted ducted to the external louvres on the north wall.

Automatic multi-bladed dampers shall be provided on the inlet and discharge. The dampers shall be arranged to open on the start signal for the appropriate CHP and to close once that engine has stopped running and residual heat dispersed.

In addition a radiator coil shall be located in the ductwork, to reject low grade waste heat. This is in addition to the CHP Heat Dump facility from the Medium Temperature Hot Water.

The ventilation system shall be designed, installed and set to work within the following criteria:-

a) Taking into consideration the louvre sizing and types provided, considering noise, vibration, velocity and pressure drop.

b) The intake air temperature to be used in calculating the air requirements shall be 30°C.

c) The maximum summertime air temperature exhausted from the louvres shall be based upon the heat dissipated from the unit and shall be no more than 50°C.

d) The maximum air volume per CHP, for combustion and cooling, is to be $18m^3/s$. Ventilation fans are to be inverter driven for variable volume control to conserve energy when ambient conditions are suitable.

e) The ductwork design and installation shall meet the requirements of Heating and Ventilation Contractors Association Document DW142.

f) The ventilation system shall keep the CHP enclosure close to the optimum temperature for the effective operation of the CHP units. Therefore in winter, the heat from the CHP can be used to keep the enclosure warm, but this should not *be* above 30°C or shall be as required by the CHP manufacturer.

g) Acoustic details mentioned in later sections.

7.2 Sound Attenuation

The operation of the whole CHP system shall be within the noise limits as set down in the Acoustic Consultant's report. The following criteria provide the basis of acoustic selection of the noise control components of the installation.

Acoustic Enclosure

Acoustic enclosures to each CHP unit shall be provided. The acoustic enclosures shall include:-

- Acoustic lining
- Access doors to enable full maintenance of the CHP unit
- Air inlet and air discharge ducts connecting the enclosures to the external louvres
- Air inlet and discharge attenuators with automatically opening and closing dampers on the internal faces of the units

The discharge air paths shall be sealed against the building fabric to prevent leakage back into the CHP room.

The Tender shall be inclusive of the design, supply and installations of the acoustic enclosure to house the CHP engine plant, and confine ventilation of the CHP plant to within the enclosure.

The CHP acoustic enclosure shall form part of the route for ventilation air to avoid the need for ventilation of the entire plant area. The Sub-contractor shall provide all necessary intake and discharge attenuation to achieve noise levels stated.

The acoustic enclosure size shall be developed to ensure that it:

- Co-ordinates with other services in the room
- Co-ordinates with the building fabric and structure
- Allows maintenance to all plant and distribution systems as detailed within the HTMs

The Sub-contractor shall give due consideration to the need to maintain maintenance access around the entire CHP enclosure and allow for ducting ventilation air accordingly. Internal access and spatial arrangements shall be adequate to allow all maintenance functions and repairs.

The enclosure shall be with an anticipated life in excess of 20 years, and shall satisfy the noise criteria detailed below.

The acoustic enclosure shall achieve maximum breakout noise levels within the CHP room, per CHP unit of 75 dBA at 1 m from the enclosure.

Each enclosure shall be provided with adequate access doors for plant servicing and replacement of major components. Access doors shall have emergency escape panic bars or similar in the event that personnel become trapped.

Locally activated lighting shall be provided within the enclosure.

Inlet and Discharge Attenuators

The external noise level at 3m from the inlet and discharge louvres shall be no more than 55 dBA.

To achieve this separate air inlet and discharge attenuators shall be provided for each of the 3 No CHP sets.

The necessary attenuators for the CHP room are to form part of the Sub-Contract works and the Sub-contractor shall take account of the pressure drop across/through them when selecting/sizing the air attenuators and fans for the CHP acoustic enclosures.

Attenuators shall be of the dissipative type and constructed of specially selected high quality materials.

Outer casings shall be made of galvanised sheet steel.
Each unit shall be constructed to prevent air leakage. Internal splitter units shall have aerodynamic leading and trailing edges to reduce pressure drop across them.

The acoustic infill shall be of inorganic high density bonded long stranded rock wool sufficient to obtain the specified acoustic performance and packed under compression to eliminate voids due to vibration and settling. Infill material shall be insect, vermin and moisture proof.

The attenuators shall be manufactured in modules to enable them to be removed and replaced so that major maintenance works can be carried out, and to enable initial installations to be achieved.

Each module shall have a rolled steel angle frame and shall be capable of free standing without distortion, sagging or mechanical damage.

Provision shall be made on each module to allow fixing of mechanical and acoustic seals. Each module shall be located firmly in the builders work opening.

All attenuators to have double skin casings on all four sides to prevent flanking.

CHP Flue Exhaust Attenuators

Provide attenuation within the exhaust flue system to reduce noise, at source, to the acceptable level of 60 dBA (per CHP unit) at 3 m from the flue. The CHP Sub-contractor shall provide the flue and exhaust attenuator to outside the acoustic enclosure, for connection to by the flue Sub-contractor.

Locate attenuation within the CHP Room.

Louvres

The Sub-contractor shall liaise with the louvre manufacturer/supplier to ensure that their scheme takes full consideration of the louvres being provided. The Sub-contractor shall ensure that the fans provided with the CHP package are able to overcome the pressure drop through the louvres. The Sub-contractor shall ensure that the CHP system, including noise generated velocity, pressure drop and noise, by or through the louvres, meets the design criteria.

7.3 Heating

The CHP units shall be used to generate medium temperature hot water. There are two boiler rooms within the Energy Centre each with an installed boiler capacity of 20 MW.

The three CHP units shall be connected in parallel and be piped to serve both the plantrooms.

The CHP units shall act as the lead boilers and feed the MTHW into the selected Primary Flow header.

Circulation/shunt pumps shall be provided to each CHP unit to suit the flow rates and pressure drops into each of the MTHW systems. The pumps shall be part of the CHP package and located within the Acoustic Enclosure.

The primary purpose of the CHP is to provide Medium Temperature Hot Water. In instances where there is insufficient MTHW demand for the boiler systems, then a CHP unit shall switch off and any residual heat shall be dumped via dry air coolers on the roof of the Energy Centre. The dry air coolers are to be provided within the CHP package.

The BMS shall provide the CHP control system with the required MTHW load. The CHP controls systems, both individually and together, shall modulate their controls system to ensure that the required load is provided in the most efficient way taking into account variation in load and limiting the number of starts of individual CHP units.

The CHP Units shall be controlled by their own controls system to provide a constant 105 °C flow.

Whilst the output from the CHP units shall be modulated by the CHP controls system varying the speed of the unit's engines, the CHP pumps shall also be inverter driven. This is so as to allow the output from the individual units to be modulated between 50 and 100%.

Each CHP Unit shall be provided with a duplicate variable flow circulating pump set to circulate water through its associated CHP Unit and to the Primary MTHW header. A motorised valve on the inlet to the CHP Unit shall close when the CHP Unit is not enabled to run. Upon receiving an enable signal the valve shall open and auxiliary contact on the valve shall then enable the CHP Unit pump to run. Upon CHP Unit shut down the duty pump shall be run only when the CHP Unit is signalled to run by the sequence controller. The CHP Unit pump sets shall be monitored by differential pressure switches.

The CHP units shall modulate their output from between 600kW to 1200kW each to keep the varying water volumes at the constant 105 °C.

The following table gives indicative modes of operation based on outputs from the BMS. It shall be for the CHP supplier to determine the optimum operating arrangement based on their selection of the units.

MTHW Load	Total MTHW Flow Required	CHP 1	CHP 1	CHP 2	CHP 2	CHP 3	CHP 3
0 – 600kW	0-4.8l/s	Off		Off		Off	
600 – 1200kW	4.8-9.6l/s	On	Modulate 600-1200	Off		Off	
1200 – 1800kW	9.6-14.4l/s	On	Modulate 600 – 900 kW	On	Modulate 600 – 900 kW	Off	
1800 – 3600 kW	14.4 – 28.7l/s	On	Modulate 600-1200 kW	On	Modulate 600-1200 kW	On	Modulate 600-1200 kW

The CHP units shall be interlocked with the CHP pumps.

The CHP units shall take it in turn in equal periods to be the 'lead unit'.

The design return temperature for the return to the CHP is 75 °C. Should the temperature rise above 80 °C then a three port heat dump control valve shall open to divert some of the water around the roof mounted dry air coolers, until the return water temperature to the CHP units has been reduced back to 75 °C. The control of the dry air units themselves shall be by the CHP control system. The fans on the dry air coolers shall modulate to reject the unwanted heat.

The CHP tenderer shall advise of any limitations with regards the maximum number of ‘starts’ over a 24 hour period.

Each CHP unit shall have its own integral safety controls and high temperature lock out thermostats.

The temperature differences shall be adjustable to permit flexibility of operation during commissioning and general use.

The operational sequence shall allow all the control set points to be adjusted in line with the common boiler system flow temperature, as it is modulated relative to the building loads. The operational sequence set points shall be interlocked with the CHP set points so that the performance of the CHP is not inhibited.

When a CHP is shut down by the control system, water shall continue to pass through the CHP unit for a period of time (variable) to dissipate stored heat, at which point the CHP pump shall shut down and the motorised valve close.

Any fault that prevents the CHP from operating shall be raised as a high priority alarm.

The CHP controls shall also monitor the gas safety valve circuit.

The CHP, boilers and primary heating system shall all operate on a 24-hour continuous basis and therefore shall not be time clock controlled.

The CHP controls shall monitor the time operation of the CHP and the software shall include change of lead CHP or pump sequence either on a hours run basis.

In the event of a mains power failure, the controls shall arrange for the CHP system to restart immediately on power restoration. The CHP controls shall, by communicating with the ENMS and by monitoring of the electrical power supply and standby generators, be aware that the original shut down was not a plant fault and be ready for a sequence re-start.

In maintenance mode only the CHP shall operate on their own integral thermostats, under manual switches, but with all safety features in place to provide emergency usage in case of a BMS or controls fault.

The CHP controls shall monitor the inlet gas pressure and/or a failure of pressure, raise alarm and shut down the CHP.

The Specialist shall supply and install a common gas pressure sensor within the circuit serving the CHP units to detect loss of gas supply.

In the event of the CHP controls system monitoring a gas fault on any one CHP unit and the common gas pressure sensor signalling the required pressure, the CHP system shall automatically shut down the faulty CHP unit

The Specialist shall provide flue temperature sensors to monitor the temperature of flue gases within each CHP flue.

The following shall be provided by the CHP Controls system, for each CHP unit, for monitoring by the BMS:

- Grid voltage.
- CHP generator voltage.
- Grid frequency.
- CHP generator frequency.
- Synchroscope.
- Ammeter
- KWH meter.
- Engine tachometer.
- MTHW Flow Temperature
- MTHW Return Temperature
- kWhrs being dumped via the Dry Air Cooler heat rejection system
- Heat Rejection Flow Temperature
- Heat Rejection Return Temperature

7.4 Base Frames

The base frame of the CHP units shall be fabricated from mild steel sections and designed to carry and distribute the weight of all the components, without undue distortion or deflection, both when in use or in transit. The base shall be complete with all necessary holding down points, jacking points and lifting points. A suitable paint finish shall be applied at works to the whole of base frame.

All dynamic components mounted on the base frame, i.e. engine, shall be complete with anti-vibration mountings.

The engine shall be fitted with torsional damping to minimise dynamic vibration.

The complete unit shall be mounted on an inertia base designed, supplied and installed by the Sub-contractor.

The Sub-contractor shall also identify the floor loadings required for the replacement of major plant items, e.g. alternator.

7.5 Engines

The packaged CHP set engines shall be of proven design specifically intended for static industrial power generation, with low operating stresses and an anticipated life in excess of 20 years. All wearing components such as bearing, valves, seats, pistons etc. shall be replaceable and readily available.

The engine shall be suitable for use with natural gas and shall be supplied complete with all necessary control valves, safety valves, low pressure cut off valves, and safety valve test and gas purge points as required by the design and shall not be less than those required to comply with all aspects of British Gas Publications including IGE/UP/3. All connections to the engine shall have flexible connections to stop vibration being transmitted to other equipment. The engine shall be complete with a pressurised oil lubrication system, cooling system complete with pump and all necessary controls to avoid damage due to overheating or oil pressure failure.

The engine fuel control system shall maintain the air fuel rates to the engine within the flammability level of natural gas under all load conditions.

The units shall be low Nox type to achieve Nox emissions of less than 500mg/m^3 (at 5% oxygen).

7.6 Primary Fuel Supply

The fuel supply to the CHP units will be natural gas at a pressure of approx. 100 mbar.

Facility shall be provided on the engine for the connection of the gas supply.

The fuel supply pipework shall be brought within the CHP plant room by others. Final pipework runs and connection shall be by the Sub-contractor. This shall include flexible connections to prevent damage due to engine set vibration.

Flexible connections shall be in accordance with the Code of Practice for Natural Gas Fueled Engines, British Gas IGE/UP/3:

1. A length of flexible pipe shall be incorporated in the gas supply to the engine to isolate any vibration, whilst being as short as is practicable.

2. The flexible pipe shall be sited downstream of at least one of the safety shut-off valves.

3. The flexible pipe shall be of metal reinforced and preferably armoured construction, suitable for continuous use at 3.5 Bar (50 psi) or three times the working pressure, whichever is the greater.

4. The flexible pipe shall be able to withstand engine suction without sustaining damage.

5. The flexible pipe shall be installed in a position where it shall not be weakened by heat from the engine system.

6. The flexible pipe shall be installed so that it is not subjected to tension, torque or other forces likely to cause damage.

7. Adequate means shall be provided for sensitive test for gas tightness of the flexible pipe and its connections. Full consideration shall need to be given so as to ensure that leakage tests can be performed frequently as part of the scheduled maintenance procedure of the plant.

7.7 Heat Recovery

Heat recovery from the CHP sets is to provide medium temperature hot water.

The packaged CHP set shall be complete with on-set heat exchangers for heat recovery from the various circuits. The exchangers will be complete with all associated pumps, pipework, controls, sensors, etc to provide a complete fully functioning system, suitable for connection to the external heat recovery/rejection systems detailed elsewhere in this specification.

7.8 Exhaust Systems

The Tender shall be inclusive of the design of the exhaust system from the CHP set. This shall include exhaust gas heat exchanger, attenuation and exhaust. The Sub-contractor shall work with the specialist providing the flue exhaust. The Sub-contractor shall provide the exhaust system, including silencers to the centre core wall. The flue specialist shall provide the flue from the centre core wall (on the side within the plantroom) to the termination point above roof level.
The Sub-contractor shall be responsible for the design of the whole exhaust systems installation. This shall include ensuring that the back pressure of the total exhaust system, exhaust gas heat exchanger, silencers, exhaust ductwork/pipework are within acceptable limits for the CHP set engines.

It should be noted that the vertical flues have already been manufactured and it is necessary for the Sub-contractor to work within the constraints of the components already constructed.

The internal exhaust shall be run using thermally insulated and metal-clad mild steel tube or similar suitable exhaust system.

The Sub-contractor shall include for the supply and installation of all associated exhaust system components including silencers, hanger supports, expansion compensators, drain points, explosion relief panels, flame quenching devices etc.

The number and type of silencers shall be determined from the noise criteria stated for the plant both internally and at relevant site boundaries as noted below.

It shall also be the Sub-contractor’s responsibility to ensure that the whole of the exhaust installation is suitable for the range of temperatures and conditions applicable to the operation of their plant.

The whole of the engine exhaust system silencers and any flexible exhaust connections fitted to absorb engine vibrations shall be of sufficient strength to withstand the effects of sudden internal pressure rises such as those caused by back firing.

To reduce heat loss from the exhaust, excessive heat gain into plant areas and provide safe surface temperatures, the exhaust system is to be insulated throughout.

The Sub-contractor shall therefore include in the Tender for insulating the engine exhaust system, including silencer(s) provided with the CHP unit.

The insulation including the silencer to be clad with plain finish Aluzinc sheet and the surface temperature of this cladding shall be below 50^{o}C in accordance with BS.3316.

7.9 CHP Heat Dump Facilities

At some site part load conditions, it may be necessary to dump heat from the CHP plant in order to eject residual unwanted heat from the system. To allow this to take place a heat dump facility shall be provided by the Sub-contractor via two roof mounted dry air coolers.

The allowance is for a total of 1200 kW of heat to be rejected via 2 No. dry air coolers, which accounts for one CHP unit of heat.

Auxiliary cooling circuits shall include all fans, pumps, pipework and controls etc. to enable continuous plant operation. Where the pipework is external, it is to be fitted with trace heating.

The Sub-contractor shall verify that this is sufficient for their needs, prior to finalising their design and/or starting manufacture.

7.10 Lifting Facilities

The Sub-contractor shall include for the provision of lifting facilities, as required for the maintenance of the plant. Lifting beams shall be certified with maximum safe working loadings in accordance with statutory regulations will be provided by others.

7.11 Access Platforms and Ladders

The Sub-contractor shall provide platforms and ladders to enable safe working access to all parts of the plant and particularly high level equipment. All platforms and ladders shall comply with the requirements of:-

BS.4592
BS.5395
BS.5950
BS.3049
BS.4211
and all other relevant codes of practices.

7.12 Oil Tanks

The Sub-contractor shall provide 1 x 3000 litre clean lubrication oil tank and 1 x 3000 litre dirty oil tank. This shall include automatic pumping facilities and all interconnecting pipework and controls. Each tank shall be double skinned, so as to have its own bund, in order to meet the latest requirements of the Scottish Environmental Protection Agency Oil Storage Regulations.

8.0 ELECTRICAL

8.1 Outline for Electrical System

The CHP units shall normally run in parallel with main incoming MV supply to the Hospital. If either side (A or B) of the Hospital's 11000V systems are being supplied from the Hospitals standby generators then the CHP units on that side will normally be disconnected from the 11000V distribution systems and shut-down. The CHP units shall not operate when the standby generators are in operation.

If the electrical load of the hospital is reduced to the level where the CHP units are in danger of exporting power to the SPEN network one or more CHP's, as appropriate, will be automatically ramped down and if necessary isolated. To achieve this it will be necessary to link the CHP controls to the ~~BMS~~ energy metering of the ~~incoming supplies~~ load demand and set a level which individual CHP's are isolated.

It will also be requirement that the CHP's only ever start one at a time.

The control of the individual HV circuit breakers through which the CHP units connect to the HV site distribution systems shall be controlled by both the CHP control systems and the Electrical Network Managements Systems (ENMS). These controls/interfaces shall:-

- Ensure the individual CHP's neutral earthing resistors are in circuit while the CHP's run up to speed and synchronise with the busbar voltage are then switched out of circuit as each CHP is paralleled onto the bus bar.
- The individual CHP HV circuit breakers (on the Energy Centre HV panels) cannot be closed unless both:-
    - the CHP controls signal the CHP is synchronised with the bus-bar voltage
    - The ENMS signals the breakers to say that the individual CHP's can parallel with through the circuit breaker

The low voltage connections required for the CHP enclosure lighting and small power, battery chargers etc will be derived from the 400V 50z Three phase, Neutral and Earth systems serving the Energy Centre.

8.2 Wiring on Engine/Generator Unit

All wiring shall be:-

Carried out with LSF cable suitably bushed and having stranded copper conductors of adequate mechanical strength and current carrying capacity, with a minimum of 1.5mm² csa.

Adequately supported and protected from accidental damage, properly installed and terminated in suitable terminal boxes with flexible connections. Special arrangements are to be made where wiring is subject to movement and vibration.

Segregated for different voltages and where necessary to avoid `pick-up' from adjacent wiring.

8.3 Power Cabling and Terminations

All power connections between the CHP set and the switchboard shall be undertaken by the Sub-contractor. The connections shall be sized to carry all normal operating currents and safely withstand all potential fault currents at their point of installation.

Specification of 11 kV Cables

HV cables from the CHP to the 11000V switchpanel shall be XLPE insulated, copper conductors, steel wire armoured with pvc outer sheath to IEC502 and rated at 11000 volts.

The cores of all HV cables shall be permanently marked to indicate phases.

Cable Installation

01. General

New cables shall be installed joint-free.

02. Single Core Cables

Single core cables shall be provided c/w wire armour and copper tape screen.

Single core cables shall be laid in trefoil to reduce magnetic field induced interface.

03. Cable Termination

HV cable glands shall be rated above the prospective fault current of the system to which they are assembled. Glands shall have integral earth lugs to which equibonding copper strip shall connect to the main earth bar.

HV cable boxes shall be made of fabricated steel and air insulated termination up to 11kV. Spacing between terminals shall conform to BS 4999/145 and IEC standards for the rated voltage.

All HV terminations and terminating cable tails shall be encapsulated in heat shrinkable insulation rated at the cable voltage. Heat shrinkable insulation shall be guaranteed by a reputable manufacturer.

Terminations shall be permanently marked to indicate phasing. The far and near ends of cables shall be tested by continuity meter to confirm correct phase rotation.

04. <u>Single Core Cables</u>

Single core cables shall be glanded at non-magentic gland plates.

On long runs of single core cables insulated terminating glands shall be used.

The open circuit induced voltage between cable armour and earth shall not exceed 25 volts when full load current flows in the cable.

8.4 Earthing Systems

The whole of the electrical systems shall be earthed and bonded to accord with the requirements of BS 7430, BS 7671 and Scottish Power Energy Networks (SPEN). The requirements for this are interpreted onto the drawings accompanying this specification.

Under mains supply conditions the systems shall rely on SPEN's earth.

Under standby generator only conditions when all standby generators are operating in parallel the systems shall be earthed to one generator's neutral via the appropriate neutral earthing panel and its HV resister.
When the standby generator systems are operating as two 'unparalleled groups, each group shall be earthed to separate standby generators via each groups neutral earthing panel.

The CHP units shall, however be provided with suitable Neutral Earthing facilities to enable them to be run to speed and tested off line.

Each of the neutral earthing panels shall be equipped with a spare/paralleled circuit earth resister in a separate compartment such that one can be removed while the other is in use.

The CHP's neutral earthing shall be controlled by the CHP's.

Two sets of earthing rods shall be provided to form a connection for the HV system to the general mass of earth. These shall each comprise a minimum of 4 No parallel earth electrodes driven to depth of 4.8m and contained in concrete inspection chambers. The minimum resistance to earth of each set of earth electrodes is one Ohm. Where this is not achieved then either additional earth rods shall be installed or the installed units shall be driven deeper.

The CHP units shall not operate in isolation of the mains or the generators, except for testing purposes. For clarification the CHP units shall not operate in island mode.

9.0 CONTROLS

9.1 Automatic Controls

The Controls for the CHP shall comply with the BMS specifications, ZBP-XX-XX-SP-660-401 through to 403.

The complete electrical controls system for the CHP set shall be designed, supplied and installed by the Sub-contractor. The Controls for the CHP shall interface seamlessly with the Building Management System in all areas of monitoring and Control. The controls shall be open protocol.

Four control panels shall be provided; one at the end of the individual CHP unit, located external to the acoustic enclosure, to control the individual CHP, with a further panel to both co-ordinate the operation of all of the CHP units and to communicate with the BMS. Selected information, set points, controls strategies, maintenance *mode* etc. that can be viewed and changed at the CHP panels shall also be viewed and changed at the BMS end.

All panels shall be manufactured and finished to the same specification to form a uniform suite.

The CHP set control panel suite shall comprise separately identifiable sections to provide the following functions:-

(a) Mains circuit breaker section.
(b) MCC section.
(c) Controls section.
(d) Battery panel.

Note: The HV circuit breaker will be located in the HV switchboard.

Synchronisation with site operating from REC supply.

The site shall be connected with the local REC grid through an automatic circuit breaker. Circuit breakers connecting CHP generators with the site high voltage system will be open. Generators will not be running.

The CHP set is started and run up to speed set point. Automatic synchronising equipment shall govern the generator voltage, frequency, and phase until they match the grid parameters. All conditions shall be ensured prior to automatic synchronising equipment closing the generator circuit breaker.

It is anticipated that synchronisation is carried out at 11 kV

Sequence of events when the set is running in synchronisation with grid

The CHP is planned to provide supply to a base load and operate only in parallel with the local public network. The unit shall shut off in the event of loss of mains, and shall not normally operate while the emergency generators are running. It is intended, however that the CHP shall operate when the generators are being tested.

Protection relays in compliance with the requirements of G59.2 shall be provided on the 11000Volt circuit breakers.

Excess electricity shall not be exported to the grid. The CHP Controls shall adjust the electrical power output to avoid export of power to the REC grid.

9.2 11000V Isolator

Each individual CHP shall be provided with a local isolator as follows;-

Voltage	11,000 V
Bus Bar Rating	1,250 A
Rated Short-Time Withstand Current	25 kA for 3 seconds
Maximum Ambient	40°C

9.3 Motor Control Centre

Each CHP unit shall be provided with an MCC panel located on the outside of the units.

All major motor loads shall be controlled and protected through a Motor Control Centre (MCC). The MCC shall be dedicated to control motors and LV electrical loads associated with the CHP set only.

All motor gear shall be grouped into a Motor Control Centre which shall comprise of form 3b type 2 of enclosure to BS EN 60439-1.

The MCC shall be capable of withstanding short circuit currents of 50kA - (35MVA at 400V for one second) ASTA certified to BS.EN 60439-1.

Where a Sub-contractor cannot comply with this Standard, he must clearly state his intended deviation at the tendering stage.

The electrical symbols used in the circuit diagrams are to be to British Standards.
Final reproducible copies of circuit diagrams and layout drawings shall be submitted after satisfactory commissioning.

Busbars

The busbar system shall be manufactured from hard or medium hard drawn high conductivity copper, including the auxiliary busbars.

The bars shall be rigidly supported by insulators of a high electrical and mechanical strength suitable for the withstand values specified.

Any access plates to the busbar chamber should be suitably marked with appropriate warning labels and when any such access plate is removed, it should reveal busbars suitably marked with phase colours and labels “L1”, “L2” and “L3”.

The busbar system shall not contain any internal interconnecting or outgoing cabling.

Main Isolator

A main isolator shall be provided in the MCC. The isolator shall be capable of interrupting the total stalled motor current from the MCC without deterioration.

The isolator shall be interlocked with the panel door and shall have facilities to padlock it in the `off' position.

The incoming supply shall terminate directly onto the main isolating device. Termination points shall be fully shrouded and suitably labelled.

Separate ammeter and voltmeters shall be fitted to the door of the incoming isolator. Both meters shall be operated through phase selector switches.

Enclosure

Enclosures shall be of the floor mounting, free standing, flush- fronted, cubicle type.

The enclosure shall comply with a minimum degree of protection, IP54 and be suitably designed to exclude vermin.

Enclosures shall be constructed from mild steel plate (unless conditions/environments dictate otherwise) with a minimum thickness of 2mm (14 SWG).

All metalwork to be degreased, rust-proofed and stoved to match all other control panels.
Access to the enclosure interior is to be via hinged front opening doors.

All gland plates to be provided.

Components and Wiring

Components mounted on baseplates must be removable from the front of the compartments. Baseplates also must be removable.

The minimum flexible wire inside the compartment shall be 1.5mm^2.

All wires to be numbered at both terminal and contactor/relay/ fuse, etc. ends.

Ring type of markers only shall be used.

All conductors shall be identified by colours as follows:-

Earth Conductors	-	Green/Yellow	
Power Circuits	-	400 Volt	
		Phase:	Brown / Black / Grey
		Neutral:	Blue
AC and DC Control Circuits	-	as IEE wiring regulations	

9.4 Motor Control Compartments

Each starter to include:-

* Triple pole fuse switch with auxiliary contacts and provision for padlocking "Off".
* Triple pole contactors with auxiliary contacts.
* Thermal overload unit with "single phase" protection - internally reset.
* Control circuit fuses.
* Terminals to be SAK 4 minimum size manufactured from polyamide material.

Please note that selection switch manual/automatic to be via a HMI (Human Machine Interface).

Start and stop push buttons to be via a HMI (Human Machine Interface).

Where there are no external/remote requirements, the control voltage to be 230V.

Where remote pieces of equipment are used such as external push button stations/limit switches, etc., then the control voltage must be 110V AC or less, obtainable from a double wound safety isolating transformer with an earthed screen. The control transformer to be used shall be fused on both sides of the primary and the switched side of the secondary with a removable link fitted into the common line.

Earthing

A main earth bar shall be provided fitted along the whole length of the MCC.

This bar shall be of adequate cross-sectional area and manufactured from hard or medium hard drawn high conductivity copper.

The completed MCC shall be efficiently bonded together and to the main earth bar.

Each door shall have a flexible earth braid to main metal framework to provide earth continuity between housing and door.

Identification

Each compartment door shall carry an engraved identification label.

The MCC manufacturers label shall contain the following information:-

(a) Name or trademark, type, designation, serial number, date of manufacture

(b) Type of protection of enclosure

(c) The electrical system characteristics - maximum load, rates supply/control voltage, etc

(d) Rated currents of the busbar system

(e) Short circuit rating

The manufacturer shall provide certificates of tests complied with in accordance with the relevant British Standard (BS.EN 60439-1).

9.5 Controls Section

General

The system shall allow full control and supervision of all operation plant parameters.

The control system shall:-

- Monitor and control the engine via an engine management system.
- Monitor and control the generator voltage, frequency and phase.
- Activate automatic synchronisation following operator initiation.
- Activate alarms, shutdown plant and warn remotely stationed plant supervisors.

It is highlighted that automatic synchronisation followed by normal parallel running with the grid is required.

Engine Management System

The engine management system shall comprise of an encased dedicated electronic control system. Signals shall be transmitted from sensors located on the engine and compared with programmed control parameters to maintain performance.

Any abnormal parameters shall initiate an alarm which shall be transmitted to the main Controller. If necessary the engine shall be shutdown in a controlled manner.

All monitored signals shall be retransmitted into the Controller for onward transmission and display on the monitoring system.

Generator Control

Generator parameters shall be monitored and controlled to enable synchronisation and parallel operation with the grid. Protection relays shall prevent electrical faults causing damage to the system by opening the generator circuit breaker.

Voltage Regulator

Voltage regulation shall be solid state with the engine governing within the limits specified in BS.5514, Class A1, and satisfy the Grade 2 requirements specified hereunder.

GRADE 2

a. At any balanced load between zero and rated load and at any load power factor from 0.8 lagging to unity and at any normal service condition temperature, the output voltage is to lie between the limits of plus or minus 2.5% of rated value.

b. On suddenly increasing the load from zero to 60% rated value the initial voltage dip is not to exceed 15% of rated value and recover to at least 97% of rated value within 0.5 seconds.

Voltage Wave Forms

A sine wave shape voltage waveform within the permitted limits of BS 4999 Part 40 and BS 5000 Part 3 shall be maintained.

Frequency Control

The output frequency from the generator shall be monitored and maintained within +/- 0.5% of 50Hz.

Automatic Synchronising

An automatic synchroniser shall be installed to adjust the generator frequency. When the generator frequency matches the grid frequency and both are in phase the CHP set shall be connected to the grid. A signal shall be transmitted from the generator controls to close the CHP set circuit breaker.

Automatic synchronising shall be achieved through the electronic engine governor. The generator AVR shall match generator voltage with grid voltage during automatic synchronising.

Controllers

General

The control/monitoring of the plant and CHP shall be by industry standard Controllers with an open protocol. Each shall have separate battery supported UPS.
A common manufacturer shall be utilised throughout the project.

Tenderers must state clearly the make and type of controllers proposed, detailing the input and output units, i.e. electrical characteristics and function, etc. and where appropriate the optional facilities programmed into the Controller.

(a) Enclosure

Each MCC shall incorporate a controller(s) in a separate cubicle. A separate controller, within a panel shall be provided as an interface between the BMS and the individual CHP units.

(b) Electrical Supply

A 230V dedicated supply shall be used for mains operation. A label shall be provided as the point of supply to warn personnel that a controller is fed from this circuit.

A separate transformer within each panel shall be used to supply:-

(i) The central processor, power supply unit, programme panel and peripheral equipment outlets.

(ii) The input and output circuits.

Transformer (i) shall be of the constant voltage type and shall be fed from the live side of the mains supply via an internally mounted, fully shrouded main incoming isolator.

Transformer (ii) shall be fed from the "dead" side of the main incoming isolator via its own I/O isolator. This allows separate isolation of the I/O circuits whilst still retaining power to the central processor.

A twin RCCD 30mA protected 240V 3 pin socket outlet shall be supplied and mounted adjacent to the main central processor.

(c) Mains Isolation

Mains isolation shall be provided. The isolator shall provide isolation for all circuits with the exception of the internal lamp and heater and a warning notice shall be displayed to warn that these circuits remain alive even when the main isolator is open. A notice shall also be displayed to state where the supply is taken from. The isolator must be mounted inside the panel to ensure that it can only be operated with the door open.

(d) Power Supplies

DC output modules shall be operated on a 24V dc system. The dc voltage must be derived from within the control panel by means of a stabilised and smoothed dc power supply with constant current capabilities.

Special attention must be given to the rating of the power supply to ensure that the input/output loadings, together with a 25% spare capacity, can be supplied by the power supply.

(e) Surge Protection Device

A surge protection device shall be installed on the power supply to the control panel.

The surge protection device shall be configured to protect the PLC and power supply against overvoltage resulting from a lightning strike and/or mains switching.

The device shall be capable of reducing an 11,000 volt transient down to a value less than 400 volts.

(f) Micro Processor Based Controllers

The controls shall fail safe. All safety interlocks critical to plant operation shall be augmented by hard wired equipment independent of the controller. Upon failure of the controller or power supply safety interlocks shall safely shutdown the plant and raise alarms.

The controller shall have the following minimum features:-

(i) Modular construction for ease of expansion

(ii) Software from an industry standard manufacturer

(iii) EEPROM or battery back-up of software

(iv) Programming via an IBM compatible computer

(g) I/O System

Remote input/output devices shall only be used to reduce the complexity of the electrical installation on large systems.

I/O control circuits shall be protected with a cartridge fuse in the line conductor and a link in the neutral. Whenever an I/O control supply is taken from the Controller enclosure it shall be individually fused. Fused terminals shall be utilised. Discrimination shall ensure that the terminal fuse is first to blow in the event of a fault.

(h) System Capacity

The tenderer shall ensure that there is spare capacity or space to expand the number of inputs, outputs, terminals and programme lines by not less than 10% on each PLC. All spare inputs and outputs shall be wired to terminals.

(i) *Operator Interface*

The operator interface shall comprise of an industrial standard colour graphics display. Multiple screens for plant functions shall be selectable via membrane function keys.

Each display screen shall provide time information on all engine, generator, and auxiliary systems. Trend and historical information shall be recorded for a maximum of 8000 hours operation. Downloading facilities onto an external data storage medium shall be included.

Any alarms shall be recorded, with identification and type. Historical alarms shall be held in memory and up to a maximum of 300 no. alarms shall be retained.

(j) *Instrumentation*

Instrumentation shall be provided on the control panel for each CHP set. On each set this shall be provided via a Human/Machine Interface, as follows:

Double volt meter and phase selector switch indicating:-

(i) Grid voltage.
(ii) CHP generator voltage.

Double frequency meter indicating:-

(i) Grid frequency.
(ii) CHP generator frequency.

Synchroscope.

Ammeter phase selector switch.

KWH meter.

Engine tachometer.

Power factor meter and phase selector switch.

(k) *Controls*

The following operators shall be provided on the control panel for each CHP set.

(i) Engine start push button.

(ii) Engine stop push button.

(iii) Initiate automatic synchronisation push button.

(iv) Alarm mute push button.

(l) *Indicating Lamps*

The following indicating devices shall be provided on the control panel for each CHP set:-

(i) Alarm lamp.

(ii) Alarm sounder.

(iii) Automatic synchronisation initiated.

(iv) Generator synchronised.

(m) *External Control Systems*

Items of plant external to the CHP set shall effect operation of the CHP set. The signals will comprise of single pole volt free contacts.

Signals shall be:-

(i) Gas safety valve closed.

This shall shut down the engine and isolate the CHP set.

(ii) Remote emergency stop.

This shall shut down the engine and isolate the CHP set.

(iv) Readiness signal for synchronisation with the grid.

9.6 Battery Panel

A regulated DC power supply shall be provided to operate controls for the CHP set. A battery shall maintain the DC voltage during transient interruptions to the incoming power supply.

D.C power supply, batteries and battery charger shall be housed in a separate ventilated cubicle. The cubicle shall be installed with other CHP set control panels and shall be similarly constructed providing a uniform suite of panels.

The battery shall comprise of nickel cadmium cells in ventilated plastic containers, all interconnected. Battery charge shall be maintained through a float charger operated to maximise battery life and minimise maintenance. The battery panel shall be provided with an ammeter and voltmeter to monitor the battery output. A `power on' lamp shall indicate that the battery panel is live.

Wiring between the battery panel and control circuits shall be adequately sized. Maximum resistance limits of cable to permit normal operation of solenoids, relays, contactors etc shall not be exceeded.

9.7 Common Controls Section

A common control panel shall be provided as an interface between the BMS, ENMS and the individual CHP units and therefore to select control regimes for the CHP set. Also the panel shall provide overall supervising control of the CHP set and switchgear signals.

The common controls section shall have the following control switches:

(a) Normal Operation/Back Synchronisation (selector switch spring return) to select the system from normal operation to provide control over the G59 circuit breaker. CHP sets will automatically synchronise with the grid. When the site voltage, frequency and phase match the grid the G59.2 circuit breaker will be automatically closed.

(b) Double volt meter via Human/machine interface and phase selector switch indicating

(i) Grid voltage

(ii) Site voltage (CHP set)

(c) Double frequency meter (via Human/machine interface) indicating:-

(i) Grid frequency

(ii) Site frequency (CHP set)

(d) Synchroscope

(e) An automatic circuit breaker will be provided by others under a separate contract. Sensors and signals are included on the circuit breakers as detailed below:-

1. Circuit voltage transformer
2. Busbar voltage transformer
3. Circuit current transformer
4. Busbar current transformer
5. Circuit breaker open - volt free contact (vfc).
6. Circuit breaker closed - vfc.
7. Circuit breaker opened on fault - vfc.
8. Circuit breaker opened manually - vfc.

(f) The common controls section of the CHP panel shall perform synchronisation between the site and the grid. To achieve synchronisation control of the main circuit breaker linking site and grid is required. When the site voltage, phase, and frequency are equal the circuit breaker can be closed.

The common control panel section shall contain `volt free' contacts wired to a terminal strip as listed below:-

Each volt free contact set shall comprise of 230 volt, 5 amp rated changeover contacts with all poles cabled to terminals.

(i) Close circuit breaker.
(ii) Open circuit breaker.

10.0 TESTING, COMMISSIONING AND HANDOVER

10.1 Testing and Commissioning

The Sub-contractor shall be responsible for the complete testing and commissioning of the CHP plant, equipment and installations to prove safe and reliable operation, compliance with statutory requirements and compliance with stated plant performance criteria, including the good quality CHP index.

The testing and commissioning shall include off site testing of individual major plant items, e.g. engine or generator skid units, which shall, at the discretion of the Client, be witnessed by the Client or his representatives. The test should include a start-up from cold conditions, a period of running (including basic response to controls), and a shutdown of the equipment. During the running period, measurement of fuel input and power output may be carried out.

The Sub-contractor shall include within the tender for the full commissioning of the complete CHP plant installations and all associated costs including all travelling, engineers' time, service parts, lubricants, coolants etc.

Commissioning of the CHP Plant shall also prove compliance with this specification in terms of equipment performance and with the manufacturers stated performance criteria.

All plant control and Instrumentation shall be subjected to comprehensive proof testing. Tests shall be conducted to ensure that each auxillary plant control and Instrumentation package provides the correct signal outputs to, and correctly responds to commands from, other auxillary plant packages, and the integrated Energy Centre System/Building Management System.

The Sub-contractor shall conduct works and site testing to the point where they are able to provide documentary evidence that each system, including those associated with services provided by others, together with the interfaces between them, function correctly before the equipment is set to work.

Initial site testing shall be carried out once all the equipment has been assembled into a functioning CHP plant and the electrical and heat connections have been made. These tests shall demonstrate that individual plant items, and the entire CHP plant, are able to perform satisfactorily under the appropriate range of conditions.

The Sub-contractor shall make allowance for seasonal commissioning by the CHP supplier when they shall be required to fine tune and prove the controls and integration of the system. This shall be carried in the winter, summer and mid-season after handover.

The Sub-contractor shall allow the Client, with reasonable notice to witness all testing, both at works and on site. This is anticipated to be at least seven calendar days.

10.2 Fuel for Commissioning

The Sub-contractor shall indicate the expected fuel consumption in the tender.

10.3 Reliability and Performance Running

Following the satisfactory completion of site testing and commissioning and the provision of commissioning results, information and instruction of the Purchaser's staff, the complete CHP plant installation shall be continuously operated for a period of 14 days, during which time it shall have trouble and fault free operation before it is considered to be practically complete. The unit shall be deemed to be acceptable when it can be run for three consecutive 8 hour continuous shifts with an operating time of over 95% of the 24 hours, i.e. max 1.2 hours down time in all.

Performance testing shall be carried out in conjunction with the above reliability running, and is intended to demonstrate that the CHP plant achieves the guaranteed performance levels. The parameters covered shall be:

- Electrical and heat outputs.
- Fuel consumption.
- Electrical consumption by plant auxiliaries.
- Noise.
- Exhaust emissions.

The performance testing shall demonstrate that the plant meets the specified performance parameters over a period of three days.

Should the plant fail these performance tests, the contractor will be required to make good the plant deficiencies and repeat the tests. The defects shall be rectified and the plant retested to meet the specified performance.

10.4 Plant Instruction

The Sub-contractor shall include within the tender for the post commissioning instruction of the Client's staff/representatives. The plant instruction shall as a minimum, enable the Purchaser's staff to:-

(a) Satisfactorily carry out the Purchaser's plant housekeeping role as defined in the contract maintenance agreement.

(b) Overview the safety of the plant operation and respond (if present) to any emergency situations.

(c) The plant instruction shall be carried out over a minimum of 2 sessions and the training shall include a review of the final operating & maintenance instructions.

10.5 On-Site Static Pre-Commissioning Checks

Static pre-commissioning checks shall take place only after the installation of all services, connections and ancillary items are complete. This may require completion of works by others.

The static pre-commissioning checks shall be witnessed by the Purchaser or his nominated representative.

The plant pre-commissioning shall include, but not be limited to confirmation that the following are complete and can be put into service:-

(a) Fuel systems are complete, commissioned in accordance with statutory requirements and are ready for use.

(b) Exhaust systems are complete throughout and are gas tight.

(c) High voltage cabling to site has been tested and terminated at both ends.

(d) Satisfactory test certificates and results shall be available for high voltage systems. This shall include proof that all high voltage cables have undergone a successful pressure test.

(e) All low voltage cabling shall be tested for continuity, insulation resistance, and correct termination.

(f) Noise and set vibration levels shall be measured and recorded.

(g) All control and signal cabling shall be tested for continuity and insulation resistance. The Sub-contractor shall confirm that all cable cores are located in the correct terminals. Cable types shall be cross checked against the manufacturers schedule to ensure that the correct types are installed.

(h) The Sub-contractor shall liaise with other contractors to confirm that all protection relays on the main site circuit breakers are fully functional.

(i) Dump radiator systems, pumps, pipework, etc are fully complete, tested, flushed out and filled with correct coolant and are ready to put into service.

(j) Lubrication systems are complete, tested and ready to put into service.

(k) All pumps, fans etc have been checked for correct rotation and are ready to put into service.

Static pre-commissioning checks must be satisfactorily completed and witnessed before dynamic commissioning can commence.

10.6 On-Site Dynamic Commissioning & Setting to Work

Dynamic commissioning and setting to work of the plant shall only take place following satisfactory completion of pre-commissioning checks on the complete CHP installation.

The dynamic testing, commissioning and setting to work of the plant shall be witnessed by the Client or his nominated representative and shall be satisfactorily completed, prior to reliability running of the plant.

The dynamic testing and commissioning shall prove the safe, reliable performance of the plant, compliance with stated performance criteria and guaranteed values and shall include, but not be limited to the following:-

(a) The engines shall be cranked and ignition system checked.

(b) The engine management systems shall be modulated and monitored to confirm engine speed control is stable.

(c) All safety and operational interlocks shall be tripped in turn to confirm control actions over engines.

(d) The engines shall be run for an extended period followed by checks to confirm no oil, water or cooling fluid leaks from the installations.

(e) Operation, interlocks and rotation of all motors shall be confirmed.

(f) The generator voltages and frequencies shall be measured and recorded.

(g) Operation of all plant items including dump radiators and cooling circuits shall be checked for satisfactory performance.

(h) The process of automatic synchronisation shall be checked prior to initiation of full synchronisation procedure.

(i) The Sub-contractor shall arrange and co-ordinate testing of protection relays with the Purchaser and the REC. Tests shall confirm the generators protection complies with the requirements of the Electricity Supply Regulations (1988), the requirements of Engineering Recommendation G59/2, G53, G75 and P28 and Engineering Technical Report 113. Following approval from the REC the Sub-contractor shall synchronise the CHP generator with the Grid.

10.7 Efficiency Testing

Efficiency testing of the CHP plant installations shall be carried out after all dynamic testing, commissioning and adjustment of the plant has been satisfactorily completed.

The efficiency tests shall be witnessed by the Client or his nominated representative and shall prove compliance with the stated plant performance criteria and guaranteed values.

The Sub-contractor shall include for the provision of all materials, test equipment and skilled operatives to carry out the tests, which, for each individual CHP unit, shall include but not be limited to:-

(a) Generator electrical output

(b) Generator and plant electrical parasitic losses, including all ancillaries at full load operation.

(c) Fuel consumption of each engine

(d) Thermal output/hot water production of exhaust gas, oil, water and other heat exchangers.

10.8 Maintenance

The manufacturer shall include for all required maintenance tasks throughout the period between installation and handover of the system to the Client. For dates and time periods reference should be made to the construction programme.

APPENDIX A

SUPPORTING DOCUMENTATION

The Sub-contractor will require access to the documentation listed below.

The following information is, or will be, available from the Contractor:-

1. General Conditions and Preliminary Clauses
2. ZBP HV Schematics ZBP-XX-00-SC-755-001
3. ZBP Earthing Schematics ZBP-EC-XX-SC-532-105 & ZBP-XX-XX-SC-539-001
4. Gillespies Site Master Plan
5. ZBP Energy Centre Drawings:-
    - ZBP-EC-00-PL-532-001
    - ZBP-EC-00-PL-532-002
    - ZBP-EC-01-PL-532-011
    - ZBP-EC-01-PL-532-012
    - ZBP-EC-02-PL-532-021
    - ZBP-EC-02-PL-532-022
    - ZBP-EC-03-PL-532-031
    - ZBP-EC-03-PL-532-032
    - ZBP-XX-XX-SC-521-401
    - ZBP-XX-XX-SC-525-501
    - ZBP-EC-XX-SC-513-002
    - ZBP-EC-00-PL-521-001
    - ZBP-EC-00-PL-521-002
    - ZBP-EC-01-PL-521-011
    - ZBP-EC-01-PL-521-012
    - ZBP-EC-02-PL-521-021
    - ZBP-EC-02-PL-521-022
    - ZBP-EC-03-PL-521-031
    - ZBP-EC-03-PL-521-032
6. ZBP LV Distribution Specification ZBP-XX-XX-SP-532-201
7. ITPD Documentation
8. Nightingale Associates Layouts and Elevations
9. WSP Plans and Sections
10. ~~Colt~~ Louvre Details
11. BMS Specifications ZBP-XX-XX-SP-660-401 through to 406
12. ENMS Specification ZBP-EC-XX-SP-532-262 and Schematic ZBP-EW-XX-SK-762-001
13. Acoustic Logic Consultants Ltd Reports and Specifications

APPENDIX B

SCHEDULES

APPENDIX C

TENDER RETURN INFORMATION FOR CHP

All items to be filled in for 1 machine

	Response	Cost for 1 machine	Notes
Capital Cost			
1. Total supplied capital cost			Mercury to add terms conditions and any requirements for installation delivery etc.
2. Testing, commissioning etc			Mercury to add terms conditions and any requirements
3. Training, record drawings, operating and maintenance instructions			Mercury to add terms conditions and any requirements
4. List any optional accessories and optional specification enhancements that are available, confirm cost or that they are included in base price			Declare cost of options
5. Total cost of ONE CHP unit			
Utilities Costs			
6. Gas input at full, 75%, 50% and 25% electrical output in m^3/hr@ 39.9 MJ/m^3		0	
7. Heat output at full, 75%, 50% and 25% electrical output in kWh.		0	Based on F & R temperatures of 105/75°C and working pressure 6.0 Bar
8. Total annual heat output in kWh based on ZBP profile for operating hours and load at			Declare offset based on 95% boiler efficiency and 3.5p/kWh gas cost
9. Total annual electrical production based on ZBP profile for operating hours and load in kWh based on 11kV			Declare offset based on 10p/kWh electricity
10. Total annual gas input based on ZBP profile for operating hours and load in kWh @ 39.9 MJ/m^3			Calculate cost of gas at 3.5p/kWh gas cost
11. Total net cost of utilities based on load profile and available operating hours			
Maintenance costs			
12. State the recommended frequency of inspection			Declare cost PER ANNUM for recommended

			inspections[1]
13. State the recommended frequency of minor maintenance			Declare cost PER ANNUM for recommended minor maintenance[2]
14. State the recommended frequency of major maintenance			Declare cost PER ANNUM for recommended major maintenance[3]
15. Basis of any increase in maintenance cost		0	State RPI or CPI or any other proposed basis of annual increase in maintenance contract cost
16. Total cost of maintenance per annum averaged over 5 years OR annual cost of maintenance contract			
End of Life and environmental costs			
17. Annual cost of oil, electrical parts and any other incidental waste			
18. Cost of disposal of plant at the end of the stated service life period			
19. Total cost of waste and disposals over the life of the plant			
Other technical matters			
20. State the availability of major parts and the guaranteed maximum time a machine will be out of operation over a 5 year period.		0	
21. What is the agreed warranty period?		0	
22. State predicted life of plant and basis of plant life – e.g. tested to BS EN 15686		0	
23. Provide a copy of the training proposals		0	
24. Guaranteed available hours per annum		0	
25. State any qualifications on guaranteed availability		0	

[1] All maintenance and inspection costs must be stated inclusive of all expenses and disbursements, travelling time and any other incidental cost to attend the New Southern General Energy Centre site.
[2] As above, plus inclusion of all consumables and parts
3 As above, plus inclusion of all consumables and parts

PR32 - DOMESTIC WATER SYSTEM DESCRIPTION

1. Overview

There are 2 No. incoming mains water supplies serving the Adults and children's hospital building. These enter the building in the basement manifold room and basement tank room and run into the tank room to serve 2no Raw water storage tanks. These incoming mains both have double check valves, water meters, 2 port isolation valves and keraflow float valves all located within the tank room.

The water meters are linked to the BMS system and allow the user to cross reference the quantity of water used against the quantity indicated on the external meter. This will highlight if there are any leaks on the external water main (see schematic included in 2 below). The 2 port valves allow the alternative use of each incoming main every 7 hours

From the raw water storage tanks the water is then filtered through the filtration plant before being stored in the potable bulk cold water storage tanks. All cold water storage tanks are 2 compartment tanks and are piped in such a way as to allow tank maintenance without disrupting the water supply to the building. Float switches within the tanks give the filtration plant the enable and stop signals based on the water level within the tanks. These levels can be adjusted to suit the water demand so that an optimal turnover of water can be achieved.

The filtered water is then pumped to serve the building via 2 no booster sets. Each booster set is set to a different set point pressure depending on which plant room it serves. (see below). Each booster set has 2no set points which will allow either serve the building in the event of failure.

There are 5 water storage tanks in the building:

- 2 No. 100,000 Litre Raw water storage break tanks
- 2 No. 275,000 Litre Potable bulk cold water storage tanks
- 1 No. 2,800 Litre Trade water storage tank

There are 2 No water booster sets in the building:

- BS01 – Feeding Plantroom 31, 32 & 33 - 7.3 Bar
- BS02 – Feeding Plantroom 21, 22 & 41 – 5.1 Bar

2. System Description

Plant room 32 is served from booster set BS01 at 7.3 Bar. The boosted water is pumped directly from the basement to PR32. As it enters the plant room the water flow rate is metered. The pressure is not reduced as it only serves the higher floors

From the plant room the BCWS is distributed to each riser and the bank of calorifiers. 32CAL01, 32CAL02 & 32CAL03. The water in the calorifiers is heated via a plate heat exchanger (feed from the MTHW circuit) on each calorifier skid. Each calorifier skid consists of a storage cylinder, shunt/de-strat pump, plate heat exchanger, expansion vessel and associated pressure, temperature and vacuum safety valves.

The BCWS and HWS F&R are then distributed together allowing for equal pressures at the outlets between the hot and cold water. The hot water is circulated to the outlet and back to the calorifiers by a hot water return pump so that temperature is maintained throughout the system. There are Kemper thermostatic balancing valves installed on the system in line with the design to ensure hot water is available within 2 minutes at every outlet.

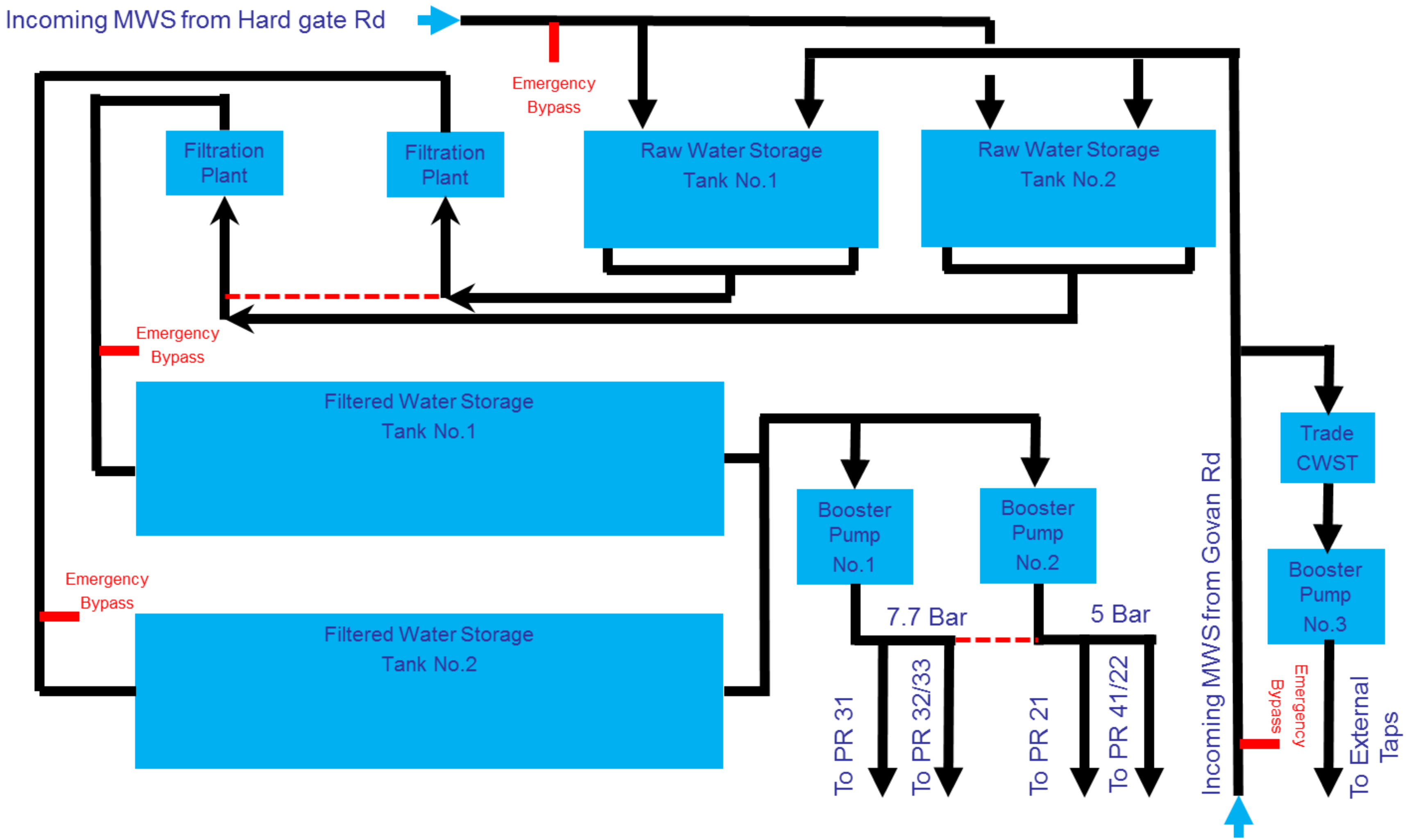
The cold feed to the calorifiers is also metered. The meter is located at the calorifier skids.

The design philosophy is that the distribution pipe work is laid out in such a way that areas of high use are at the end of lines. This ensures good turn-over of water within the system. Where this cannot be achieved temperature operated dump valves are installed.

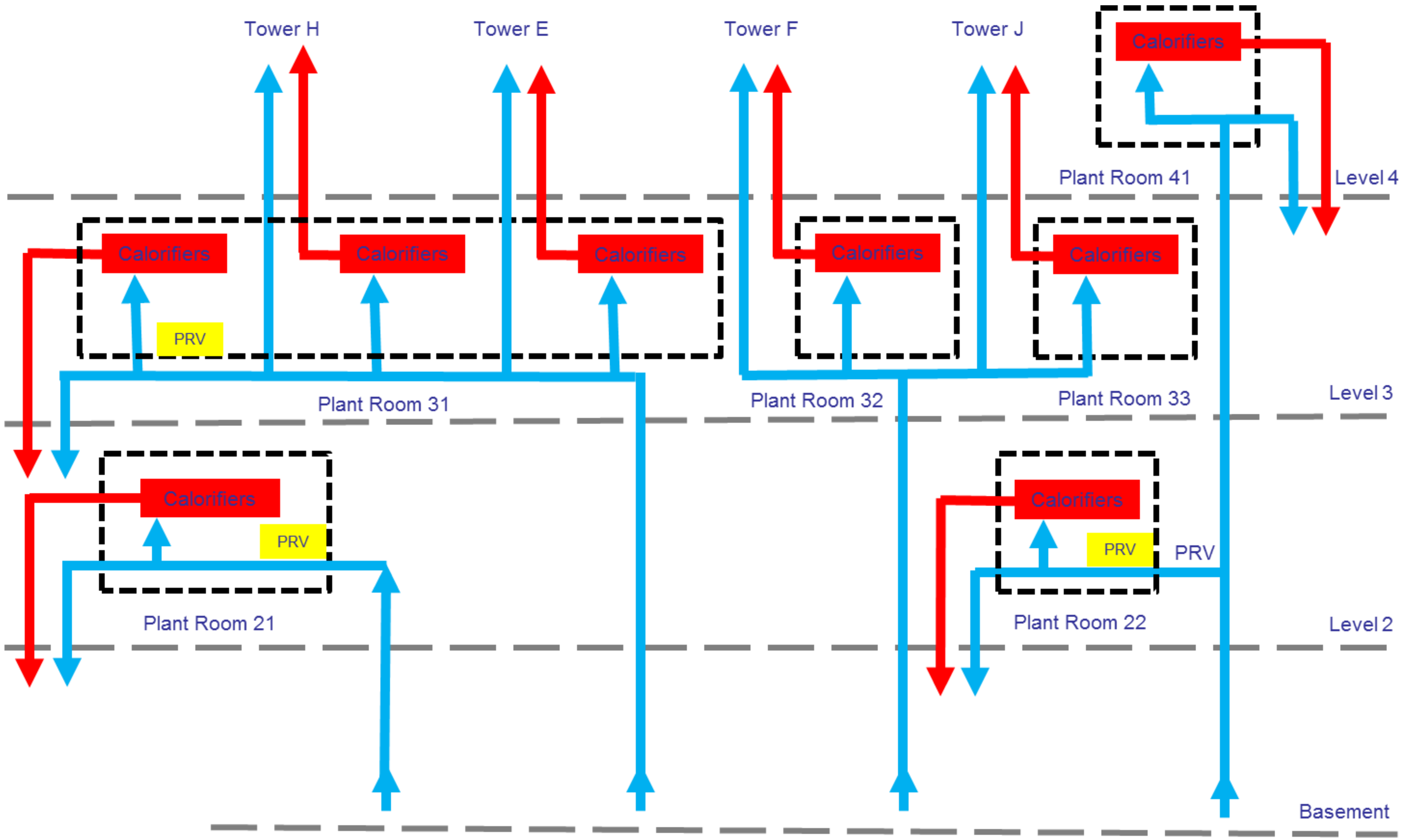
For record drawing information please refer to the ***500*** series drawings for details on the pipe work distribution on the floors and plant rooms.

For the distribution of the domestic water systems in relation to plant rooms please see “schedule of risers” document.

3. Overview of Domestic Water System (A&C Tank Room)



4. Schematic of DWS Area Served by Plantroom



CAPITA

NEW SOUTH GLASGOW HOSPITAL

ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

NEC 3 SUPERVISORS REPORT NO. 45

JANUARY 2015

NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

SUPERVISOR'S REPORT NO. 45 **JANUARY 2015**

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NEW SOUTH GLASGOW HOSPITAL ADULT AND CHILDREN'S HOSPITAL AND ENERGY CENTRE

1.0 EXECUTIVE SUMMARY: ADULT & CHILDREN'S HOSPITAL

The hospital was handed over to the NHS on the 26th January 2015 and in accordance with the NEC3 Contract we issued the Defect Certificate on Completion listing the outstanding defects.

In accordance with the NEC3 Contract our activities as NEC3 Supervisor's during January 2015 are highlighted below.

During January Brookfield provided us with their QA documentation including a list of their defects which had been logged on their IDMS system. We reviewed their information prior to undertaking the inspections. The areas inspected were generally to a good industrial standard and the defects captured by Brookfield were generally of a minor nature. These were recorded onto their IDMS system. No inspections of areas identified in Brookfield's Final Sweep Programme were carried out in January. We await a revised inspection programme from Brookfield which will include the Cores Electrical Cupboards Plantrooms and Hubrooms.

Quality and compliance and back checks were carried out on the following Levels.

- Level 0 "B" Rooms.
- Courtyards 1, 2, 3, 8 and 9.
- Level 1 Atrium Corridors CXA1-046, 047, 048 and 049.
- Levels 0 Children's entrance.
- Level 1 Floor Rest + Dining
- Level 0 Areas 0-501, 0-502, 0-503, 0-504 and 0-505.
- Link Bridge Neo-natal 1-515.
- Children's Link Bridge> Neo natal - 1-515.

Inspections following Brookfield's Final Sweep Programme.

- Inspect Sweep Up Level 2 - Zones GDH&E.

Final inspections.

Inspections were carried out on Levels 6, 5, 3, 2, 1 and 0 before completion of the hospital and any defects were issued on the day of inspection for Brookfield to address. Brookfield put all of their efforts into ensuring that issues with fire doors were resolved prior to handover.

We continue to liaise between Brookfield and the NHS Project Team in relation to snags/defects identified by the NHS Project Team.

Zutec entries continue to be under review.

At the car park some minor snagging remains outstanding and this together with items determined at a final inspection will be addressed towards the end of the project. This snagging will include some ponding issues on the top floor, and trip hazards at stairwell entrances.

Clearing up in plant rooms has revealed some steel column base plate issues in the Children's area – Brookfield are aware of this and are pursuing the matter.

Road surfacing work has been ongoing during the period on the dual carriageway leading to Govan Road, and that leading to Hardgate Road as well as in areas north and south of the ACH. Quality to date appears satisfactory. Local ponding on the north side of Govan Road remains outstanding. The two footpath issues which arose during the last period remain outstanding ie ponding at the extended footpath area on the east side of the maternity unit and potential specification non-compliance on sections of the footpath to the dual carriageway just north of the energy centre.

Pavement blockwork on west, east and south sides together with granite blockwork to the north is almost complete with good quality in all areas.

The M&E final installation and commissioning and testing continued on all levels and zones during January and we were in attendance to witness tests offered by Brookfield.

In the Energy Centre the testing and commissioning of the CHP has been completed satisfactorily and is now ready for service.

During January, in the A&C Hospitals, we witnessed the following:

- (357) CHP G59 settings.
- (358) WI FI Coverage.
- (359) Macerator demonstration.
- (360) Smoke dampers tests on L2 Zones G, D, E & H.
- (361) Fire panel tests, P44, 52 & 67.
- (362) Fire panel tests, P33, 61 & 62.
- (363) EMS / Generator interface.
- (364) Pneumatic tube demonstration.
- (365) Ventilation air flow commissioning, PR123 AHU 06, PR122 AHU 01.
- (366) Stair core ventilation systems.
- (367) Fire alarm cause and effect, Tower.
- (368) Fire alarm cause and effect, Childrens.
- (369) Fire alarm cause and effect, Podium.
- (370) Ventilation air flows, PR32 AHU 14.
- (371) Generator / EMS black start.
- (372) Fire damper drop tests, level 01.
- (373) Fire panel tests, P63.
- (374) Multipaging system.
- (375) Water quality testing.
- (376) AGV witnessing.
- (377) Witnessing of food waste system.
- (378) Fire shut down tests of AHU's in PR21 AHU 19, 21 & 29.during fire activation.
- (379) Smoke damper tests in level 11.
- (380) Operation of escalators, PA system and basement and Pharmacy roller shutter doors during fire activation.
- (381) Operation of Aseptic suite and kitchen server roller shutter doors during fire condition:

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We are continuing to work with Brookfield during our inspections highlighting any items that have raised concern. Items identified in this manner are generally being addressed by the site team in advance of any defect notice being raised.
In general terms we are satisfied that the installations continue to be installed to a compliant standard, and are of a good quality. However we have noted that certain items this month have raised concern. These have been raised with the Contractor as follows:-

Supervisor's Communication General Matters / Other Instructions No's 235, 236, 237, 238 and 239 were issued during January.

- Seeking confirmation that the existing column base details are capable of safely resisting the loads which may be applied to it and that it conforms to the design intent. Children's 4th floor.
- Seeking confirmation that the footpath make up to the dual carriageway just north of the energy centre complies with the specification Seeking confirmation when incomplete fire protection and fire stopping in plantroom 41 and 41A.
- Seeking confirmation on Brookfiled's action to address the ponding to the footpath to the east side of the maternity unit Seeking confirmation that edge protection to the ramp serving the computer room in plantroom 41 will be provided.
- Seeking confirmation that the change from three to two lights is an agreed change to the drawing (Level 2 Core C.
- Seeking confirmation that incomplete works in the Risers, Electrical Cupboards and IT Hub Rooms on Level 11 will be complete by 26th January 2015.

Supervisor's Notification of Defect No 89, 90 and 91 were issued during January.

- Seeking confirmation of the action to remedy the excessive gap between the underside of the doors and the floor at fire doors leading from corridor CCO-006 into EMC-061 Staff Base adjacent to EMC-058.
- Seeking confirmation when smoke dampers No's PS 2 522 009, PS 2 522 010 & PS 2 522 011 on Level 2 Zone D will be re-test. Seeking confirm when Smoke damper No SD 2 527 017 which displays a permanent red light has been addressed.
- Seeking confirmation if the enclosure on level 4 Core L is to be extended up to the underside of the ceiling.

2.0 DESIGN COMPLIANCE CHECK

Currently nothing to report.

3.0 PROCEDURES REVIEW

3.1 Contractor's QA Procedures / Compliance Inspections

<u>Audit of Brookfield's Contract Control Systems in relation to their Completion Criteria Documentation.</u>

As per the Employer's Requirements an audit of Brookfield's Contract Control Systems in relation to their Completion Criteria Documentation was undertaken on Thursday 15 January 2015. The object of the audit was to determine if their systems recorded and stored the Completion Criteria information required for handover of the Hospital on completion.

The audit involved reviewing the Schedule of Completion Criteria and our comments as follows relate to the appropriate text reference.

1.07 Construction Certificate.

We viewed letters from Brookfield's relevant trade and sub-contractors and this is being populated by Brookfield. They are awaiting letters from some of their trade and sub-contractors.

1.11 (Employers Requirement ref 6.46) Delap Survey.

The Delap Survey was carried out prior to construction by Doig and Smith. The documentation was seen to be retained in Brookfield's site office.

1.13 (Employers Requirement ref 6.7.3h(i)) Notice of Completion.

The notice of completion has been agreed and minuted at meetings between the client and Brookfield.

1.23 (Employers Requirement ref 6.8.5.25) Supervisor's Documentation.
Documentation for the Supervisor is being complied and will reflect the outstanding works in the form of defects at completion. (The clause in the Employers Requirements has an incomplete sentence).

1.24 (Employers Requirement ref 6.8.5.26) O&M and H&S Files

Brookfield continues to populate Zutec with documentation as per the Employers Requirement.

1.26 (Employers Requirement ref 6.8.6.1) Clinical Clean

It was agreed to sparkle clean in lieu of clinical clean and Brookfield are seeking evidence of this agreement.

1.29 (Employers Requirement ref 6.8.7.1) Testing and Commissioning Documentation.

Brookfield is currently populating the Section 2 file titled Works Inspection Testing Commissioning and Acceptance. The information is held on Zutec. It should be noted that some of this information is also held in the Building Control File which is progress to completion.

1.30 (Employers Requirement ref a) Building Warrant.

The collation of documentation required to be provided to Building Control is nearing completion.

1.31 (Employers Requirement ref a.1) Planning Consent.

The planning letter confirming that the planning conditions have been discharged was reviewed.

1.32 (Employers Requirement ref c) Road Construction Consent.

The Road Construction Consent letters were reviewed.

1.33 (Employers Requirement ref d) Design Warrants.

The hardcopy file was reviewed and letters were present from consultants. Letters were awaited from WSP and Acoustic logic. Acoustic Logic was planning to carry out a plant on 7 off test on the 19th January. Brookfield confirmed that a letter would be sent following this test.

1.34 Energy performance Certificate.

We reviewed the certificate received by Brookfield.

1.35 (Employers Requirement ref 7.14.12) BREAM
.
Brookfield confirmed that they would obtain the Certificate post completion.

1.36 Planned Preventative Maintenance.

Brookfield is populating Zutec with documents related to the Soft Landing Schedule.

1.40 Radiation Protection.

There are still minor penetrations in the Schiehallon to be completed to satisfy the requirements for radiation Protection and a new door required.

1.41 Medical Gases.

Brookfield confirmed that a letter of approval from Ian Sandford is awaited.

1.48 Helipad.

Action to be carried out by the Board to complete this section. CA to provide information in relation to "core item" documents.

1.50, 1.51 and 1.52 Awaiting letters from Dunne for below ground drainage and from Mercury for above ground drainage.

Conclusion.

Brookfield is diligently gathering the necessary documentation, certificates and letter to ensure that the Completion Criteria is populated with all the information to enable completion of the works.

<u>Quality and Compliance inspections</u>

Brookfield and their subcontractors have continued with their QA and checking and inspection procedures during this period. We are in discussion and liaise with Brookfield's Quality Manager on QA matters and we undertake regular reviews of their QA documentation.

Quality and compliance inspections were carried out with Brookfield to Level 1 Atrium Corridors CXA1-046, 047, 048 and 049. The majority of the snags were superficial and had been recorded on to their IDMS. However there were four sets of fire doors which had work or associated work required to ensure they provided the requisite fire protection.

Quality & Compliance inspections were also carried out to Courtyards 1, 2, 3, 8 and 9. The Courtyards inspected were generally to a good standard and the defects captured by Brookfield were generally of a minor nature. We did note that insulation to pipework was short in one position and the connections were not insulated. Brookfield recorded these two issues were recorded on the IDMS.

Quality & Compliance inspections were also carried out to Level 1 Atrium Corridors CXA1-046, 047, 048 and 049. The corridors were generally to a good standard and the defects captured by Brookfield were generally of a minor nature.

Quality & Compliance inspections were also carried out on Level 0 Areas 0-501, 0-502, 0-503, 0-504 and 0-505. The areas inspected were generally to a good standard and the defects captured by Brookfield were generally of a minor nature. Some finishing works were in progress at the time of inspection.

Quality & Compliance inspections were also carried out on Level 0 Children's Entrance. The corridors were generally to a good standard and the defects captured by Brookfield were generally of a minor nature.

Quality & Compliance inspections were also carried out in the Children's Link Bridge Neo natal - 1-515. At the time of the inspection final coat paint work was in progress. The rooms inspected were generally to a good standard and the defects captured by Brookfield were generally of a minor nature. Some finishing works were in progress at the time of inspection.
We asked Brookfield to confirm that all vertical blind wands will be fitted throughout the Adult and Children's Hospitals and that all blinds will be fully functional prior to handover. They anticipate that all wands will be fitted to windows and all blinds will be fully functioning prior to project handover. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 223).

Quality & Compliance inspections were also carried out to Levels 0 Children's entrance. The areas and corridors inspected were generally to a good standard and the defects captured by Brookfield were generally of a minor nature. We indentified a few superficial snags/defects which Brookfield recorded on the IDMS.

We inspected "B" Rooms on Level 4 and 5. The work completed was generally to a good industrial standard and all snags/defects were recorded during the inspection.

We note that there was insufficient activity space in front of the WC bowl in the room WS5-020 on Level 5 Atrium Bridge. We asked Brookfield to confirm their action to address this issue. Brookfield confirmed that the toilet layout has been constructed and the WC installed as the NA 400 Series drawing which has been approved by NHS Board. However they carried out further investigations in Levels 9 and 5 in the male toilet of the male changing room. The doors have been installed larger than required resulting in the activity space being reduced. Brookfield confirmed that these two toilet doors will be reduced to allow the required 450mm activity space for access. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 217 is closed out in this report.

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Following recent inspection on site we noted that there were door sets which had veneers that did not match. This poor quality of finish occurs in isolated locations throughout the Hospital. We asked Brookfield to confirm that a review of the doors has been carried out on all levels and that door sets are matched where there are dissimilar veneers. Brookfield confirmed that it is their intention to have all 2 leafed doors rectified by 26/01/15 to have all leaf's matching. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 221 is closed out in this report.

We carried out roof inspections to the Roof R4-009, R3-001 and R3-021 and R2-005. Generally Brookfield has captured all the snags/defects. However we did note that some of the capping pieces on Level 3 south elevation are a different shade from the others. Consequently we have raised Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 213 We asked Brookfield if the different shaded capping pieces have been recorded in the IDMS as a snag/defect and that further remedial action will be undertaken. Brookfield advised that regrettably, Prater advises them that the issue raised is not a defect but a consequence of using a metallic paint finish on multiple pieces of metal. The angles of the metallic flecks differ when applied to individual components which sometimes create an apparent difference in appearance depending on the light conditions when viewed from distance. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 213 is closed out in this report.

Prater will supply test samples of the specified RAL colour and demonstrate that the components are the same colour.

<u>Room Back Checks</u>

It was noted during fire damper tests at various locations on Level 1 that access to testing the operations of each fire damper was difficult due to the size of the access hatch. Brookfield confirmed that access doors have been widened on Level 1 Area 1-505 and 1-538. All fire dampers noted on the various locations on Level 1 have been rectified with the exception of the dampers at Level 1-537 which is still to be completed This defect has now been addressed, consequently Supervisor's Communication General Matters / Other Instructions (Cal 13.1) No 206 is closed out.

The recessed area on the right hand side of the wash hand basin in room OPD1-004 Level 1 Area 1-539 is congested. There is a nurse call, dispenser and grab rail to be fitted. We asked Brookfield to confirm how the fittings can be fitted within the present space or if there are any proposals to reposition fittings. Brookfield has confirmed that the OPD1-005 – nurse call is to be positioned to the correct location as per 400 series drawing and the grab rail may be situated on side panel but this has to be investigated. In OPD1-004 the grab rails will be positioned on side of IPS – dispenser's repositioned to opposite wall this will happen to both toilets. Brookfield confirmed that following a walk round between NHS (P Moir) and BMCE it was agreed that only one handrail was required in this instance. Consequently Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 194 is closed out.

Inspections following Brookfield's Final Sweep Programme.

No inspections of areas identified in Brookfield's Final Sweep Programme were carried out in January. We await a revised inspection programme from Brookfield. which will include the Cores Electrical Cupboards Plantrooms and Hubrooms.

Zutec Review

We are continuing to review the testing information on Zutec on a regular basis as it is entered.

Acoustic Tests

There remains one partition between rooms' THE-326 and THE-327 which require a crosstalk attenuator to be fitted.

Above Ceiling Inspections.

We reviewed Brookfield's above ceiling documentation in relation to their inspections on Level 2 Zone B, Level 9 Zone E, Level 0 Zone J, Level 6 Zone H, Level 6 Zone F, Level 4 Zone F, Level 5 Zone K, Level 10 Zone E, Level 8 Zone F, Level 6 Zone K, Level 11 Zone F, Level 10 Zone F, Level 6 Zone H, Level 11 Zone E, Level 11 Zone F, Level 11 Zone K, Level 9 Zone F, Level 9 Zone K, Level 7 Zone E, Level 7 Zone H, Level 7 Zone F, Level 5 Zone J, Level 5 Zone F, Level 4 Zone K and Level 4 Zone H, Level 8 Zone K, Level 3 Zones E, K and F, L1 Zone , E, H, Level 1 Zone E/H part Hospital Street/Adults, Level 1 Zone K PART Atrium Core D & 1-501, Level 9 Zone H and J, Level 7 Zone K, Level 0 Zone B and Level 6 Zone J and E . The documents were found to be satisfactory.

General Inspections

During inspections of Risers, Electrical Cupboards and IT Hub Rooms on the Level 11 we noted incomplete work. We raised a Communication with Brookfield listing the incomplete works and asked them to confirm when these are completed prior to the 26th January. See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 239.

We asked Brookfield to provide the waterproofing detail for the smoke extract fans. They intimated that a detail is being prepared to show how this area will be insulated, DPM fitted and flashed over the gap between the fan and the main building. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 226 is closed out in this report.

Drawing No NA-XX-05-PL-252-150 for the 5th floor show an access ladder between two roofs on the south elevation adjacent to Plantroom 41A. However this has not been fitted. We asked Brookfield to confirm when this will be fitted or confirmation that it is an omission. Brookfield confirmed that an access ladder was not practical at this location and steps have been installed. This part of Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 227 is closed out.

There are two door thresholds providing access and egress from Plantroom 41A which are too high. These are located on the north and west elevations of the Plantroom. There is an access stairs shown on drawings NA-XX-05-PL-252-150 and NA-XX-05-PL-572-010. We asked Brookfield to confirm when stairs/steps will be fitted. Brookfield confirmed steps have been installed at these access/ egress door locations. This part of Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 227 is closed out.

There is staining, slight erosion and cracking to some parts of the semi circular Sto covered wall above the Atrium at the entrance to the Children's Hospital. We asked Brooklfield to confirm measures to address these issues. They have confirmed that the staining will be repaired following the introduction of new flashings from roof to the elevations. (Sample has been fitted for approval. This part of Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 227 is closed out.

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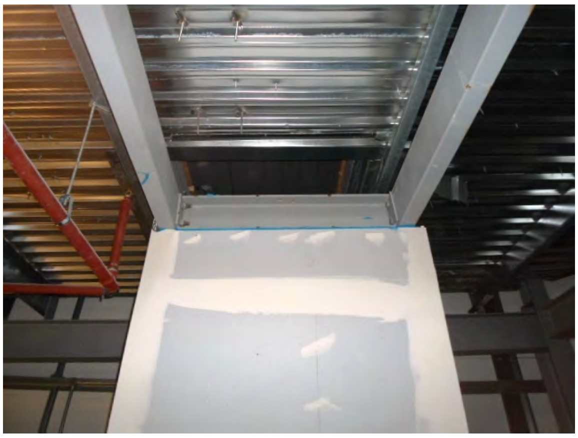
The glassed door leading into Core L from the roof does not appear to be fire rated consequently does not provide fire integrity of the compartmental wall. There is also an opening between the room at the top of the core and the area above the top landing. Confirm if the existing door and door frame is 60 minutes fire rated or if a new door is required. Brookfield has confirmed that the glass door has been altered and a steel panel door fitted. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 227. This section of the Communication is closed out.

There is an excessive drop between the fire doors leading to Core K on Level 5 and the floor in Plantroom 41A. We asked Brookfield to confirm measures to address this taking into account that this is a fire exit route. Brookfield has confirmed that a Step over has been fitted to the upstand to allow safe access to the fire exit route. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 228 is closed out.

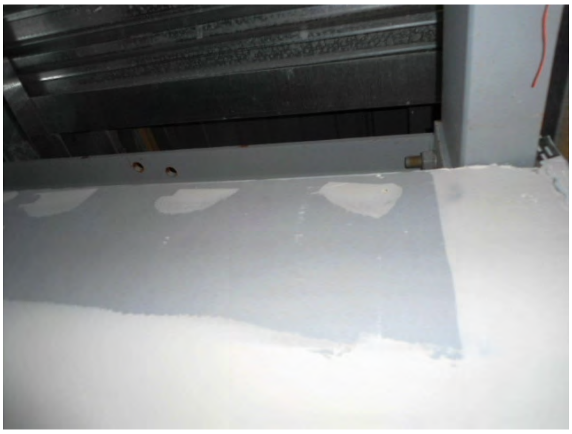
The partitions forming fire protection to the fire vent on the roof between the two fire doors in plantroom 41A leading to Core K is incomplete. Brookfi8eld has confirmed that Level 5 PR41A - smoke shaft has now been sealed.



Brookfield has informed us that the two vent holes to the lift shaft and will be sealed with insect screens and grills.

Brookfield confirmed that fire stopping has been completed around the services.

There is a gap between the underside of the roof and the top of the partitions and the steelwork has not been painted with intumescent paint. Brookfield has confirmed that the gap at roof level has been sealed. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 229 is closed out.



We noted bolts missing or not tightened to steel cleats connecting columns to beams. We asked Brookfield to confirm when all bolts have been fitted. E&A Sub contractors of Mercury revisited the site on Friday 9th and Saturday 10th January, fitted additional bolts, and tightened existing bolts as necessary. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 230 is closed out.

The ramp which serves the Computer Room in Plantroom 41 does not have a handrail or protections to the edge of the ramp and platt to prevent a fall. The do not comply with current Building Regulations. Brookfield confirmed that the handrail to the ramp has been fitted. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 231 is closed out.

The method of isolation of the equipment installed was too remote from the supply source (the control panel installed in the fourth floor plantroom) and that localised isolation is required as per IEE Regulations 537.3.2.4. We have asked Brookfield to confirm that a safe means of isolation will be provided. A similar requirement exists in two areas of plantroom 41 and in one plantroom on level 5 where fume fans have been installed. Isolators have been fitted. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 232 is closed out.

Room's THE-070 and THE-076 both share the same floor space. There is no light switch on the wall next to the pass door leading from room THE-076 into THE-067. We asked Brookfield to confirm if lighting should be controlled in room THE-067 when accessing and egressing between rooms' THE-076 and THE-067. Brookfield confirmed that Mercury will arrange for their sub contractor to fit additional switches to allow 2 way switching for safe access / egress to the room THE 076. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 233 is closed out in this report.

Room THE-067: Door between THE-076 and THE-067.

Room THE-067: Door between THE-067 and corridor THE-075.

Drawing No NA-XX-05-PL-252-150 for the 5th floor Roof between Plantroom 41A and Core L shows an access cat ladder. However this has not been fitted. We asked Brookfield to confirm when this will be fitted or if this has been omitted from the contract. Cat Ladder is now fitted and inspected along with Brookfield Managers. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 234 is closed out.

During an inspection of the Children's Roof adjacent to Plantroom 41A we noted that there were no bulkhead lights fitted above the doors. There were also no lights fitted in the room on the roof providing access and egress via the cat ladder in Core L. These were not taken in the approved drawings, however Brookfield intend to fit lighting in these areas.

We carried out an inspection of the fire doors with Brookfield on Level 0 and Level 1 Zone J. There were faults identified and these were recorded by Brookfield for immediate attention.

Completion Criteria

We reviewed Brookfield procedures for collating letters, certificates, licences, approvals etc to populate the Completion Criteria. Brookfield has compiled hard copy folders which contains the completion verification information as stated above. The folder has items which relates to contents uploaded to Zutec. We have noted that Brookfield is populating their files satisfactorily.

An audit of Brookfield's Contract Control Systems in relation to their Completion Criteria Documentation was carried out. See 3.1.

Final Inspections before completion of the hospital.

Inspections were carried out on levels 6, 5, 3, 2, 1 and 0 before completion of the hospital and any defects were issued on the day of inspection for Brookfield to address. Brookfield put all of their efforts into ensuring that issues with fire doors were resolved prior to handover.

3.2 Witness Testing and Commissioning

We witnessed a number of tests during January 2015 which were satisfactory and these were as follows:

- (357) CHP G59 settings.
- (358) WI FI Coverage.
- (359) Macerator demonstration.
- (360) Smoke dampers tests on L2 Zones G, D, E & H.
- (361) Fire panel tests, P44, 52 & 67.
- (362) Fire panel tests, P33, 61 & 62.
- (363) EMS / Generator interface.
- (364) Pneumatic tube demonstration.
- (365) Ventilation air flow commissioning, PR123 AHU 06, PR122 AHU 01.
- (366) Stair core ventilation systems.
- (367) Fire alarm cause and effect, Tower.
- (368) Fire alarm cause and effect, Children's.
- (369) Fire alarm cause and effect, Podium.
- (370) Ventilation air flows, PR32 AHU 14.
- (371) Generator / EMS black start.
- (372) Fire damper drop tests, level 01.
- (373) Fire panel tests, P63.
- (374) Multipaging system.
- (375) Water quality testing.
- (376) AGV witnessing.
- (377) Witnessing of food waste system.
- (379) Smoke damper tests in level 11.
- (380) Operation of escalators, PA system and basement and Pharmacy roller shutter doors during fire activation.

We witnessed tests during January 2015 which were unsatisfactory:

- (378) Fire shut down tests of AHU's in PR21 AHU 19, 21 & 29. During fire activation simulation. (PR21 AHU 19 did not shut down.)
- (381) Operation of Aseptic suite and kitchen server roller shutter doors during fire condition: 1. Aseptic roller shutter, part required. 2 Servery roller shutter, external warning panel not working and key switch operation reversed.
-

Previously witnessed tests which failed and have been re-tested successfully:

- (87) Smoke damper test verification was tested successfully on level 0 zone D. Zone G still outstanding. (Cleared 18.12.2014.)
- Smoke damper tests in PR31. (Retested 26.01.2015)
- (180) FD 1-538 008 - Access hatch too small. (Cleared 19. 09. 2015)
- (342) CCTV witnessing. (Retested 16.12.2015)
- (181) FD 1-537 004 - Access hatch too small and fire seal or repositioning required. Dampers No's 002, 003 & 004 are not installed within walls and were not tested. (Retested 21.01.2015.)

- (242) Fire Panels P24. One optical detector requires to be changed to strobe in room OWD-033. Damper retested successfully 11.11.2014, Address to be confirmed. (Cleared 19.01.2015)
- (139) Smoke dampers were tested in plantroom 31 and there were some which failed. No power to panel. (Cleared 26.01.2015)
- (324) Fire panel tests, P3 - One SD N/W and two sounders set for voice activation, & P7 - One beacon N/W tested successfully. (09.01.2015)
- (258) Fire damper drop tests on Level 0-zones 531, 532, 533, 535 & 536.
- Two dampers inaccessible, FD 0 536 014 & FD 0 536 015. (Retested 25.01.2015)
- (259) Fire damper drop tests in Basement zones 504, 505 & 506. Unable to access FD B 504 001, + no damper fitted to adjacent duct. Retested 25.01.2015)
- (318) Smoke dampers, level 3, 3 crossed addresses, and 1 mechanically faulty. Retested 24.01.2015)
- (304) Fire damper drop tests on level 9.

Previously witnessed tests which require to be retaken:

- (176) VPI missing from Level 0 Zone H fire damper FD 0 530 013.
- (217) Fire damper drop testing on Level 0. (FD 0-537 005 & FD 0-540 002, VPI's obscured).
- (232) VPI missing on Level 1 Zone J Fire damper No FD 1 539 015.

3.3 Board Equipment Installation,

Currently nothing to report.

3.4 Non Conformance Reports

We reviewed Brookfield's NCR Tracker and noted the issues raised by the Package Managers. Brookfield confirmed that the tinting to the blockwork is complete to the pointing on the south and east elevations.

4.0 CONSTRUCTION REVIEW

4.1 Visits to the Works

The following members of our team undertook site inspections, reviewed documentation, attended meetings and met with relevant Contractors representatives on-site personnel:- John Redmond (Lead NEC3 Supervisor) 5th to 9th, 12th to 16th, 19th to 23rd and 24th to 30th. Douglas Wilson (M&E NEC3 Supervisor) 5th to 9th, 12th to 17th, and 19th to 23rd and 24th to 30th. Willie Roxburgh (Civils/Structural NEC3 Supervisor) part days on the 7th, 15th, 20th and 23rd January. Capita's NEC3 Supervisor's team visited site a combined 53 person days.

4.2 Elements of the Works available for inspection

Main building – structural areas very limited.

Structural steelwork to all roof areas (increasingly limited due to access and partitions).
Neuro bridge (partly limited due to access).
Dual carriageway to Renfrew Road, turning area in front of the main entrance and carriageway from Hardgate Road.
All sides external works.
Internal courtyards.
Perimeter hard and soft landscaping
All works fit out works, fabric, and works to roofs and cladding are nearing completion.

4.3 Current Observations

The visual inspections of the work carried out to date indicate that the works are generally being carried out to a satisfactory standard. We continue to be assisted by the site teams and the NHS Project Team in resolving various construction, mechanical, electrical, and quality issues. We continue to close out our Supervisor's Notification and Defects when we have received satisfactory responses.

4.3.1 Structural and Civil Works

The steel framework in riser on Level 0 ZF Riser M30 has had the legs extended immediately in front of the entrance door. There are other legs which have not been extended yet and we asked Brookfield to confirm when the other legs will be extended. Brookfield informed us that Mercury removed the feet on the framing and it is suspended from the soffit of the floor above. Brookfield initially consulted with WSP re the allowable load on the slab edge around the risers. However more recently they have consulted with John Hinchliffe from RKD (the MD of RKD - the designers of the Risers and structural engineer who has confirmed that the structure is supported from the floor above. We will close this out when the redundant framing has been cut off. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 162 is closed out in this report.

Extended legs

Leg still to be extended.

Car Park 1.

The car park is now in use as the main project site car park. Some minor snagging remains outstanding and this together with items determined at a final inspection will be addressed towards the end of the project. This snagging will include some ponding issues on the top floor, and trip hazards at stairwell entrances.

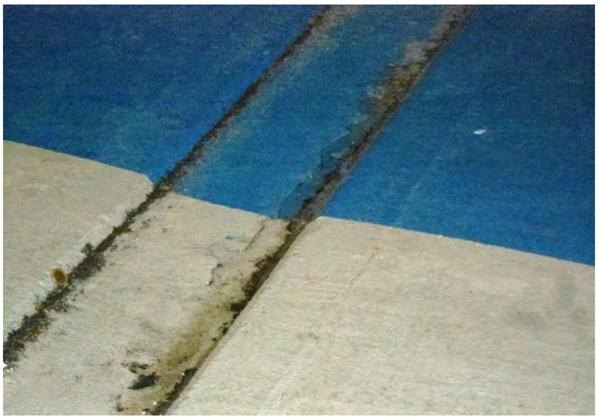
We noted a distribution board fixing has caused the concrete column to crack on Level 2 Plant Room 22. Following discussions with Brookfield they have confirmed that repairs were carried out using R4 Mortar repair to this concrete column and all other similar situations were checked out. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 222 is closed out.

The car park floors on levels 1, 2, 3, 4, and 5 adjacent to the stair on the east elevation have recessed channels which cross the pedestrian walkway similar to the potential trip hazards identified in Communication No 209. Brookfield has confirmed that IFT is to infill the channels with coloured screed on the walkways. They have intimated that these locations do not interfere with the water flow as they are the opposite end to the outlet gulley. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 224).


Level 5


Level 4

Level 3



Level 3: Channel exceeds 30mm deep.

4.3.2 Children's Area

Clearing up in plant rooms has revealed some steel column base plate issues in the Children's area 4th floor – Brookfield are aware of this and are pursuing the matter.

We have asked Brookfield to confirm that the existing base detail as shown on the attached photographs in the Children's 4th floor plant room area is capable of safely resisting the loads which may be applied to it and that it conforms to the design intent. Brookfield confirmed that the steelwork installed by JD Pierce is adequate and capable of safely resisting the loads that have been applied to it and JD Pierce have issued a letter of conformity for all works. We are currently reviewing this information. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 235).

4.3.3 External Works

Building Surround

Pavement blockwork on west, east and south sides together with granite blockwork to the north is almost complete with good quality in all areas.

Govan Road/Renfrew Road & ACH Entrance Road

Road surfacing work has been ongoing during the period on the dual carriageway leading to Govan Road, and that leading to Hardgate Road as well as in areas north and south of the ACH. Quality to date appears satisfactory. Local ponding on the north side of Govan Road remains outstanding. The two footpath issues which arose during the last period remain outstanding ie ponding at the extended footpath area on the east side of the maternity unit and potential specification non-compliance on sections of the footpath to the dual carriageway just north of the energy centre, as noted below.

Footpath to the east side of the maternity unit.

We advised the Brookfield team on 16th December that ponding on the new extended footpath to the east side of the maternity unit has the potential to be a significant slip hazard in cold weather.

We have asked them to confirm their action to address this hazard. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 237).

Ponding at the extended footpath area on the east side of the maternity unit, and potential specification non-compliance on sections of the footpath to the dual carriageway just north of the energy centre.

We have asked Brookfield to confirm that the footpath make up to the dual carriageway just north of the energy centre complies with the specification - attached photographs refer. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 236).

4.3.5 Mechanical Services

Installation of hot, cold, heating & chilled water pipework in the A&C Hospital is nearing completion in all plantrooms and is general to a good standard. Leachate flushing is in progress.

Witnessing of the ventilation systems is ongoing. The operating theatre areas are to be revisited for final proving once doors, lights and grilles are installed.
Minor tidying up works and completion of the Venture clad jacketing is ongoing. Any damage reported during our joint inspections of plant rooms with Brookfield is being addressed. We will still continue to monitor the quality of the installation and await an invitation for final inspection.

Brookfield has informed us that pre commissioning is in progress and we await an invitation to witness any tests.

The pressure testing of the sprinkler systems is nearing completion in the basement and remaining levels in the tower.

Mechanical fire damper drop tests and the Quality and Compliance Inspections, are continuing and the damper positional indicators which have been found to be obscured by sealant are continuing to being addressed by Brookfield.

The three high level smoke extract fans on Level 4 Zone C appear to be complete with the fans and actuator totally enclosed with no access for maintenance.

Brookfield has confirmed that external actuators have been fitted.

The weather seal enclosing the electrical box on the 3 smoke extract fans on Level 5 is done by others and not part of Mercury's install. The weather seal is under review and we anticipate forming a boxing over the junction between the fans and the main building. Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 214 is closed out.

4.3.06 Electrical Services

Work in relation to containment is complete.

Final commissioning is being carried out security, CCTV and intruder alarm.

The quality of the general and emergency lighting installed to date is of a good standard with the witnessing of the lighting controls ongoing.

The installation of the power outlets is ongoing.

We noted that the drawing for Level 2 Core C bed Patient Lift Lobby allows for a light above each lift door. Only two have been fitted on one side and not above the lift doors. We have asked Brookfield to confirm if this change has been agreed. If this is not an agreed change we have asked them to confirm when the lights will be fitted in the correct positions. (See Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 238).

4.3.07 Energy Centre

We await notification to witness the commissioning of the CHP's.

4.3.08 Intake Sub Station

Brookfield has informed us that all cables have now been pulled through to the sub-station and all water has been removed from the pits. We are awaiting confirmation that the cables have been sealed. This defect has now been placed on the IDMS system, consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 30 & 45 is closed out in this report.

4.3.09 Partitions

Nothing to report.

4.3.10 Doors

Adjustment to floors beneath doors continuing.

The east door clashes with one of the fans on Level 3 Core H link corridor. We asked Brookfield to confirm their action to resolve this clash. They have confirmed that the door arrangement will be re -arranged with the lead door being the opposite door and a restrictor fitted to the door which currently clashes with the fan. Consequently Supervisor's Communication General Matters / Other Instructions (CI 13.1) No 215) is closed out.

4.3.11 Windows

Nothing to report.

4.1.12 Equipment

Nothing to report.

4.3.13 Ducting

Ductwork to several items of plant which has still to be installed within plantrooms 41, 121, 122, 123 & 124 which are nearing completion.

4.3.14 Floors

Nothing to report.

4.3.15 Blockwork

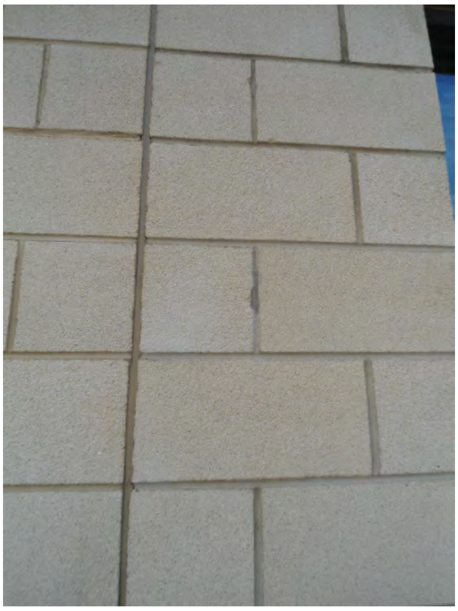
Nothing to report.

4.3.16 Heating

There are gaps in the thermal insulation in the back box of the remote TRV's mounted on external walls controlling the radiant panel heater in Level 0, ZA ward OBW 009. There is the likelihood that this will cause the TRV to be affected by the lower temperature in the partition void causing the Radiant panel to emit heat unnecessarily wasting energy. This applies to other similar TRV's on outside walls. We have asked Brookfield to confirm if this has been considered and if remedial action will be taken to address this. Brookfield has asked Mercury to report on this issue. (See Supervisor's Communication General Matters / Other Instructions (Cl 13.1) No 199).

4.4 Current Defects.

Although some work has been carried out to improve the quality the pointing on the external blockwork on the south and east elevations. Some of the blockwork does not reflect the quality of the pointing on the blockwork benchmark sample. Brookfield has informed us that all mortar tinting is now complete. Brookfield Manager F Shaw is to review the pointing with NHS (P Moir). See Supervisor's Notification of Defect (Cl 42.2) No 81.



Some of the outlets taking the rainwater from the top level of the Car park are too high consequently water is ponding in the recessed channels.

We asked Brookfield to confirm what remedial work will be undertaken to resolve this issue and confirm when the work is complete. They have intimated that the recessed channels will revised to give a fall to the outlets. See Supervisor's Notification of Defect (Cl 42.2) No 83.

The vinyl across the full length of the Atrium Bridge had sustained damaged. We asked Brookfield to confirm that the vinyl floor covering will be replaced across the full width of the bridge to match the benchmark floor on Level 4 Link Bridge. Following an inspection with Peter Moir a solution to replace the vinyl was agreed. This work is complete. Consequently Supervisor's Notification of Defect (Cl 42.2) No 84 is closed out.

Cables used in the fire alarm installation have been forced into conduits boxes on Level 12 stair core G which is not in accordance with the manufacturer's recommendations. This was previously raised through Supervisors Defect Notification No 68 regarding the stress caused to FP and was addressed. We asked Brookfield to confirm when this defect has been addressed. They have confirmed that this has been addressed and rectified. Consequently Supervisor's Notification of Defect (Cl 42.2) No 85 Is closed out.

The edging kerb near the south west corner of the Children's Hospital has been poorly laid. This work has been completed satisfactorily. Consequently Supervisor's Notification of Defect (Cl 42.2) No 86 is closed out.

The cladding to the column on the South Elevation of the Adult Hospital is damaged. Brookfield has confirmed that this has been repaired. See Supervisor's Notification of Defect (Cl 42.2) No 87.

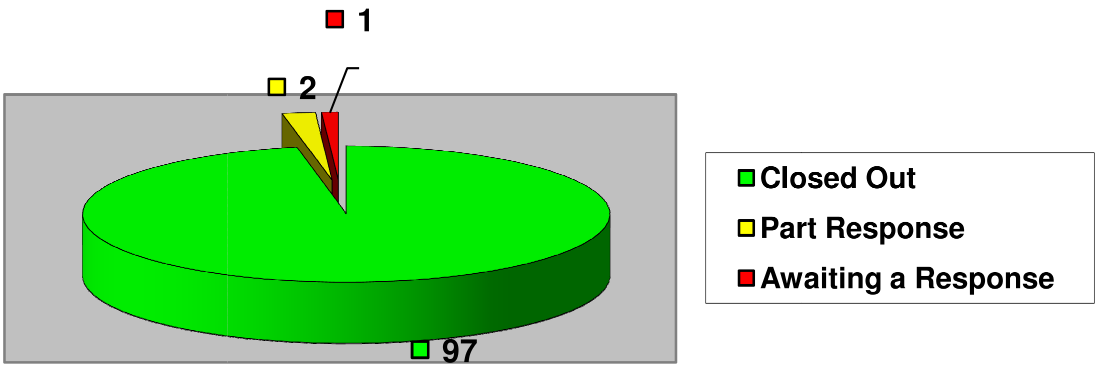
The capping piece on the north facing elevation of the Children's Hospital has two discoloured areas. We asked Brookfield to confirm their remedial action to address this and confirm when complete. They have confirmed that if the marks can't be cleaned off, Prater will paint repair or replace panels if required. See Supervisor's Notification of Defect (Cl 42.2) No 88.

The fire doors leading from corridor CCO-006 into EMC-061 Staff Base adjacent to EMC-058 has an excessive gap of 20mm between the underside of the doors and the floor. We asked Brookfield to confirm their action to ensure the fire doors provide the requisite designed fire resistance. Brookfield has confirmed that the doors have been altered to provide the requisite fire protection. Consequently Supervisor's Notification of Defect (Cl 42.2) No 89 is closed out.

During tests of smoke damper on 8.01.2015, the contractor was unable to successfully demonstrate the operation and correct addresses of smoke dampers No's PS 2 522 009, PS 2 522 010 & PS 2 522 011 on Level 2 Zone D. A further test was carried out successfully. Smoke damper No SD 2 527 017 which had a constantly displays red light has been addressed Consequently Supervisor's Notification of Defect (Cl 42.2) No 90 is closed out..

The cat ladder provides access/egress from the stairwell in Core L into a roof level vestibule through a door size opening. The vestibule has a glazed door providing access onto the roof and is not fire rated. Consequently the stairwell is not a fully enclosed safe means of escape. We asked Brookfield to confirm if it is their intention to construct the containment area partition walls up to the underside of the ceiling. They confirmed that the door from the roof level vestibule has been altered to a steel door as all other roof access doors and this will maintain the fire protected zone. Consequently Supervisor's Notification of Defect (Cl 42.2) No 91 is closed out.

5.0 INFORMATION REQUIRED



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Item No.	Description	Date Requested	Comment	
Items 1 to 29 have been closed out.				
30	Confirm when cabling is complete, water pumped out and batteries removed.	10.08.12	Closed out.	
Items 31 to 44 have been closed out				
45	See Supervisor's Communication No 30.	18.09.12	Closed out.	
Items 46 to 161have been closed out				
162	Confirm when the other legs have been extended to the steel framework in riser on Level 0 ZF Riser M30.	16.09.13	Closed out.	
Items 163 to 193 have been closed out				
194	Seeking confirmation how the fittings can be fitted within the present space or congested.	17.02.14	Closed out.	
Items 195 to 198 have been closed out				
199	There are gaps in the thermal insulation in back box of remote TVR's. Confirm remedial action.	20.03.14	Response received.	
Items 200 to 205 have been closed out				
206	Confirm that the difficult access to various fire dampers on Level 1 Areas 505, 508 and 537 will be addressed.	19.05.14	Closed out.	
Items 207 to 212 have been closed out				
213	Seeking confirmation that the different shaded capping pieces have been recorded in the IDMS as a snag/defect and that further remedial action will be undertaken.	09.10.14	Closed out.	
214	Seeking confirmation how access for maintenance high level smoke extract fans on Level 4 Zone C without cutting into weatherproof membrane.	09.10.14	Closed out.	
215	Seeking confirmation of action to resolve the east door clashes with one of the fans on Level 4 Core H link corridor.	09.10.14	Closed out.	
216	Seeking confirmation that the low lintel at the Electrical Cupboard WS4 032 will be lowered.	09.10.14	Closed out.	
217	Seeking confirmation that the sufficient activity space will be created at the front of the wc bowl	14.10.14	Closed out.	
Items 218 to 220 have been closed out				
221	Confirm that a review of the doors has been carried out on all levels and that door sets match.	29.10.14	Closed out.	
222	Confirm that all the plant rooms have been inspected to identify and repair cracks to concrete behind distribution boards.	29.10.14	Closed out.	
223	Confirm that all vertical blind wands will be fitted throughout and will be fully functional prior to handover.	13.11.14	Response received.	
224	Seeking confirmation that trip hazards similar to Communication No 209 will be considered for the installation of grills.	13.11.14	Response received.	
225	Confirm if you will be fitting temporary doors or a section of partition at the break out area in room RCF-024 to provide a 60 minutes fire rating.	19.11.14	Closed out.	
226	Provide the waterproofing detail for the smoke extract fan.	19.11.14	Closed out.	
227	Seeking confirmation in relation to access to the roof adjacent plantroom 41 A, plant room doors, access door to room above core L.	04.12.14	Closed out.	
228	Seeking confirmation of measures at high step in plantroom 41A.	04.12.14	Closed out.	
229	Seeking confirmation that the gap between the roof vent and partitions will be filled.	04.12.14	Closed out.	

230	Seeking confirmation that bolts to steel cleat connectors have been fitted and loose bolts tightened.	04.12.14	Closed out.	
231	Seeking confirmation that edge protection to the ramp serving the computer room in plantroom 41 will provide.	04.12.14	Closed out.	
232	Seeking confirmation that localised isolation as required as per IEE Regulations 537.3.2.4 will be provided to smoke extract fan damper motor installed on the 5th floor.	10.12.14	Closed out.	
233	Seeking confirmation if lighting should be controlled in room THE-067 when accessing and egressing between rooms THE-076 and THE-067.	12.12.14	Closed out.	
234	Seeking confirmation that the cat ladder providing access and egress to the 5th floor Roof between Plantroom 41A and Core L will be fitted.	12.12.14	Closed out.	
235	Confirm that the existing base details are capable of safely resisting the loads which may be applied to it and that it conforms to the design intent. Children's 4th floor.	06.01.15	Response received.	
236	Confirm that the footpath make up to the dual carriageway just north of the energy centre complies with the specification	07.01.15	Open.	
237	Seeking confirmation on Brookfield's action to address the ponding to the footpath to the east side of the maternity unit.	08.01.15	Open.	
238	Three lights taken on the drawing only two fitted. Seeking confirmation that his is an agreed change.	09.01.15	Open.	
239	Seeking confirmation that incomplete works in the Risers, Electrical Cupboards and IT Hub Rooms on Level 11 will be complete by 26th January 2015.	12.01.15	Closed out.	

6.0 SUPERVISORS TESTS AND INSPECTIONS

Tests not required	N/A
Tests required but not tested	Fail
Tests required which has passed tests	Pass

Tests				
Ref	Title	To be Notified by	Status	Test Date
01-86	Various tests undertaken and passed from the 09. 07.2012 To the 30.06 2013.			
87	Smoke damper test verification - Level 0, zones ~~D~~ & G. Zone G still outstanding.	Brookfield	Pass	24.09.2013 Retested 18.12.2014
88-138	Tests 28.09.2013 to 29.02.2014			
139	Smoke damper tests in plantroom 31. Some fails.	Witnessing arranged for 24/25 01 2015	Pass	26.01.2015
140-175	Various tests undertaken and passed from the 03.02.2014 to the 29.04.2014.			
176	VPI missing from FD 0-530 012. Not 013 as previously recorded.	List of obscured / missing VPI,s being collated by BMCE for contractor to action (IDMS).	Pass	29.04.2014 19.01.2015
177-179	Various tests undertaken and passed from 08.05.2014 to 09.05.2014.			
180	Fire dampers on Level 1 Zones 505 (FD 1-505 006, 508 (FD 1-508 005), 519 (All ok) FD 1-538 008.	Brookfield	Pass Pass	15.05.2014 12.06.2014 19.09.2014
181	Fire dampers on Level 1 Zone 537. FD 1-537 002, FD 1-537 003 & FD 1-537 004 not in wall.	Work scheduled for completion for Friday 23rd January 2014.	Pass	15.05.2014 21.01.2015
181 - 216	Various tests undertaken and passed from 19.04.2014 to 06.08.2014.			
217	~~FD 0-537 005 & FD 0-540 002 VPI hidden, retest required.~~ ~~Retested successfully 21.01.2015~~ ~~FD 0-537 005 retested successfully 19.09.2014.~~	List of obscured / missing VPI,s being collated by BMCE for contractor to action.	PASS	06.08.2014 19.09.2014 21.01.2015
218 - 231	Various tests undertaken and passed from 13.08.2014 to 28.08.2014			
232	Fire damper No FD 1-539 015 VPI loose.	List of obscured / missing VPI,s being collated by BMCE for contractor to action	Pass	29.08.2014

		(IDMS).		
233-238	Various tests undertaken and passed from 02.09.2014to 11.11.2014			
239-241	Various tests undertaken and passed from 11.09.2014to 15.09.2014.			
242	Fire test P23 tested ok. P24 One optical detector requires to be changed to strobe on room OWD 033.	Brookfield	Pass	15.09.2014 19.01.2015
243-257	Various tests undertaken and passed from 15.09.2014to 26.09.2014.			
258	Fire damper drop tests on Level 0-zones 531, 532, 533, 535 & 536. Two dampers inaccessible, FD 536 014 & FD 536 015. Hatch through plasterboard access required to access both.	Brookfield	PASS	26.09.2014 25.01.2015
259	Fire damper drop tests in Basement zones 504, 505 & 506. Unable to access FD B 504 001, + no damper fitted to adjacent duct.	Brookfield	PASS	26.09.2014 23.01.2015
260-299	Various tests undertaken and passed from 26.09.2014 to 29.10.2014.			
300	Re-witnessing of fire panels. (See 288)	Brookfield	PASS	11.11.2014 09.01.2015 22.01.2015
301-304	Various tests undertaken and passed from 12.11.2014 to 13.11.2014			
305	Fire damper drop tests on level 9.	Brookfield	PASS	14.11.2014 22.01.2015
306-317	Various tests undertaken and passed from 13.11.2014 to 21.11.2014			
318	Smoke dampers, level 3. 3 crossed addresses, and 1 mechanically faulty.	Brookfield	PASS	21.11.2014 22.01.2015
319-323	Various tests undertaken and passed from 21.11.2014 to 26.11.2014			
324	Fire panel tests, fire panel. P3 - One SD N/W and two sounders set for voice activation. P7 - One beacon N/W	Brookfield	PASS	28.11.2014 09.01.2015
325	Fire panel tests, fire panel P41 & P46. Randomly tested SD's and call points tested successfully.	Brookfield	PASS	28.11.2014
326	WI FI Coverage.	Brookfield	PASS	03.12.2014
327	Chlorination of water on level1 zones D & G.	Brookfield	PASS	03.12.2014
328	Air flows - 121 AHU 02 & 03.	Brookfield	PASS	03.12.2014
329	Sprinkler pump tests.	Brookfield	PASS	03.12.2014
330	Air flows, 41 AHU 13, 15, 18, 37, 38, & 39.	Brookfield	PASS	04.12.2014
331	Smoke dampers, Level 2 zones D, E, G & H. 1. SD 2 526 009 & SD 2 526 010 wrongly addressed. 2. SD 2 524 028 locked off. 3. SD 2 522 028 seized. 4. SD 2 521 026 hatch required.	Brookfield	PASS	04.12.2014 26.01.2015

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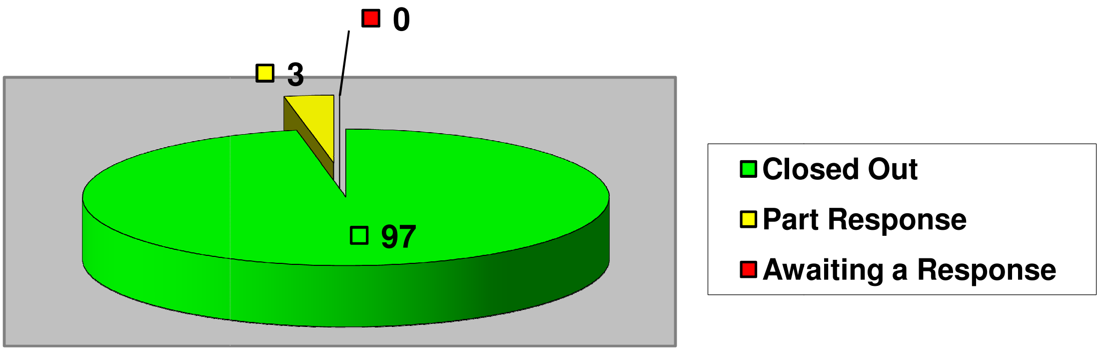
332	Fire panel, P42 & 45.	Brookfield	PASS	04.12.2014
333	Fire panels, P40 & P52 & revisit P03. P03 failed.	Brookfield	PASS	05.12.2014 09.01.2015
334	Pneumatic tube commissioning. Zones 5, 9 & 7.	Brookfield	PASS	09.12.2014
335	Air flow test - PR41 AHU 08, EF06, 25 EF02 & PR124 AHO 02.	Brookfield	PASS	11.12.2014
336	Renal system pressure test	Brookfield	PASS	11.12.2014
337	MTW Flow rates - Energy Centre.	Brookfield	PASS	12.12.2014
338	Air flows, PR124 AHU 02.	Brookfield	PASS	12.12.2014
339	Fire panel, P30.	Brookfield	PASS	12.12.2014
340	Air flows, PR41 AHU 03, 33, 40 & 41.	Brookfield	PASS	12.12.2014
341	Air flows, PR 41 AHU 42, 43, 44 & 45	Brookfield	PASS	15.12.2014
342	CCTV - Not all cameras focussed or positioned correctly	Brookfield	PASS	16.12.2014 22.01.2015
343	Security - Several doors failed due to broken glasses at emergency egress points, damaged or disconnected wiring at magnets and magnets not aligned.	Brookfield	FAIL	16.12.2014
344	Children's Hospital panic alarms.	Brookfield	PASS	16.12.2014
345	Air flows, PR121 AHU 06, PR41 AHU 03b & PR22 AHU 18	Brookfield	PASS	17.12.2014
346	Air flows, PR41 AHU 19, 23, 28 & 29.	Brookfield	PASS	17.12.2014
347	Air flows, PR41 AHU's 30, 31 & 32.	Brookfield	PASS	18.12.2014
348	Fire dampers, L0 & Basement. Access hatch required through plasterboard at 0 507 FD 005. Damper to be left in the closed position until permanent solution.	Brookfield	PASS	18.12.2014
349	Renal water pressure test.	Brookfield	PASS	18.12.2014
350	Lifts cause and effect test.	Brookfield	PASS	18.12.2014
351	Fire panel P3 revisit.	Brookfield	PASS	19.12.2014
352	Air flows, PRE31 27 EF02, 61 EF02, 63 EF01 & 64 EF 02.	Brookfield	PASS	19.12.2014
353	BMS Commissioning, PR32 & PR 33, AHU's and calorifiers.	Brookfield	PASS	19.12.2014
354	Water sterilisation.	Brookfield	PASS	22.12.2014
355	Ventilation, PR31 AHU's 63 & 64 & 31 EF11 + PR124 7 EF02.	Brookfield	PASS	22.12.2014
356	Fire panel P54 retest.	Brookfield	PASS	22.12.2014
357	CHP G59 settings.	Brookfield	PASS	06.01.2012
358	WI FI Coverage.	Brookfield	PASS	07.01.2012
359	Macerator demonstration.	Brookfield	PASS	07.01.2012
360	Smoke dampers tests on L2 Zones G, D, E & H. 3 dampers on L2ZG failed. 1 damper on L2ZH failed.	Brookfield	PASS	08.01.2012
361	Fire panel tests, P44, 52 & 67.	Brookfield	PASS	09.01.2015
362	Fire panel tests, P33, 61, & 62.	Brookfield	PASS	09.01.2015
363	EMS / Generator interface.	Brookfield	PASS	14.01.2015
364	Pneumatic tube demonstration.	Brookfield	PASS	15.01.2015
365	Ventilation air flow commissioning, PR123 AHU 06, PR122 AHU 01.	Brookfield	PAS	15.01.2015
366	Stair core ventilation systems.	Brookfield	PASS	15.01.2015

367	Fire alarm cause and effect, Tower.	Brookfield	PASS	16.01.2015
368	Fire alarm cause and effect in Children's.	Brookfield	PASS	16.01.2015
369	Fire alarm cause and effect in Podium.	Brookfield	PASS	17.01.2015
370	Ventilation air flows, PR32 AHU 14.	Brookfield	PASS	17.01.2015
371	Generator / EMS black start.	Brookfield	PASS	19.01.2015
372	Fire damper drop tests, level 01, basket tray to be cut.	Brookfield	PASS	21.01.2015
373	Fire panel tests, P63.	Brookfield	PASS	21.01.2015
374	Multipaging system.	Brookfield	PASS	22.01.2015
375	Water quality testing.	Brookfield	PASS	23.01.2015
376	AGV witnessing.	Brookfield	PASS	23.01.2015
377	Witnessing of food waste system.	Brookfield	PASS	23.01.2015
378	Fire shut down tests of AHU's during fire activation.	Brookfield	PASS	23.01.2015
379	Smoke damper tests in level 11.	Brookfield	PASS	24.01.2015
380	Operation of escalators, PA system and basement and Pharmacy roller shutter doors during fire activation.	Brookfield	PASS	25.01.2015
381	Operation of Aseptic suite and kitchen server roller shutter doors during fire condition.	Brookfield	FAIL	25.01.2015

7.0 DEFECTS NOTIFICATIONS ISSUED



	Description	Date Requested	Comment	
Items 1 to 78 have been closed out.				
79	Confirm when the poor workmanship to the blockwork outside room EMC-009 has been addressed.	01.07.14	Closed out.	
80	Confirm when the damaged blockwork to the external curve in area 2-513 has been addressed.	01.07.14	Closed out.	
81	External Blockwork on the south and east elevations does not reflect the quality of the pointing on the blockwork benchmark sample.	31.10.14	Response received.	
82	Confirm when plasterboard with mould growth has been replaced.	12.11.14	Closed out.	
83	Seeking confirmation of remedial action to resolve ponding.	13.11.14	Response received.	
84	Seeking confirm that the vinyl floor covering will be replaced across the full width of the bridge to match the benchmark floor on Level 4 Link Bridge.	17.11.14	Closed out.	
85	Level 12 stair core G which is not in accordance with the manufacturer's recommendations.	17.11.14	Closed out.	
86	Poorly laid edging kerb at the south west corner of the Children's Hospital.	18.11.14	Closed out.	
87	Cladding to column damaged on the South Elevation	18.11.14	Closed out.	
88	Seeking confirmation of remedial measures to address the discolouration of the capping pieces.	20.11.14	Response received.	
89	Excessive gap between the underside of the doors and the floor at Fire doors leading from corridor CCO-006 into EMC-061 Staff Base adjacent to EMC-058	09.01.15	Closed out.	
90	Confirm when smoke dampers No's PS 2 522 009, PS 2 522 010 & PS 2 522 011 on Level 2 Zone D will be re-test. Confirm when Smoke damper No SD 2 527 017 which displays a permanent red light has been addressed.	09.01.15	Closed out.	
91	Seeking confirmation if the to the cat ladder Level 4 Core L partition it is being continued to the underside of the ceiling.	09.01.15	Closed out.	

John Redmond, Technical Advisory Services

Property and infrastructure
Capita, The Beacon, 8th Floor, 176 St Vincent Street, Glasgow G2 5SG

	Signed	Date
Originated by	John Redmond	30th January 2015
Completed by	Douglas Wilson	30th January 2015

Gap Analysis of L8/HSG 274 and SHTM 04-01 requirements

Queen Elizabeth University Hospital (and Royal Children's Hospital)

8th March 2016

Meeting with David Watson, Allan McRobbie, Jim Guthrie, Hugh McCarten

Summary of L8 Management Tasks Required for L8 and SHTM 04-01 Compliance	**In place or being carried at present?**
Regular check to ensure that legislation and guidance has not changed	This has not been happening to date. SHTM 04-01 Part G now official document (Issued July 2015). Review Written Scheme to ensure compliance and revise monitoring works etc. to ensure that works being carried out cover all tasks/duties required.
Regular review of all policies relating to legionella control (e.g. Maintenance, Water Treatment, Water Management, Energy) to ensure still valid and correct	This has not been happening to date. Jim & Hugh going to look on "Staffnet" to lift the latest up to date water policy (and will send on a copy to DMA)
Regular review of L8 Management Structure to ensure up-to-date and accurate	This has not been happening to date. Review the management structure to ensure compliance with L8/SHTM 04-01 Part G. Ian Powrie to advise DMA of the structure and individuals named within this (example communication structures detailed within SHTM 04-01 Part G)
Regular review of communication lines to ensure still accurate and correct	This has not been happening to date. Example escalation lines of communication structure are included within GG&C Policy/SHTM 04-01 Part G (and also within Section 10 of DMA L8 Risk Assessment for pre-occupancy of QEUH)
Regular review of escalation & emergency procedures to ensure still valid and correct	This has not been happening to date. Example escalation & emergency procedures are included within GG&C Policy/SHTM 04-01 Part G (and also within Section 10 of DMA L8 Risk Assessment for pre-occupancy of QEUH)
Regular review of duties allocated to site staff and ensure accurate and recorded	This has not been happening to date. Example table of responsibilities are included within GG&C Policy/SHTM 04-01 Part G (and also within Section 10 of DMA L8 Risk Assessment for pre-occupancy of QEUH) which will allow confirmation of who individual tasks have been allocated to.
Regular review of duties of sub-contractors and ensure accurate and recorded and contractors are suitably qualified/competent for tasks assigned to them (e.g. Water Hygiene contractors should be LCA Approved, Plumbing contractors should be SNIPEF and Water Safe Registered)	This has not been happening to date. Example table of responsibilities are included within GG&C Policy/SHTM 04-01 Part G (and also within Section 10 of DMA L8 Risk Assessment for pre-occupancy of QEUH) which will allow confirmation of sub-contractors individual tasks have been allocated to. Veolia maintaining filtration units – though this is not under a formal contract at present. Eden Spring maintaining water coolers – though this requires to be confirmed if under contract or still in the process of being set up. (122 units within the building) DMA advised all pre-handover and subsequent disinfections carried out within the building carried out by non-LCA approved contractors.
Regular review of staff training requirements and update training matrix	This has not been happening to date. AP and CP training is being organised though no dates for this set yet. All other training records should be held recorded location (Or logbook). Training matrix should be updated and provided to DMA for review.
Regular review of method statements and risk assessments to ensure still valid and correct	This has not been happening to date. Example RAMS included within DMA RA carried out in the pre-occupation phase (March 2015)
Regular review of site documentation to ensure all records up to date and present	Jim Guthrie advised he monitors the PPM records of the works being carried out though there may be gaps where tasks and/or records incomplete.
Regular update of "Patient Risk Rating" register for all areas of hospital.	This is being reviewed (updated "High Risk" areas across the estate has been issued – January 2016)

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Regular review of sentinel outlet locations register.	This has not been happening to date. Allocation of outlets as "sentinel" locations has been queried by NHS though no further information available at this time. End of line sensors are now being incorporated into the BEMS system (Approx half on system currently)
Regular review of primary, sub-ordinate and tertiary hot flow and return loops to reflect any system alterations.	No alterations have been carried out and as above sensors now being incorporated into the BEMS systems
Regular review of plant and equipment maintenance schedules.	This has not been happening to date. These require to be reviewed to ensure compliance with SHTM 04-01 Part G
Regular review of BEMS temperature sensor locations to reflect any system alterations	This has not been happening to date. Jim Guthrie advised he is going to review this once he moves onto day shift to ensure that an adequate spread of sensors throughout the systems.
Regular review of schematic/as-fitted drawings to ensure up-to-date and accurate	No alterations since building completion. (Bernie McCulloch is CAD controller and manages this)
Regular review of L8 risk assessment (particularly as the phased occupation process progresses) with a maximum period of two years between updates. (e.g. if change of use or changes in legislation or any other factor which could affect validity of current assessment)	Previous Risk Assessment was carried out during the Pre-Occupation period. This now requires to be updated/reviewed.

N.B. By "Regular" DMA would advise a Quarterly or 6 monthly review of all tasks above or as and when there are changes in system operation, management or other control parameters which would warrant a review of any particular task. (e.g. if change of use or changes in legislation or any other factor which could affect validity any of the current documentation)

Initial tasks required to aid compilation of PPM schedules/registers within site written scheme	In place or being carried at present?
Identify, label and record all plant, valves and services	All labelling carried out at construction phase
Identify, label and record sentinel outlets on hot and cold water services.[1]	All sentinel outlets are recorded on a sentinel outlet register. No access to "many" of the sentinels though due to panels requiring to be removed though Sensors linked to BEMS is assisting with recording.
Identify, label and record all "drinking" and "non-drinking" water outlets	All cold water is deemed as wholesome throughout the hospital.
Identify, label and record all primary, sub-ordinate and tertiary flow and return loops and their access points for temperature profile/mapping	Hot flow and return loops are identified and there are sensors fitted. Jim Guthrie is on the process of creating a register of where all sensors are and that all Primary/Sub-Ordinate loops are included within the BEMS monitoring system.
Identify, label and record all BEMS temperature sensor locations for temperature profile/mapping	As above Jim Guthrie is working on this once he moves onto day shift.
Identify, label and log all mixing devices (TMVs) with a unique identification as well as identification of its type. Hot and cold water pressures also need to be measured and recorded for each mixing device together with all the test parameters from the in-service tests	This has been completed for the "High Risk" areas. This is for locations only – not the actual tap. (practicalities of labelling and recording TMVs and then logging where taps are installed etc. make this prohibitive)
Identify, label and log all "other uses of water" (e.g. use of ice machines, drinking water fountains, bottled water dispensers etc.)	DMA advised no bottled water dispensers within the building. No ice machines fitted, though DMA advised that wards/clinical staff may initiate or arrange installation of equipment without notifying estates management. DMA would advise estates emphasise to clinical staff the importance of keeping estates staff abreast of any changes to the water system. Clogg washers installed in the theatre changing rooms (DMA Advised these are sealed units "identical" to a dishwasher). Endoscope washers, Renal System (Maintained by Veolia) MRI Chillers - confirm if this is an Adiabatic chiller as DMA suspect. If so suitable remedial actions and monitoring regime should be implemented.

[1] Sentinel outlets are normally those that – on a hot water service – are the first and last outlets on a recirculating system with additional points on larger systems where monitoring of primary, sub-ordinate and tertiary loops is required. On cold water systems (or non-recirculating hot water systems), they are the closest and furthermost from the storage tank (or water heater). The choice of sentinel taps should also include other outlets that are considered to represent a particular risk, for example those installed in accommodation in which particularly susceptible patients are treated, or others identified in the risk assessment and temperature mapping exercise as having the least satisfactory temperature performance.

Summary of ppm tasks required within site written scheme to aid compliance with SHTM 04-01 and L8 / HSG 274	**In place or being carried at present?**
Daily water draw-off should form part of the daily cleaning process.	Being carried out by ward staff. Hospital is now fully occupied and all areas in full use. This is all out with estates remit. No flushing required.
Daily check the flow and return temperatures on the domestic hot water calorifier systems using the temperature gauges fitted or a suitable surface temperature probe – required until such times as Estates staff have full access to BEMS system.	BEMS now always on. Also a contract in place for the BEMS now. Advise an manual check system in place (and documented). Jim Guthrie going to complete this.
Daily check of BEMS incidents and faults	Yes this is being carried out. This is an integral part of Estates managers jobs.
Incoming Water Mains - maintain in accordance with installation/design guidelines, ensuring alteration of incoming mains lines to run at least daily. (DMA advised 9 hourly swap over).	This is still occurring. Automatically via BEMS.
Cyclical alteration of CWST booster pumps (ensuring every pump runs at least weekly)	Automatic via BEMS
Daily check to ensure entire body of calorifier(top, middle, base) reaches 60°c for a period of 1 hour each day (generally at a time of low use e.g. Early morning/late evening)	BEMS monitors top, base and return temperatures to all calorifiers. The control parameters for the base temperature within BEMS setup should be confirmed.
Daily flushing of all outlets in "High Risk Areas"/ICUs. Hot and cold outlets should be flushed for a minimum of 3 minutes and until the water temperature stabilises in line with current temperature profile.	This is the responsibility of ward staff
Twice-weekly flushing of all outlets in unoccupied areas and low use/sporadically used outlets. Hot and cold outlets should be flushed for a minimum of 3 minutes and until the water temperature stabilises in line with current temperature profile.	Trades Water – these should be included within the twice weekly flushing regime, but this is not being carried out as frequently as required due to other requirements. Line to roof level fire tank – confirm if this requires to be included within this flushing.
Twice weekly flushing of emergency/deluge shower for a minimum of 3 minutes and the water temperature stabilises in line with current temperature profile.	Trade System water outlets to be carried out
Twice weekly flushing of deadlegs/blind ends where these cannot be removed. All deadlegs should be flushed for a minimum of 3 minutes and until the water temperature stabilises in line with current temperature profile. [2]	All deadlegs should now be utilised as any deadlegs identified were connections for drinking water/vending water machines (Waiting areas). It is advised each area is surveyed to confirm vending machines installed and deadlegs now being utilised as a draw-off point.
Weekly water system check for chloramines (if required)	This is not being carried out at present. SHTM requirement.
Weekly check to ensure that non-return valves shut off tightly. Remove covers and examine further if they do not.	This is not being carried out. (Brookfield maintenance issue)
Weekly check of water levels within water tanks	Yes this is done and recorded
Check spray taps for satisfactory spray, where necessary remove spray orifice and clean, remove any accumulation of scale. *(DMA understands no spray taps fitted though this is to be confirmed)*	NO spray taps fitted. Spray washers in kitchens are cleaned/disinfected by catering staff
Monthly (minimum) *manual* test to confirm water system pumps operating correctly	Yes this is being carried out
Monthly calorifier storage temperatures checks at top (flow) and return pipework Flow temperature – min 60°C, return temperature – min 55°C	This is monitored by BEMS.

Summary of ppm tasks required within site written scheme to aid compliance with SHTM 04-01 and L8/HSG 274 (cont...)	In place or being carried at present?
Monthly temperature checks on hot outlets at sentinel, little-used & selected outlets. >55°c within 1 minute (also note potential scald risks and out of spec TMVs)[2] to create a temperature profile of building and monitor flow and return system with all primary flow and return loops being monitored monthly, sub-ordinates quarterly and tertiary loops annually.	Sentinel outlets only being monitored. Trades system - tank only monitored. No other outlets being monitored. High risk areas do not have a specific monitoring regime.
Monthly temperature checks on cold outlets at sentinel, little-used & selected outlets. <20°c within 2 minutes to create a temperature profile of building and monitor heat gain within the cold water system.	Sentinel outlets only being monitored. Trades system - tank only monitored. No other outlets being monitored. High risk areas do not have a specific monitoring regime.
Monthly check to ensure CWST overflows are unobstructed	Not currently on a checklist – this requires to be added to PPM.
Monthly flushing of expansion vessels as not 'flow through' design	Not currently being carried out. Potentially convert to flow through with retro-fit valves.
Quarterly descaling, cleaning and disinfection of showerheads & hoses & spray outlets, or replace with replace with new disinfected Shower Head and Hose (or frequency as indicated by the rate of fouling or other risk factors, e.g. areas with high risk patients)	High risk areas only being carried out at present, but no other areas currently (using showerhead plus)
Quarterly each calorifier and any associated storage/buffer vessels should be flushed through its drain valve by opening the drain valve 3 times, each time for a 3 minute period.	This is not currently being carried out but drains are being piped to the drain (not into) to allow this to be carried out.
Quarterly servicing TMV's or mixer valves, including fail safe tests and cleaning/disinfection of strainers within "Designated High Risk Area"/ICUs (more frequently if manufacturer recommends – Documentation not available on Zutec at time of writing, or if 'drift' in excess of 1°C at mixed outlet temperature highlighted during temperature monitoring or other maintenance)	This is not currently being carried out but there are plans to commence this (potentially using night shift staff). Test /disinfection rig has not been set up yet.
Six monthly servicing TMV's or mixer valves, including fail safe tests and cleaning/disinfection of strainers. (more frequently if manufacturer recommends – Documentation not available on Zutec at time of writing, or if 'drift' in excess of 1°C at mixed outlet temperature highlighted during temperature monitoring or other maintenance)	Not currently being carried out but there are plans to commence this (potentially using night shift staff). Test /disinfection rig has not been set up yet.
Six monthly CWST condition inspection noting appearance of water, stagnation, odour, rust, scale, sediment, debris, paint/liner condition and bio film accumulation and tank lid fitting ok and insulation condition	This is being carried out
Six monthly CWST temperature checks (summer and winter) on tank supply and stored water at opposite side from tank inlet if possible (inlet and stored water should be <20°C, with stored water no more than 2°C warmer than make-up water.)	This is being carried out
Six monthly chemical and microbiological water samples from water tanks which feed drinking water outlets	This is not being carried out at present.
Annually arrange for samples to be taken from hot water calorifiers/water heaters in order to note condition of drain water.	Not being carried out at present

In "High Risk" areas every 2 years every single water outlet is being sampled (with temperatures being recorded). Samples are both first flush and 2 minute flush samples.

For pseudomonas sampling we would advise input from infection control and microbiologists to determine the sampling regime which should be put in place (Flow straighteners cannot be removed therefore some additional "mitigation" is required)

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

Summary of ppm tasks required within site written scheme to aid compliance with SHTM 04-01 and L8/HSG 274 (cont…)	**In place or being carried at present?**
Annual cleaning and disinfection CWST *and downservices* (more frequently if required dependant on CWST inspection & sample results). TVC and Legionella samples should be taken upon completion of disinfection works. **Please Note:** *Due to the system design and installation complete disinfection of all downservices fed from the Raw and Bulk water storage tanks may not be practical as "high risk" system such as renal dialysis is fed from these tanks. Alternative protocols/method statements for local disinfections should be prepared and maintained.*	This has not been carried out. Filtration unit should cope with filling required. Sepa/Scottish Water may require to be notified.
[A] Annual descaling, cleaning and disinfection of strainers (including angle valve strainers) (or frequency as indicated by the rate of fouling or other risk factors, e.g. areas with high risk patients)	Not being carried out at present.
[B] Annual internal inspection and cleaning/descaling of the calorifier/water heater with disinfection/pasteurisation upon completion	Not being carried out at present.
Annual inspection of vibration coupling on pumps/plant, replacing as necessary (more frequently if recommended by manufacturer)	Not being carried out at present.
Annual inspection of plant and pipework insulation, repairing where necessary.	Ongoing task – very little works have been carried out on the water system.
Biennial stratification checks on plate heat exchangers/calorifiers. These checks should extend over a period of seven (7) days using a logging device to establish that the water temperature at the base of the vessel achieves 50ºC.	Covered by BEMS
Arrange for microbiological samples to be taken from water system which represent the complexity of the water system(s) and particularly in areas of concern. All sampling should be carried out in accordance with BS 7592:2008 and all analysis by a UKAS accredited laboratory.	Ongoing but requires formalisation of the sampling regime.
[C] Pasteurisation/disinfection of calorifier/water heaters carried out as and when required dependent on temperature monitoring and sample results	DMA advised this has not been required as yet.
Turnover test on cold water storage system. Checks should be carried out to ensure that volume of water stored is no more than would generally be used in a normal 12 hour period. **N.B.** This should be reviewed as part of the phased occupancy period with volume of sorted water adjusted as the building use alters during this process.	No formal records of this being being carried out, though there have been instances of the CWSTs running dry within a "short period of time" when filtration sets malfunctioned, indicating a good turnover of water through the CWSTs.
As required descaling of taps/outlets (including aerators and flow straighteners) (frequency dependent on inspection results and hardness of water on site)	No inspections records and/or instances of taps being scaled have been reported to estates.
All EPDM flexi hoses (where fitted to articulated taps/outlets e.g. assisted baths) should be WRAS approved and should be replaced every 2 years if alternative materials cannot be used.	Flexible hoses fitted at time of construction are still in situ.
All plant items should be maintained in accordance with manufacturer's instructions and maintenance schedules, with tasks/duties allocated and recorded.	Further review of manufacturers/installers instructions required.
Filtration equipment (Elga) – maintain in accordance with manufacturers guidelines, ensuring alteration of filtration sets to run at least daily. (DMA advised 9 hourly swap over).	Filtration units swapped automatically by BEMS system. Veolia maintaining filtration units – though this is not under a formal contract at present.

System / service	Task	Minimum Frequency	In place or being carried at present?
MRI Chillers Wet/Dry (Adiabatic) Cooling)	Depending on the actual design and operation of these units they may require to be registered with the local authority under the NCTEC Notification Requirements (See HSG 274 Part 1 Para 1.18 – 1.21 inclusive of Figure 1.4 and Info Box 1.1). These may also require ongoing treatment or monitoring programmes to be implemented depending on assessment. Maintain in accordance with manufacturers/installers instructions. Consider use of POU disinfection system such as UV for spray water.	TBC	No information on this at present. Estates to investigate further.
	Connection point to MRI unit(s) should be included in site flushing regime and have suitable backflow protection fitted.	Twice weekly as part of site flushing regime	Not included at present. These should be formally included in site flushing regime.
Emergency Showers	HSG 274 Part 3 recommends minimum six monthly flushing of emergency/deluge shower, though Risk Control Notice 11/advises "flush through and purge to drain twice per week– source SHTM 04-01 Part G (Draft). NHS Estates should formulate an appropriate flushing regime and maintain in accordance with manufacturers/installers instructions.	Twice weekly as part of site flushing regime	Intermittent flushing at present. These should be formally included in site flushing regime.
Dental Chairs/System	HSG 274 Part 3 states "Drain down, clean, flush and disinfect all system components, pipework and bottles twice daily. Disinfectant contact time as recommended by manufacturer. Take microbiological measurements (Refer to Decontamination HTM 01-05)	Twice daily	No information on this at present. Estates have not carried out any work on these systems and advise these should be managed by "clinical" staff.
	SHTM 04-01 Part G (Draft) states "Drain down and clean at the end of each working day".	Daily	
	HTM 01-05 provides advice and recommendations for on-going maintenance and this should be followed in addition to manufacturers and installers instructions.	As per manufacturers/ installers instructions.	
	Take microbiological measurements – refer to *Decontamination Health Technical Memorandum 01-05: Decontamination in primary care dental practices*[5]	As indicated by bespoke risk assessment *(to be carried out by others)*	
Hydrotherapy Pool	Maintain in accordance with manufacturers/installers instructions and "PHLS Hygiene for Hydrotherapy Pools" and Pool Water Treatment Advisory Group (PWTAG) Code of Practice (Feb 2015).	Bespoke written scheme should be created for the hydrotherapy pool based on PHLS/PWTAG and manufacturers/ installers instructions.	Daily checks carried out by estates staff. No formal written scheme created for this at present.

System / service	Task	Minimum Frequency	In place or being carried at present?
Air Conditioning & Ventilation	Maintain in accordance with manufacturers/installers instructions and SHTM 03-01 and SHTM 04-01 Part G (Draft).	Maintenance regime/Written Scheme should be created based on SHTMs and manufacturers/installers instructions.	Estates (Cyril Dowson) to issue PPM schedule for ventilation plant and equipment.
	This may include:		
	Inspect, clean & log glass traps	Monthly	Glass traps inspected "periodically" and cleaned as and when require, though not monthly.
	Humidity Section Inspection, Cooling Section Inspection and Ventilation Plant Inspection and Disinfection	Six monthly	These will be included within the ventilation PPMs being issued by estates.
Steam Humidification	Maintain in accordance with manufacturers/installers instructions and SHTM 03-01 and SHTM 04-01 Part G (Draft). Offline at time of survey.	Maintenance regime/Written Scheme should be created based on SHTMs and manufacturers/ installers instructions.	These will be included within the ventilation PPMs being issued by estates. DMA advised the humidifiers have been commissioned.
Medical Gases/Medical Equipment (e.g. Nebulisers, incubators, etc.)	Conduct a risk assessment of each system, preferably using an assessment team comprising members knowledgeable in legionella management and control, as well as those familiar with the design and operation of the system and Infection Control/Clinical staff where appropriate. Control procedures within appropriate SHTM (or other relevant guidance) for system being assessed should be taken in to account during assessment(s). Any water softeners or other filtration equipment connected to these systems should be assessed at this time. Devise a control scheme based on the risk assessment.	Monitoring, inspection, and testing frequencies to be determined as indicated by bespoke risk assessment *(to be carried out by others)*	Clinical information required. Allocation of responsibilities unclear at this time.
Sprinkler System	Minimise aerosol creation during maintenance procedures. Consider wearing suitable masks to prevent ingestion as recommended by the FIA guidance. Maintain in accordance with manufacturers/installers instructions.	As per manufacturers/ installers instructions.	Tested at pumps only and recirculation to tank.
12th Floor Heli-pad fire suppression system	Minimise aerosol creation during maintenance procedures. Consider wearing suitable masks to prevent ingestion as recommended by the FIA guidance. Maintain in accordance with manufacturers/installers instructions.	As per manufacturers/ installers instructions.	DMA advised this system is tested by the porters, with no input from estates.
	Include all points on the 12th floor Trades system (including inlet to fire tank) in site flushing regime.	Twice weekly as part of site flushing regime	This is not being carried out at present. These should be formally included in site flushing regime.
Irrigation System	Include in site flushing regime. Additional flushing may also be required (outlets run for extended periods) to bring temperatures on distribution system down particularly during periods of low use (e.g. in winter when irrigation system is not required to operate frequently). Maintain in accordance with manufacturers/installers instructions.	Twice weekly as part of site flushing regime	This is not being carried out at present. Allocation of responsibilities unclear at this time. These should be formally included in site flushing regime.
Water Softeners	Maintain in accordance with manufacturers/installers instructions (including cleaning and disinfection of resin and brine tanks). Ensure aerosol creation is minimised during maintenance and testing procedures.	As per manufacturers/ installers instructions.	As per other installed equipment maintenance schedules allocation of responsibilities unclear at this time. This requires to be formalised and PPM schedule created.

System / service	Task	Minimum Frequency	In place or being carried at present?
Endoscopy Wash	Maintain in accordance with manufacturers/installers instructions and current NHS (SHTM) protocols. Ensure aerosol creation is minimised during maintenance and testing procedures.	Maintenance regime/Written Scheme should be created based on SHTMs and manufacturers/ installers instructions.	DMA advised this is a clinical responsibility with no input from estates.
Renal Dialysis (Adult)	Maintain in accordance with manufacturers/installers instructions, current NHS (SHTM) protocols and "Clinical Practice Guideline by the UK Renal Association of Renal Technologists". Ensure aerosol creation is minimised during maintenance and testing procedures.	Maintenance regime/Written Scheme should be created based on SHTMs and manufacturers/ installers instructions.	DMA advised this is a clinical responsibility with no input from estates.
Renal Dialysis (Children's)	Maintain in accordance with manufacturers/installers instructions, current NHS (SHTM) protocols and "Clinical Practice Guideline by the UK Renal Association of Renal Technologists". Ensure aerosol creation is minimised during maintenance and testing procedures.	Maintenance regime/Written Scheme should be created based on SHTMs and manufacturers/ installers instructions.	DMA advised this is a clinical responsibility with no input from estates.
Arjo Bath	Maintain in accordance with manufacturers/installers instructions. Where flexible hoses (i.e. internal to bath unit) cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered.	As required	These are maintained by a sub-contractor, though as per other installed equipment the details of maintenance contracts have not been formalised.
Closed Chilled Systems	Minimise aerosol creation during maintenance procedures. Maintain in accordance with manufacturers/installers instructions.	As required	DMA advised H&V are the maintenance contactors for closed systems. DMA also advised biocides have been dosed to all closed systems.
Closed Heating Systems	Minimise aerosol creation during maintenance procedures. Maintain in accordance with manufacturers/installers instructions.	As required	DMA advised H&V are the maintenance contactors for closed systems. DMA also advised biocides have been dosed to all closed systems.
Decorative Bubble Lamps	Maintain in accordance with manufacturers/installers instructions and ensure aerosols minimised during maintenance.	As required	These are maintained by a sub-contractor, though details relating to legionella control and the allocation of responsibilities for these have not been established.

MERCURY

QEUH Adults & Children's

Domestic Water System Sample Schedule

Sample No.	NHS Department	Level	Adults/ Childrens	Dept.	Pass/Fail	Witness		
						Mer	BM	NHS
1	Acute Assesment Ward	0	Adults	Cleaners room next to AAW-313	✓	[redacted]		[redacted]
2	Acure Assesment	0	Adults	Next to AAW-322	✓	[redacted]		[redacted]
3	Critical Care	0	Adults	AAW-205 Dirty Utility	✓	[redacted]		[redacted]
4	Critical Care	0	Adults	AAW-153	✓	[redacted]		[redacted]
5	OPD	0	Childrens	OPD-090 Workshop	✓	[redacted]		[redacted]
6	OPD	0	Childrens	OPD-060 Physiology Room	✓	[redacted]		[redacted]
7	Cardiology	1	Childrens	CAR-026 En-suite	✓	[redacted]		[redacted]
8	Cardiology	1	Childrens	CAR-043 WC	✓	[redacted]		[redacted]
9	23 Hour Unit	1	Childrens	23HU-032 Dirty Utility	✓	[redacted]		[redacted]
10	23 Hour Unit	1	Childrens	23HU-093 Pantry	✓	[redacted]		[redacted]
11	OPD1	1	Adults	OPD1-123 Cleaners	✓	[redacted]		[redacted]
12	OPD1	1	Adults	OPD1-145	✓	[redacted]		[redacted]
13	ARU	2	Adults	ARU-003 Dirty Utility	✓	[redacted]		[redacted]
14	ARU	2	Adults	Next to ARU-003	✓	[redacted]		[redacted]

				Office				
15	Dermatology Ward	2	Adults	DMW-054 En-suite	✓	[redacted]		[redacted]
16	Dermatology Ward	2	Adults	DMW-083 Regen Kitchen	✓	[redacted]		[redacted]
17	Core A	2	Adults	CA2-001 Lobby	✓	[redacted]		[redacted]
18	Dermatology Support	2	Adults	FMA2-010 WC	✓	[redacted]		[redacted]
19	Facilities management	3	Adults	FM3-019 WC	✓	[redacted]		[redacted]
20	Facilities Management	3	Adults	FM3-030	✓	[redacted]		[redacted]
21	Core C	4	Adults	WS4-016	✓	[redacted]		[redacted]
22	Core B	4	Adults	WS4-007	✓	[redacted]		[redacted]
23	Ward 5B	5	Adults	GENWD-009	✓	[redacted]		[redacted]
24	Ward 5B	5	Adults	GENWD-076	✓	[redacted]		[redacted]
25	Core B	6	Adults	WS6-009	✓	[redacted]		[redacted]
26	Core D	6	Adults	WS6-021	✓	[redacted]		[redacted]
27	Core D	6	Adults	WS6-027	✓	[redacted]		[redacted]
28	Ward 7A	7	Adults	Genw5-061	✓	[redacted]		[redacted]
29	Ward 7A	7	Adults	Genw5-033	✓	[redacted]		[redacted]
30	Ward 8C	8	Adults	Genw11-081	✓	[redacted]		[redacted]
31	Ward 8C	8	Adults	Genw11-034	✓	[redacted]		[redacted]
32	Ward 9C	9	Adults	Genw15-034	✓	[redacted]		[redacted]
33	Ward 9C	9	Adults	Genw15-081	✓	[redacted]		[redacted]
34	Ward 9C	9	Adults	Genw15-080	✓	[redacted]		[redacted]
35	Ward 10D	10	Adults	Genw18-066	✓	[redacted]		[redacted]
36	Ward 10D	10	Adults	Genw18-	✓	[redacted]		[redacted]

				068				
37	Ward 11B	11	Adults	Genw24-032	✓	[redacted]		[redacted]
38	Ward 11B	11	Adults	Genw24-081	✓	[redacted]		[redacted]
39	Core B	11	Adults	WS11-011	✓	[redacted]		[redacted]
40	Core D	11	Adults	WS11-027	✓	[redacted]		[redacted]
41	Acute Assesment Ward	0	Adults	AAW-351	✓	[redacted]		[redacted]
42	Acute Assesment Ward	0	Adults	AAW-363	✓	[redacted]		[redacted]
43	Acute Assesment Ward	0	Adults	AAW-365	✓	[redacted]		[redacted]
44	Acute Assesment Ward	0	Adults	AAW-366	✓	[redacted]		[redacted]
45	Acute Assesment Ward	0	Adults	AAW-382	✓	[redacted]		[redacted]

Please refer to attached drawings for sample locations.

The domestic water system at each location has been tested with a magnet to prove that stainless steel pipe work has been used.

Test Date: 16/11/16 – 17/11/16

Test Witness: **Mer:** [redacted]

BM: [redacted]

NHS:

REV 0

Ticket No	Stock Status	Description	Status	Mob...	Reported	Planned	Completed	Terminat...	Pri
1604477818		Flush outside taps and rec...	Complet...	No	29/04/2016 10:08:00	02/05/2016 08:00:00	03/05/2016 [illegible]		CA
1605485198		Please flush all outside tap...	Complet...	No	19/05/2016 07:00:00		20/05/2016 14:39:00		CA
1605490094		Flush outside taps and rec...	Complet...	No	31/05/2016 10:38:00		03/06/2016 22:53:00		CA
1607505099		Flush all outside taps and r...	Complet...	No	11/07/2016 09:36:00		15/07/2016 11:59:00		CA
1607510467		Flush outside taps on nigh...	Complet...	No	25/07/2016 08:40:00		30/07/2016 21:56:00		CA
1608520740		Flush all outsider taps and ...	Complet...	No	21/08/2016 07:46:00		23/08/2016 18:49:00		CA
1610547340		On nightshift flush all outs...	Complet...	No	31/10/2016 11:27:00		01/11/2016 01:24:00		CA
1611552613		Please flush all outside tap...	Complet...	No	14/11/2016 08:48:00		20/11/2016 05:07:00		CA
1611552616		Please flush all outside tap...	Complet...	No	14/11/2016 08:52:00		20/11/2016 23:06:00		CA
1611558493		Flush all outside taps in bu...	Complet...	No	28/11/2016 09:03:00		29/11/2016 21:00:00		CA

A47392376

PF 19

NEC3

***SUPERVISOR'S* FINAL DEFECTS CERTIFICATE (Cl 43.3)**	CAPITA	FRAMEWORKS SCOTLAND EXCELLENCE IN HEALTHCARE CONSTRUCTION

Short Description **Stage 3 Adult and Children's Hospital and Energy Centre** ***Date:*** **26th January 2017**

Notification Nr: A/C/002

To: *Contractor's* Agent

Contractor – (Name) Multiplex Construction Europe Ltd

Project Office Address Fairfield - Suite 12,
1048 Govan Road
Glasgow, G51 4XS, United Kingdom

1. Dear Sir

SUPERVISOR'S FINAL DEFECTS CERTIFICATE AT COMPLETION OF WHOLE OF WORKS

☐ ~~Following an inspection of the works on (Date)~~ ~~I certify that no Defects were found~~

Alternatively

☑ Following an inspection of the works on (Date) 26th January 2017 I certify that the following Defects have not been corrected

Location of Defect	Description of Defect
VARIOUS	ATTACHED LIST 1 - FM First Summary Schedule (reference "QEUH FM First Summary_170126")
VARIOUS	ATTACHED LIST 2 - Supervisor Defects Notifications (refer status in red)
VARIOUS	ATTACHED LIST 3 - PM Schedule of Incomplete Works 26/01/2015 (refer status in red)

Signed [redacted] ***Supervisor (NHS) or delegate*** **Date:** 15th February 2017

Distribution:

The Employer	David Loudon
Project Manager (NHS)	Graham Forsyth
Other	Douglas Ross (Cost Advisor)

STAGE 3 FINAL DEFECTS CERTIFICATE
ATTACHED LIST 1 — QEUH FM FIRST SUMMARY_ 170126.

1

First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1602447401			FIN LIGHT INSTALLATION - ZONE F (PR122) - NOT INSTALLED, ZONE J (PR123) - 1 SET DISCONNECTED/ DAMAGED, ZONE H (PR124) - INSTALLED	08-Mar-16	MER	CG	NHS to advise when BMU will be available			1	
1607502650	Energy Centre		ENMS HEAD END ISSUES. ENMS DOES NOT DISPLAY TOTAL SITE LOAD WHEN SUPPLIED FROM THE GRID. THERE ARE VARIOUS OTHER ISSUES WITH	11-Jul-16	MER	MH	Further ENMS works carried out with 4 remaining breaker issues to resolve. Further work carried out and			1	
1608517998	A-03-FM3-051	FM Support	Children's Theatre 7 sockets on UCV have not wired up since they moved in. Require power supply to be run in to feed these sockets.	13-Oct-16	MER	MH	Install work complete but due to isolation restrictions testing to be complete by 18/20/17.			1	
1609528661	A-02-THE-003	Office	S/VIDEO OUTPUT FROM STARKSTROM CAMERA UNIT FAULTY- PICTURE EITHER DOES NOT DISPLAY OR CONSTANTLY SCROLLING AND FLASHING.	20-Dec-16	MER	MH	Starkstrom returning to site Tuesday 07/02/17 for further investigation. No access. Await access			1	
1610540507	A-00-CCB-032		Labelling of fire dampers throughout site is found not to be robust. Labelling already detaching from damper mechanisms.Please investigate and provide programme for replacement	17-Oct-16	MER	MH	Require location of failed labelling for review			1	
1610541786	Energy Centre		Lateral expansions joints appear to be fitted correctly however in several locations the joints are fitted in the opposite plane and often restricted by	17-Oct-16	MER	MH	The 4 bellows (1 in B side and 3 in A side) will be altered as per Specialist advice. Full pack of information (RAMS			1	
1610541805	Energy Centre		The majority of lateral expansions joints appear to be fitted correctly	17-Oct-16	MER	MH	The 4 bellows (1 in B side and 3 in A side) will be altered			1	
1611549537	A-03-FM3-051	FM Support	LED strip lighting running externally down Tower D has came unattached	22-Nov-16	MER	MH	Brackets now rectified. Rope lights being fitted			1	
1611559026	A-02-THE-167	Theatre	UCV THEATRES.WHEN UCV SYSTEMS ARE RUNNING THE PRESSURE	06-Dec-16	MER	MH	MER arranging investigation by H&V. Date to be			1	

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First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1509393372	A-01-CCU-056	Office	Medical HDU UNIT 4 ISOLATION ROOM 43 blind faulty in window (not closing for patient dignity) can this please be sorted as soon as possible). Note added by ROBERT GEDDES (12/10/2015 14:57:52) ROOM No CCW-158 OBSERVATION WINDOW. Note added by ROBERT GEDDES (07/10/2016 15:35:38) ROOM No CCW-158 OBSERVATION WINDOWS x2	01-Nov-16	TDSL	JM	Access restricted by IC and users. Awaiting IC sign off and access arrangement.		1		
1602446208	C-01-CCW-054	Bed Area	Exterior blind faulty Ward 1D CCW-054. Actual room CCW-105	18-Oct-16	TDSL	JM	Users have not given access to address snag.		1		
1604473405	C-02-SCH-026	Staff Base	ROOM SCH-044 EXTERNAL WINDOW BLINDS NOT WORKING	18-Oct-16	TDSL	JM	Awaiting dates from NHS for access to room.		1		
1604477748	A-01-CCU-056	Office	No CCW disk at bed space 22 so it means this area doesnt have a reference	20-Dec-16		JM	Due to the delayed receipt of these notifications MPX will review and respond from w/c 09/01/17.		1		
1605484889	A-03-FM3-051	FM Support	Channel in drain manhole at ARU entrance has edges and constantly traps waste and blocks lines. Brookfield has attended before but still not finished off properly.	20-May-16		JM			1		
1606500267	A-01-CCU-056	Office	ITU 2 Unit 4 Room 31 CCW-007 observation window blind not working	29-Jun-16	TDSL	JM	Access restricted by IC and users. Awaiting IC sign off and access arrangement.		1		
1607506712	C-00-ENT-006	Security	PART OF SEATING AREA ON CYCLE SHED BETWEEN CAR PARK 1 AND CHILDRENS HOSPITAL HAS SWOLLEN AND IS LIFTING AWAY FROM FIXINGS	18-Oct-16		JM	Not a BM issue - this lies with Genko. COMPLETION OF TASK DISPUTED BY NHS.Brookfield as main contractor to contact Genko under contract		1		
1607511668	C-00-ENT-006	Security	HANDRAILS ON EXTERNAL PLAYPARK CAROUSEL COMING LOOSE	03-Aug-16	LE	JM			1		
1607512150	A-00-ENT-006	Concourse	Manhole loose and breaking up. Possibility of collapse. Main road opposite Bus stand shown as position 06 on layout forwarded to P.McGuiness 28/07/16	03-Aug-16	LE	JM	Tar team back Wednesday 25/01/17.		1		
1608514221	A-B1-KIT-003	Kitchen	Hi can we chase up steamer getting replaced! Badly needed in diet kitchen Thanks Location KIT-014	20-Dec-16			Due to the delayed receipt of these notifications MPX will review and respond from w/c 09/01/17.		1		
1608514504	A-01-STW-083	Nurse Base	Window blinds broken in Room 9 ROOM No STW-033 EXTERNAL WINDOW. SAME OPERATOR MECHANISM AS ADULT TOWER WARD OBSERVATION	20-Dec-16	TDSL	JM	Users have not given access to address snag.		1		
1609527386	C-00-OPD-037	Sub-reception	Roof in out-patient leaking - near Clinic 9 (Respiratory Function Lab) entrance door.	13-Oct-16	VEC	JM			1		
1609532274			Primary sub-station HV sections A & B, cable ducts in both location are full of water, ingressed from underground cable penetrations? This requires urgent attention, HV cable should not be submerged in water (this is a non compliance issue) potential risk of electrical HV cable fault & potential corrosion of HV switch gear due to condensation from high humidity environment within both of these Switch Rooms.	13-Oct-16	MER	MH	Duct sealing to be completed on Monday 13/02/17 and Monday 20/02/17.		1		
1610536423	A-B1-FMB-006	Plant Room	Fastenings undersize, unidentified threaded rod use, expansion joints stretched beyond manufacturers limit (350mm) & not CE marked.	13-Oct-16	MER	MH	Works commencing 13/20/17 and to be complete 17/02/17.		1		
1610536574	A-B1-FMB-006	Plant Room	Localised cracks appearing around hanging support anchor points (water ingress also present).	13-Oct-16		JM			1		
1610537021	A-01-CCU-056	Office	Blind closed and unable to open as level is spinning and appears loose. BED 17 CCW-060 EXTERNAL BLIND (DYNAMO OPERATED TYPE AS PER OBSERVATION WINDOWS)	17-Oct-16	TDSL	JM	Access restricted by IC and users. Awaiting IC sign off and access arrangement.		1		
1610537698	A-01-CCW-051	Bed Area	BLIND FAULTY OBSERVATION WINDOW ROOM No CCW-051	13-Oct-16	TDSL	JM	Access restricted by IC and users. Awaiting IC sign off and access arrangement.		1		
1610540406	A-00-CCB-032		AGV are not returning to auto charge when required, this is resulting in each unit battery totally discharging and failing in operation, which stops the whole system. AGV's then need manual recovery and boost charge. Swisslog have been investigating fault but todate have no solution. Suspect this will lead to a position that will require complete battery replacement on all units? (Warranty issue) Can you please raise a formal defect report with Swisslog and accellerate efforts to conclude this route cause of this issue.	17-Oct-16	MER	MH	Remaining batteries being delivered w/c 30/01/17 and installed thereafter		1		

First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1610540509	A-00-CCB-032		Identification of ventilation plant & associated ductwork to be carried out as per HTM03-01B Clause 3.60. Brookfield have agreed this will be carried out. Please supply timescale & programme of works.	17-Oct-16	MER	MH	Labelling of the Isolation room ventilation plant and ductwork cas SHPN 04 Supplement 1 completed. Other Vent plant being reviewed - ongoing.		1		
1610542978	A-00-AAW-078	Single Bed	BLIND FAULTY ARU BED 90 ROOM No AAW-078 EXTERNAL BLIND(SAME MECHANISM AS ADULT TOWER OBSERVATION WINDOWS)	21-Oct-16	TDSL	JM	Users have not given access to address snag.		1		
1610546056			CHP control is still set back at 80% heat output, based on higher than expected return temperatures, despite recently adding the laboratory medicine demand being introduced, this is combine with the heat dump valve being set at 50% minimum setting, therefore the CHP is continuously rejecting 50% of 1CHP heat output (600KW rejection). as a result this system cannot be operating at optimum design efficiency. the issue over the dump valve has been reported previously, this job was closed advising that the valve control was rectified. However advise from Schneider installation team is that they were instructed by H&V commissioning to set the vale at a minimum 50% (5V) in order to achieve the required flow rates to balance the system. this cannot be correct? please provide commission detail to justify the current configuration against the design control philosophy? detailed review of CHP control philosophy and performance is urgently required.	28-Oct-16	MER	MH	Boiler flow temperature now reduced and system being monitored. Edina to be arranged w/c 06/02/17 to put CHPS back into 100% performance and 3-port valve to be re-set.		1		
1610547245	A-02-THE-003	Office	The camera system in theatre is showing up black and white. Also, intermittent interference with SDI scope system so not able to use. Note added by ROBERT GEDDES (09/12/2016 08:42:24) Pictures from overhead cameras are only showing in black and white rather than colour. Interference also showing on visual.This appears to be a cabling problem in Adult Theatre 1 THE-085, Theatre 9 THE-137, Theatre 11 THE-150 and Theatre 15 THE-232. Similar to previous resolved problem in Childrens Theatres	20-Dec-16	MER	MH	Starkstrom returning to site Tuesday 07/02/17 for further investigation. No access. Await access 17/02/17.		1		
1611549826	A-02-RENO-070	Reception	Blind not working in Room 1. Units not closing shut. ROOM No RENO-013 EXTERNAL WINDOW BLIND. (SAME TYPE OPERATOR AS TOWER WARD OBSERVATION WINDOWS)	22-Nov-16	TDSL	JM	Users have not given access to address snag.		1		
1611550482	C-02-SCH-026	Staff Base	SCH-057 external window blind non-operational. Same mechanism as adult tower wards observation window.	06-Dec-16	TDSL	JM	Awaiting dates from NHS for access to room.		1		
1611550482	C-02-SCH-026	Staff Base	SCH-054 external window blind non-operational. Same mechanism as adult tower wards observation window.	06-Dec-16	TDSL	JM	Awaiting dates from NHS for access to room.		1		
1611550482	C-02-SCH-026	Staff Base	SCH-053 external window blind non-operational. Same mechanism as adult tower wards observation window.	06-Dec-16	TDSL	JM	Awaiting dates from NHS for access to room.		1		
1611550560	A-00-AAW-385	Office	Window blind not closing in Room 98 ARU5 ROOM No AAW-129 EXTERNAL WINDOW (SAME TYPE OPERATOR AS OBSERVATION WINDOWS IN TOWER WARDS)	22-Nov-16	TDSL	JM	Users have not given access to address snag.		1		
1611553153	A-00-ENT-006	Concourse	Numerous external walkway uplighters on paving outside main entrance are failing due to water ingress. Rusting now apparent on internals of fittings	22-Nov-16	MER	MH	MER to order and install new fittings - fittings due 03/03/17.		1		

First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1611554655	A-03-FM3-007	Radiological Support	DIVERTOR No 303 QEUH OUTSIDE WARD 1C STW-081. SERVICES RESTRICTING ACCESS DIVERTOR No 304 QEUH OUTSIDE MDU MDU-002. SERVICES RESTRICTING ACCESS DIVERTOR No 402 QEUH FM3-007.FIXED COMPUTER DESK UNDER DEVICE REQUIRES TO BE MOVED DIVERTOR No 504 QEUH DMW-083. SERVICES INCLUDING CONDUIT REQUIRE MOVING FOR ACCESS DIVERTOR No 803 QEUH A&E RESUS AT CENTURION GAS PANEL. EMC-105.SERVICES RESTRICTING ACCESS DIVERTOR No 902 QEUH RAF-079.SOLID CEILING WHERE DEVICE IS LOCATED DIVERTOR No 905 RCH ACROSS FROM RCF-020. SERVICES RESTRICTING ACCESS DIVERTOR No 906 RHC RCI-011. SERVICES RESTRICTING ACCESS DIVERTOR No 1603 LABORATORY BLOCK L1/B/015. ONLY ACCESS IS TO CLIMB INTO CEILING SPACE AND WALK ON TOP OF SAMPLE FRIDGE	22-Nov-16	MER	MH	Divertor 303 checked and access available. Divertor 304 - no diverter in room? Divertor 402 checked and access available with stepladder (platform) next to desk. Divertor 504 checked and access available via ceiling tile removal (PIR on sprinkler tile). Divertor 803 checked and access availablle Divertor 902 hatch to be installed in solid ceiling by MPX. Divertor 906 access to room unavailable. To be re-surveyed w/c 23/01/17. Divertor 1603 (lab) Checked and access available Walked with Mark McKaig (NHS). 1 MPX action - access hatch in QRUH RAF-079 Diverter 902. To be installed by 17/02/17.		1		
1611556227	A-B1-KIT-025	Frozen Food Storage	LARGE FREEZER/COLD ROOM IN BASEMENT CATERING AREA OF ADULT HOSPITAL LEAKING INSIDE ROOM FREEZING ONTO FLOOR AND CAUSING SLIP HAZARD. ROOM No KIT-025	22-Nov-16	MER	MH	Reviewed by Fosters. Repair/re-routing of drain line to be completed 23/02/17.		1		
1611557236	C-02-ASU-010	Main Office	Spot welds failed on Safety Cabinet 4 causing H&S issue for staff. Note added by ROBERT GEDDES (25/11/2016 07:48:58) This is a failure of window stainless steel edge finish within safety cabinet. Safety check required on all cabinets with same edge finish. Note added by ROBERT GEDDES (25/11/2016 07:50:37) Room No ASU-019 Note added by SHIRLEY QUINN (20/12/2016 09:06:04) Nuaire cabinet Serial No 162241031814 (Dept Cabinet No 4). Spot welds failed and edge dropped from cabinet across operatives working area.	06-Dec-16	MPX	JM			1		
1612561205	A-03-FM3-051	FM Support	Childrens outpatients clinics drainage inspection hatches have been covered by vinyl see screws are covered	06-Dec-16	ACF	JM			1		
1612563316	A-05-GENWC-073	Nurse Base	Small and large cracks on corridor walls - Above windows Room 65, 68, 70, 72, 75. Above doors 63, 81. Windows between room 62 and 63 and rooms 75 and 76. Below room 70 and below window room 79. Above disposal room door. Above facilities room. Above senior charge nurse room. Side of door rooms 76 and 79. Wall between kitchen and dirty utility room and wall across from dirty utility room.	20-Dec-16	BAG	JM	Only exceesive cracking requires to be revoewed and repaired where appropriate. MPX will review and respond.		1		
1612563608	A-B1-CAB-036	Core C FM Clean Lift Lobby	Cracks evident around pipework hanging supports. Level -1 At fire doors main corridor before room FMB-007. Defect 27 on Zurich report	20-Dec-16		JM			1		
1612565091	C-00-CC0-031	Core K Lift	LIFT CC0-031 K Core. Flooring is carpet in this lift was supposed to be changed to safety flooring	20-Dec-16	MER	MH	Due to the delayed receipt of these notifications MPX will review and respond from w/c 09/01/17.		1		

First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1612566281	C-00-OPD-014	Observation Room	USERS SAYING THEY CAN STILL SEE PEOPLE EITHER SIDE OF ONE WAY GLASS PANEL - OBS-301	20-Dec-16		JM			1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Door leaf does not open 90 degrees (LHS viewed from outside). Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Door selector missing. Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Bottom channel to LHS door leaf coming loose, door finish coming off and rusting apparent. Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Bottom channel to RHS door missing and rusting apparent. Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Door coating peeling off doors at top, bottom and door edges (both doors). Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Threshold plate starting to come loose. Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566541	Car Park 1		Main Stair Core Entrance Doors - Bolt keeper in threshold plate blocked. Please note this is for the new part of the carpark,as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566593	Car Park 1		Other Stair Core Entrance Doors - Door selector not functioning. As per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566593	Car Park 1		Other Stair Core Entrance Doors - Door coating peeling off doors at top, bottom and door edges (both doors). As per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566593	Car Park 1		Other Stair Core Entrance Doors - Gravel worn away adjacent entrance doors. As per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP	Prima door have been contacted. Awaiting response to confirm action.		1		
1612566609	Car Park 1		Other Areas - Edge kerb to gravel perimeter strip is raised and could be a trip hazard (corner of main stair core). All as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP			1		
1612566609	Car Park 1		Other Areas - Edge kerb to gravel perimeter strip not visible (Hospital Boulevard side of main stair core). All as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP			1		
1612566609	Car Park 1		Other Areas - Concrete hardstanding surface worn away on Hardgate Road side towards Hospital Boulevard. All as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP			1		
1612566609	Car Park 1		Other Areas - Cracking in concrete central kerb area around central column at car park entrance. All as per CAPITA A01 29/11/2016	20-Dec-16	MPX	JP			1		
1612568068	A-10-GENW20-073	Nurse Base	Large window in Room 98 leaking rainwater. Please fix urgently. Note added by THOMAS ROMEO (25/12/2016 18:57:00) Window leaking at bottom can this be passed back to Brookfield. T Baxter attended this job, there is also a picture of the Rm ID attached. Note added by ROBERT GEDDES (28/12/2016 11:04:20) GENW20-033 WATER LEAKING THROUGH WINDOW. SILL NOW SWELLING DUE TO WATER INGRESS	05-Jan-17	STR	JM	Structal have been contacted. Date still to be confirmed.		1		
1612568081	A-B1-KIT-003	Kitchen	On the left hand side of the main entrance (Behind the barrier erected to deter smoking behind the pillar) a metal panel has blown down. THE PANEL IS LYING NEXT TO THE CONDENSERS FOR M&S, NEXT TO CORE N STAIRWELL - P MCALLISTER	05-Jan-17	MPX	JM			1		

6

First FM	Location	Room	Issue	Received	S/C	BMCE	Comments	Closed	O	IP	C
1612569384			Suspended ceiling has collapsed in Adults Level 3 corridor outside lift lobby. Fixings have dislodged from ceiling. I think this section has collapsed previously. Note added by PAUL MCALLISTER (02/01/2017 13:20:12) CORE A	05-Jan-17	MPX	JM	PFP have been contacted. MPX await response.		1		
1701569990			BMS CONTROL/ FAULTY PUMP ISSUES. THERE ARE VARIOUS CONTROL/ MECHANICAL ISSUES WITH PUMPS ACROSS A&C. PR 21 - LTHW LVT Pump 1 is running but not communicating with BMS - not allowing switchover to standby pump. PR 22 - LTHW CT Pump 1 E054 fault on VFD - loss of comms, LTHW VT Pumps 1 & 2 - both in manual control, not working via BMS, LTHW LVT Pump 2 failing when switched on duty via BMS. PR 31 - LTHW CT1 not working via BMS (OK on hand), LTHW VT Pump 1 is locked off - looks like a mercury padlock, CHW CT Pump 4 isolator has been taped off since handover. PR 33 - CHW 'A' CB Pump 2 running but not communicating with the BMS - not allowing switchover to standby pump, CHW 'B' Pump 2 running but not communicating with the BMS - not allowing switchover to standby pump. PR 41 - LTHW 'A' VT Pump 2 not communicating with BMS - not switching over to standby pump, LTHW 'A' LVT Pump 1 not communicating with BMS - not switching over to standby pump, LTHW 'B' VT Pump 2 not communicating with BMS - not switching over to standby pump.	05-Jan-17	MER	MH	Both Schneider and WILO have investigated the fault and will return to site with replacement batchnet cards to rectify communication issues. Date TBC. Note the following cleared actions: - 1. P31 LTHW CT - issue resolved. 2. P31 VT Pumps - NHS issue. 3. P31 NHW Pump 4 - NHS issue. 4. P33 CHW Plant 2 - issue resolved.		1		

STAGE 3 FINAL DEFECTS CERTIFICATE
ATTACHED LIST 2 - SUPERVISOR DEFECTS LIST

1

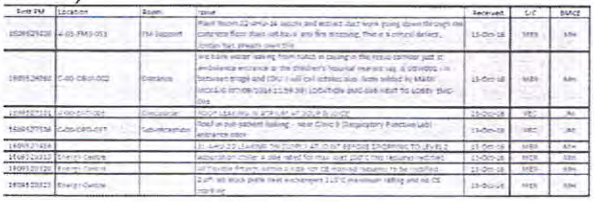
3.1.3 Supervisor's Notifications of Defects under Clause 42.2

The parties to ensure correction of defects raised by Supervisor's Notifications of Defects under Clause 42.2 prior to 26th January 2017.

3.2 SUPERVISOR MEETINGS WITH ESTATES

The following in italics is retained from Supervisor Report No 63

John McEwan and Dave Ramsay met with Ian Powrie and the FM/Estates Team (Cyril Dowson, Bob Geddes, David Brattey, Mark McKaig) on 11th October 2016 to discuss the FM First Summary Schedule (extract below right) as the consolidated list for defect matters raised by NHS GGC FM and Estates inclusive of any defects matters consequent to PPM. This meeting was consequent to NHS GGC liaison with Estates on Defects Close Out and the issue of the Defects Close Out programme by NHS GGC PM (extract below left).



3.3 DEFECTS MEETINGS (POST COMPLETION WORKS MEETINGS)

We attended regular monthly Defects Meeting (Post Completion Works Meeting) for the New South Glasgow Hospital Stage 3 Adult and Children's Hospitals on 28th November and 12th December 2016 at which the relevant FM First Summary Schedules (Consolidated Defects List) were discussed and tracked.

It has been previously agreed with the parties that going forward until the Defects Date for Stage 3 of 26th January 2017 that the Supervisor would only issue formal Supervisor's Notifications of Defect (Cl 42.2) "Stage 3 A&C Energy Centre" as and when instructed to do so by the NHS GGC Project Team.

3.4 FM FIRST DEFECTS SUMMARY (File Ref: *20161223 FM First Summary.xlsx*)

The FM First Summary spreadsheet with **File Ref: *20161223 FM First Summary.xlsx*** lists information received to 21/12/16 which was the final issue of FM First Summary from Multiplex until w/c 09/01/17.
Green – Advised Complete or Duplicate
Amber – Returned to NHS Estates due to Insufficient Detail
Red – Outstanding
Open Defects – 126; Defects in progress – 11; Closed – 3,051

The FM First Summary spreadsheet with **File Ref: *20170106 FM First Summary.xlsx*** lists information received up to 6th January 2017.
Open Defects – 167; Defects in progress – 12; Closed – 3,063

4.0 CONSTRUCTION REVIEW

4.1 VISITS TO THE WORKS

Site visits were carried out by the NEC3 Supervisor Team: - Dave Ramsay (Lead & Architect Supervisor); Willie Roxburgh (Civil/Structural Engineer Supervisor); John McEwan (M&E Supervisor).

4.2 POST COMPLETION ISSUES

4.2.1 Visual Shrinkage Cracks

The interpretation of the appearance of shrinkage cracking to completed building elements in general and in particular in connection with finished internal partitions in a clinical environment requires to be agreed between the parties.

4.2.2 Fire Doors

We attended an initial site inspection on 22nd August 2016 of fire doors in the QEUH & the RHC to agree grading standards for the proposed survey of doors by Multiplex. PMI 486 refers.

4.3 SUPERVISOR'S NOTIFICATION OF DEFECTS - ACH

4.3.1 Supervisor's Notification of Defect (Cl 42.2) No 147

We issued No 147 on 12th May 2016. Confirm that the Oil Delivery point and filling process is compliant and if not advise corrective action to be undertaken. We await formal response from Multiplex.

EDINA TO SUPPLY & INSTALL PARTS WHERE REQUIRED
NOT MPX (DW)

CAPITA

A47392376

4.3.2 **Supervisor's Notification of Defect (Cl 42.2) No 146**

COMPLETE

We issued No 146 on 12th May 2016 Bellows Tie Rod Failures. Confirm the corrective procedures, actions, relevant parties and timescales required to resolve the bellows tie rod failures.
Multiplex (D Wilson) responded on Aconex on 13th May 2016 and corrective action is being tracked at the Energy Centre Meetings. We will retain this defect open until formally closed out.

4.3.3 **Supervisor's Notification of Defect (Cl 42.2) No 145**

COMPLETE

We issued No 145 on 25th April 2016 Water Leak – Mild Steel Tail In Domestic Cold Water Pipe. Although discussed at Energy Centre meetings, and although tracked in separate e-mail correspondence, we await formal response. We will retain this defect open until formally closed out.

4.3.4 **Supervisor's Notification of Defect (Cl 42.2) No 140.**

Corrective work to spindles nearly complete. Refer to Supervisor Report No 59 for background to this matter. Multiplex issued us with the proposed "Visicom Highline blind programme". The closure of this is being tracked at the Post Completion Works Meetings and once completed we shall close out this defect.

COMPLETE EXCEPT RESTRICTED ACCESS AREAS (CCU, CCW, SCH etc.)

4.3.5 **Supervisor's Notification of Defect (Cl 42.2) No 137.**

COMPLETE

The cladding on the west facing elevation has been damaged and an unsuccessful attempt has been made to repair the damage. We requested Multiplex to advise when this defect is to be rectified. Multiplex has confirmed that this has been passed onto the relevant sub-contractor Prater to rectify the unsuccessful attempt at the repair.

4.3.6 **Supervisor's Notification of Defect (Cl 42.2) No 129.**

The Bicycle Shelter roof does not drain rainwater to the two corner outlets, consequently the rainwater is ponding. We requested Multiplex to confirm their proposed remedial action to resolve this defect. They have confirmed that following a meeting with the designer a level survey is required. The plan is to introduce a further outlet. Multiplex to advise when remedial works will be undertaken.

WEATHER DEPENDENT.

4.3.7 **Supervisor's Notification of Defect (Cl 42.2) No 125.**

Following recent excavations around the buildings to expose and repair collapsed main drains, the Board request video surveys to be undertaken and reports provided of the repaired drain runs and also other neighbouring runs that may have been affected by proximity to the 200t crane. Multiplex has confirmed that the survey is complete and will issue to the Board. Dunnes are uploading information onto Zutec. We request confirmation from Multiplex that this has been uploaded and once received, we shall close out this Defect.

SPEAK TO JAMIE

4.3.8 **Supervisor's Notification of Defect (Cl 42.2) No 124**

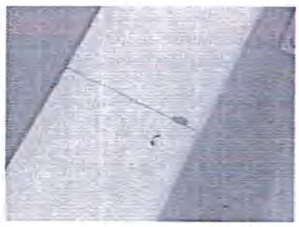
This matter is being discussed and tracked to resolution at Energy Centre meetings background as follows:-

MTHW Global Conformity Assessment - Zurich assessment. This matter has been discussed at Energy Centre meetings. Await declaration of conformity which has not yet been received. The closure of this is being tracked at the Post Completion Works Meetings and once completed we shall close out this defect.

MPX NOT CARRYING OUT THIS ITEM (DW)

4.3.9 **Supervisor's Notification of Defect (Cl 42.2) No 99**

The joints at window cills are opening up. We requested Multiplex to confirm the remedial action to resolve this problem. Multiplex has filled and painted the joints but they have opened up again. Thereafter Multiplex sealed a joint with sealant to determine if this resolved the defect.
Multiplex has advised that in general excessive shrinkage cracking in building elements of completed work will be addressed immediately prior to the end of defects period and that this defect falls into this category.
We shall therefore retain this defect notification open.



B&G TO COMPLETE THURSDAY 26th

4.3.10 **Supervisor's Notification of Defect (Cl 42.2) No 88.**

The capping piece on the north facing elevation of the Children's Hospital has two discoloured areas. We requested Multiplex to confirm the remedial action to address this and advise when complete. Multiplex has advised that work is being planned to be carried out and we await confirmation.

D&B TO COMPLETE WED 25th.

4.4 OPEN SUPERVISOR'S NOTIFICATION OF DEFECTS - LABORATORY

4.4.1 Supervisor's Notification of Defect (Cl 42.2) No 501 - Laboratory Medicine Reception Disabled Door

The actuator for Laboratory Medicine Reception Disabled Door has a ground mounted drive unit which the manufacturer (Record Ltd) has advised that their installation drawings and instructions require that the ground mounted actuator housing drain spigot is connected to the drainage system to ensure that the actuator is not submerged in rain water.

At the time of installation Multiplex did not install underground drainage to support this and instructed the Record installation team to drill a sink hole from the actuator housing as an alternative. This arrangement was queried at the time under one of the original failures covered during the warranty as a defect however Multiplex advised that this was Multiplex's call, as the Contractor and that in their opinion this solution was suitable for this installation.

This disabled access door has been out of service for over a year as the integrity of the actuator housing cannot be maintained and therefore it is evident that the Multiplex solution is not suitable.

It is understood that the Board has installed 3 new actuators with unsuccessful attempts to protect against flooding, the last of which failed within 2 days of installation.

The Board has decided to take an alternative approach and install an overhead actuator solution which will be installed in early January 2015.

Although the warranty has expired, the Board is seeking to recover costs from Multiplex as a latent defect.

Multiplex has responded on 25th January 2016 and requested details of NHS costs to rectify the defect as follows:-

The issue raised is understood however we require details of the costs associated with;-

"To date the Board have committed approximately £10 - 12k in unsuccessful repair/replacement parts via the installer/manufacturer of this equipment."

4.4.1 Supervisor's Notification of Defect (Cl 42.2) No 502 - Partially Collapsed Manhole

Matter raised by Ian Powrie (NHS Estates) on 9th June 2016 as follows:-

"Recently discovered a broken\partially collapsed manhole just before the traffic lights on the east side of the laboratory medicine.

On seeking support from Multiplex on this matter we were advised by Paul McGuiness that this is no longer covered under warranty as this road was handed over with the Labs building (circa 4 years ago). The full dual carriage way was not handed over until Jan 2015, up until this point there was little traffic using this road. This issue has only now materialised since full traffic volumes have been introduced, suggesting that this and possible the other man holes are not suitable for the heavy traffic flow experience on this road.

I would like have this issued repaired urgently to avoid risk of incident as a result of the failure."

Although the partial collapse of the manhole has occurred after the issue of the Final Defects Certificate (9th April 2014), Multiplex to correct the defect as a latent defect. Multiplex to investigate and advise remedial work/timescales for correction.

4.5 INSPECTION OF EXTERNAL AREAS ADJACENT TO MULTIPLEX MULTI STOREY CAR PARK

We visually inspected the External Areas adjacent to Multiplex Multi Storey Car Park on 29th November 2016 and consequently issued our Observation Sheet A01 also dated 29th November 2016. We acknowledge that some of the observations may be as a result of damage, however these are worth recording to bring to the attention of the parties.

5.0 INFORMATION REQUIRED
(Supervisor's Communication General Matters / Other Instructions - Clause 13.1)

Shading indicates item closed, clear indicates current item.

Item	Description	Date Requested	Comment
The following items are not closed out.			
All other Supervisor's Communication General Matters / Other Instructions raised have been closed out. A total of 253 Supervisor's Communication General Matters / Other Instructions have been issued to date.			

6.0 SUPERVISOR'S TESTS and INSPECTIONS

Shading indicates item closed, clear indicates current item.

Ref	Title	Notified by	Status	Test Date
The following items are not closed out.				

7.0 DEFECTS NOTIFICATIONS ISSUED

Shading indicates item closed, clear indicates current item.

Item	Description	Date Requested	Comment
The following items are not closed out.			
147	Confirm that the Oil Delivery point and filling process is compliant and if not advise corrective action to be undertaken.	12.05.19	Await formal response.
146	Confirm the corrective procedures, actions, relevant parties and timescales required to resolve the bellows tie rod failures.	12.05.19	Initial response rec'd 13.05.16 Await formal response.
145	Water Leak – Mild Steel Tail In Domestic Cold Water Pipe	25.04.16	Await formal response.
140	Defective spindles to privacy visicom panels to timber doors and screens.	29.09.15	Rectification programme rec'd. Corrective work ongoing. Once resolved we shall close out this defect.
137	Seeking confirmation when the damaged cladding has been rectified.	01.07.15	Initial response received.
129	Ponding to Bicycle Shelter.	11.05.15	Response received.
125	Seeking video surveys with reject to drain repairs.	16.04.15	Response received. Await confirmation that CCTV survey uploaded to Zutec
124	Defects in relation to the Zurich Engineers inspection.	16.04.15	Closure is being tracked at the Post Completion Works Meetings. Once resolved we shall close out this defect.
99	Confirm to open window cill joints.	24.02.15	Response received.
88	Seeking confirmation of remedial measures to address the discolouration of the capping pieces.	20.11.14	Response received. Multiplex advised will be towards the end of Defects Period.
All other Defects Notifications raised have been closed out. A total of 147 defects notices have been issued to date.			

8.0 LATENT DEFECTS NOTIFICATIONS ISSUED - LABORATORY

Shading indicates item closed, clear indicates current item.

Item	Description	Date Requested	Comment
The following items are not closed out.			
501	Drain system for Laboratory Medicine Reception Disabled Door actuator.	20.11.14	Response received. NHS to provide Multiplex with details of costs incurred.
502	Partially Collapsed Manhole	09.06.16	Await formal response from Multiplex to enable closure

STAGE 3 FINAL DEFECTS CERTIFICATE
ATTACHED LIST 3 – PM SCHEDULE OF INCOMPLETE
WORKS 26/01/2015 (1)

Ramsay, David (Capita)

From:	Fergus Shaw <Fergus.Shaw[redacted]
Sent:	23 January 2017 16:45
To:	Graham.Forsyth[redacted]
Cc:	Ramsay, David (Capita); Grant Wallace; Jordan Munro
Subject:	FW: NEC3 & Project Manager List
Attachments:	CCF23012017.pdf; RE: Supervisors Report NEC3 QEUH

Graham,

Please find an electronic version of document from earlier, highlighting status of items.

We will address the Capita Notification of Defect on Aconex for your review. (*JM*)

The "Incomplete Works" list has comments with following no noted as complete

6 – Art Strategy - this requires the two shelters externally be complete (which we are installing the roofs of, but require good weather for the resin. These can sit in 3A)
7 – Incomplete Landscaping - this is what can be seen around SUDS pond, orchard etc., and effectively sits in 3A.
22 – Street Lighting and Landscaping to boulevard - this is planned to be completed in February 2017.
31 – External LED is now a repair, and requires BMU
44 – Energy Model is ongoing
45-47 – see attached mail confirming completion.
48 – we believe this is cleared as it does not appear on Capita Notification of Defects (discussed with DR earlier)

I trust this covers

Regards

Fergus

Fergus Shaw FCIOB
Project Manager - Construction

MULTIPLEX

Multiplex Construction Europe Ltd
Fairfield - Suite 12,
1048 Govan Road
Glasgow, G51 4XS, United Kingdom
Tel: +44 141 445 7590
[redacted]
W: www.multiplex.global

NEW SOUTH GLASGOW HOSPITALS - STAGE 3 ADULT & CHILDRENS HOSPITALS
PROJECT MANAGER'S SCHEDULE OF INCOMPLETE WORKS - 26th January 2015

No	Description of Defect	Location	Defects Completion Date
1	VIE Slab and associated works	Maternity Unit	30.06.2015
✓ 2	Neuro Link Bridge - connection to T&LC	Adult / INS	17.04.2015
✓ 3	Neuro Link Bridge - oxygen connection	Adult / INS	31.03.2015
✓ 4	Neuro Link Bridge - connection to INS	Adult / INS	30.06.2015
✓ 5	Separation Tank	Adult ED Dept.	13.03.2015
X 6	Art Strategy installation - complete	All areas	28.02.2015
X 7	Land Eng: incomplete landscape works	All areas 16th FEB	31.03.2015
✓ 8	Cores A&B & Main Entrance - meet and greet panels glass cabinets	Adult Hospital	28.02.2015
✓ 9	Lead lined units and associated worktops - ADB codes STF1021, 1024 & 1025.	Adult Hospital / Nuclear Medicine	28.02.2015
✓ 10	DCFP Room 024 - ROMPA wall padding by BM	DCFP	31.03.2015
✓ 11	Additional divider screens and fabric boards	MIL009, RAG082, DOPD022	28.02.2015
✓ 12	Group 5 areas - where Board subs are working	Both	15.04.2015
✓ 13	Adult sanctuary - roof access hatch	Adult Hospital	28.02.2015
✓ 14	Interventional theatre - PMI works	Adult L2	03.02.2015
✓ 15	Adult sanctuary - install Gustav's panels	Adult Hospital	28.02.2015
✓ 16	Decontamination Room - complete	ED Department	28.02.2015
✓ 17	MRI Rooms - knock out panels	Various	28.02.2015
✓ 18	New VIE turning circle	Adult	28.02.2015
✓ 19	New VIE - pavement works south of road (bus stop not required).	Adult	11.02.2015
✓ 20	Main entrance walls and signage	Campus	15.04.2015
✓ 21	Neuro steel bridge works	INS	15.04.2015
X 22	Street lights to boulevard, complete landscaping to boulevard	Campus 16th FEB	15.04.2015
✓ 23	BREEAM Report application	Both	31.03.2015
✓ 24	AGV - performance tests and trials	Adult's Hospital	28.02.2015
✓ 25	Structal - replacement of panels, complete install and review BMU protection	Adult's Hospital	31.03.2015
✓ 26	Sanctuary - sun pipes	Children's Hospital	28.02.2015
✓ 27	Sanctuary - stained glass install	Children's Hospital	28.02.2015
✓ 28	Schiehallion radio nuclide room doors	Children's Hospital	13.03.2015
✓ 29	DCFP anti-ligature works	Children's Hospital	27.03.2015
✓ 30	Telecoms 600 pair lines install plus additional 600 lines req. by Board	Both	28.02.2015
X 31	External LED lighting	Adult Hospital	31.03.2015
✓ 32	Patient entertainment - screens	Children's Hospital	30.04.2015
✓ 33	External facade - BM drawings	Both	31.03.2015
✓ 34	LTHW - PMI works	Laboratory	28.02.2015
✓ 35	Isolation Rooms - HEPA filters		
✓ 36	Internal signage, wayfinding, door signage	Both	23.02.2015

No	Description of Defect	Location	Defects Completion Date
✓ 37	Neo-natal link bridge - internals and ext. Cladding panels	Children's Hospital	31.03.2015
✓ 38	Neo-natal link bridge - knock out panel replacement	Children's Hospital	31.07.2015
✓ 39	Lifts - works to beneficial lifts	Both	31.03.2015
✓ 40	Pneumatic tube gantry - removal	Laboratory	10.04.2015
✓ 41	Core G L13 - complete helipad ramp, install bird sounder and clean area	Adult Hospital	28.02.2015
✓ 42	Theatres - complete Starkstrom install incl. DVI/SDI sockets and accessories on arms	Both	21.02.2015
✓ 43	Hardgate Road - white lining		15.04.2015
? 44	Energy model - evidence of compliance with energy target	Both	28.02.2017
? 45	NEC Supervisors Communication No.236		06.02.2015
? 46	NEC Supervisors Communication No.237		06.02.2015
? 47	NEC Supervisors Communication No.238		06.02.2015
? 48	NEC Supervisors Defect No.081		13.02.2015
X 49	NEC Supervisors Defect No.088	26th JAN	13.02.2015
✓ 50	Completion of sweep up programme and inspections with Supervisor	Both	17.04.2015.
✓ 51	Medical Gas System - testing & witnessing of med gas system by CSO.	Both	28.02.2015
✓ 52	Completion of Children's Park SUDS	Children's Hospital	30.06.2015
✓ 53	Completion of Children's Park	Children's Hospital	30.08.2015
✓ 54	Completion of Car Park 1		10.04.2015

Legionella control

Legionella Management and Compliance Audit – Domestic Water Systems

Site Address

Queen Elizabeth University Hospital, 1345 Govan Rd, Govan, Glasgow, G51 4TF

Date:	**Auditor:**	**Staff Interviewed:**	
4th May 2017	Dennis Kelly	Tommy Romeo – Estates Manager Phyllis Urquhart – Compliance Manager	

Site General Description:

The QEUH property is a new build 12 storey multi functional state of the art hospital with 7436 rooms. There are 1280 single en suite bedrooms and 30 operating theatres. The hospital has a number of acute areas where Pseudomonas may be considered to be an issue. Sampling in these areas is controlled by Infection Control.

There are two mains supplies into the hospital building. Mains water is first stored in two raw water storage tanks. It then goes through a filtration system before being stored in the potable water storage tanks. There are eleven cold water storage tanks in the property. These are as follows:-

- Four raw water storage tanks of 100,000 litres each
- Four potable water storage tanks of 275,000 litres each
- Two trade water storage tank of 2,800 litres. This tank serves the Helipad fire suppression systems and the bib taps in the plant rooms
- Fire suppression cold water storage tank below the helipad.

From the potable water storage tanks water is distributed throughout the hospital. There are two booster sets delivering water to the cold water outlets and to the calorifiers in the various plant rooms throughout the hospital. In the hospital there are twenty four calorifiers split between 8 plant rooms.

Executive Summary:

Given the findings of this audit, and the gaps in the existing risk reduction systems and processes, in the event of a legionella based incident at the hospital NHSGGC would not be in a strong position with regards to its stance on risk reduction and compliance with existing guidelines.

The Hospital is now in full use. The current risk assessment was completed over two years ago and prior to the hospital being fully opened. There is therefore a need to complete a new risk assessment, and from that, define the required tasks in a new and updated written scheme.

It is worth noting however that there is not a complete absence of risk reduction processes and procedures at the hospital. There is an existing system in place. This system was created by the previous Estates' manager. The system does contain many of the required monitoring and control tasks and these are being recorded in a paper based log book. However, the system appears to be in places haphazard. It took some time to go through the paperwork and define what was happening in the hospital from a water point of view. There are tasks missing and also there does not appear to be an escalation and recoding of remedials process.

As the hospital is extremely large and complex, it may be beneficial, and may also increase efficiency and levels of compliance task completion, if an electronic based planning, control and recording process for the legionella based risk reduction processes and procedures was considered.

There are recommendations below for improving the execution and recording of the required tasks and for clarifying some of the confusion and the issues that exist in the current paper based system.

With regard to competency, there is an urgent need for training to be delivered to the Estates' manager who currently appears to hold the responsibility for the delivery of the required processes and procedures. There is a lack of clarity in the paper based system of who is accountable for what and of the competencies of the involved NHS GGC staff and the contractors that are used. It should be pointed out that there in not an authorised person for water in post at the QEUH.

In summary, there is currently a delivery of many of the perceived required processes and procedures. However, it needs to be reviewed in order to meet the required compliance standards, and to ensure that a reduced level of risk is maintained. The delivery of the processes should be based on a new risk assessment. This will help to define the actual current requirements which will be defined by the risk assessment. There is also a need to clarify the management structure, and also to ensure that all involved personnel, from both NHS GGC and also contractors staff are trained and have an adequate level of competency in order to deliver the required level of water based risk reduction in the QEUH.

Legionella Management and Compliance Audit – Domestic Water Systems

Summary of Comments and Recommendations	**Completed Date**	**Signature**
Comments and Recommendations on the Risk Assessment		
1. Complete a new risk assessment for the QEUH building.		
2. Ensure the new risk assessment covers all the ancillary water systems on site such as renal dialysis.		
3. There is a cold water storage tank in a floor 12 plant room which feeds the helipad fire suppression system. This tank should be included in the next risk assessment.		
4. The names and positions of all involved management personnel, as well as those of the involved water contractors, should be included in the new risk assessment.		
5. The competency of all named, involved personnel should be reviewed at the time of the new risk assessment.		
Comments and Recommendations on Schematic Drawings		
6. Create an up to date set of schematics for the QEUH.		
7. Maintain these in electronic format and ensure that they can be accessed by the responsible person and any others who may need access.		
8. Secondary loops should be inspected on the drawings to ensure that the correct outlets are being monitored in the risk reduction programme.		
9. It is recommended that as any pipework changes are made, that appropriate amendments are made to the site drawings.		
10. It is further recommended that the drawings are reviewed annually to ensure that they are being kept up to date and representative of the systems on site. The annual inspection of the drawings should be added to the risk reductions ppm's.		
Comments and Recommendations on Management and		

Competency		
11. A list of named management personnel, with the details of their responsibility should be created and added to the on site written scheme for the QEUH.		
12. Lines of communication should be clearly defined and added to the written scheme.		
13. A full written scheme, in accordance with the requirements as outlined in Appendix 2 of the HSG 274 document should be created for he site.		
14. Consideration should be given to creating a form which carries the training details of the on site involved staff.		
15. The involved Estates' staff should ask for copies of proof of competency for contractor's staff.		
16. It is recommended that any contractors who are working on the water systems on site are able to show proof of competency for the work being completed. This would include plumbing contractors who may be used on the site.		
17. NHS GGC should consider what contractor management process should be introduced to ensure the quality and standards of the contractors are acceptable.		
18. It is recommended that the contractor management process should include review meetings with contractors. The details of these meetings should be recorded and added to the written scheme on site.		
19. It is recommended that the outcomes from the risk reduction processes and procedures are reviewed regularly, and at least annually. Part of the review should focus on the out of specification results, and the associated remedial actions to ensure that they have been successful.		
20. It is recommended that the outcomes from the risk reduction processes and procedures are reviewed regularly, and at least annually. Part of the review should focus on the out of specification results, and the associated remedial actions to ensure that they have been successful.		
21. The relevant personnel, including the recently appointed Estates' Manager, for the role of authorised person on site should be defined, and they should receive		

adequate training prior to being competency checked by the AE.		
22. Training, at the appropriate level, should be arranged for the newly appointed Estates' Manager as soon as possible.		
Comments and Recommendations on Written Scheme, Monitoring and Records		
23. In future all records should be dated and signed.		
24. There are very few hot water temperatures measured in the records. Most of the temperatures recorded are from mixed outlets. In future temperatures need to be taken of the hot water system and not from mixed temperature outlets.		
25. Consider whether it is necessary to take temperatures manually at the top and bottom of the calorifiers, and instead, utilise the capabilities of the BMS system and monitor and record monthly.		
26. Cold water storage tank, and mains water inlet temperature measurements could be reduced to twice yearly.		
27. The internal and external condition of the tank should be recorded in the records.		
28. Check and ensure that the flushing procedure for the hydrotherapy pool deluge shower is reinstated and recorded.		
29. External taps and all outlets attached to the trade tanks should be flushed twice weekly and the action recorded in the log book.		
30. It was noted that there is a water storage tank in a 12th floor plant room. There are no monitoring or risk reduction processes and procedures in place for this tank. The tank should be risk assessed and appropriate procedures put in place if required.		
31. AHU Trap Monthly Check – a decision should be made as to whether these checks should be reinstated.		
32. Records for shower cleans and disinfections should be filed in a way that allows for suitable reviews of the data to take place.		

33. There are records for calorifier flushes running from Sep 2016. Expansion Vessels should also be flushed on an agreed basis and this needs to be included in the written scheme.		
34. A check should be made to ensure that the Estates' staff who are taking legionella samples are adequately trained.		
35. The Alcontrol sample form should indicate as to whether the samples were taken on a pre flush or a post flush basis.		
36. Upgrade the records to make them more user friendly and easier to review.		
37. Define the required service profile for the TMT's.		
38. Implement the required servicing procedures for the TMT's.		
39. No evidence that the risk assessment remedial actions have been completed. Once a new risk assessment has been completed a plan for addressing the remedial actions should be implemented.		
40. If a new risk assessment is not to be completed, then a review of the risk assessments from the existing risk assessment should be made and the appropriate remedials should be completed.		
41. Create a register of individual's training courses attended and also of training requirements.		
42. A definition of correct and safe operation of the water systems for the QEUH should be created and added to the written scheme.		
43. A response to out of specification situations should be recorded in the folder created for the purpose. The remedial actions that are completed should also be recorded.		
44. Create an escalation procedure for positive legionella results and ensure that all sites have a copy and understand the process.		
45. With regard to legionella sampling the competency status of the involved staff should be checked and training, if required, should be put in place.		
46. A check should be made to ensure that method statements for all in house tasks		

	are in place in the written scheme.		
	47. Incident plans need to be created for the written scheme. There may be a generic incident plan in the NHS GGC water policy, but site specific plans need to be created for the QEUH.		
	Comments and Recommendations on the Correct and Safe Operation		
	48. Remove the dead legs that are identified in the 2015 risk assessment report and record this fact in the written scheme.		
	49. A check should be made to ensure that domestic staff are cleaning all wash hand basins and sinks in the appropriate manner.		
	50. Add the records of the pressure drop across the membrane pre-filters, as well as any service records of the filtration system, to the legionella records.		
	51. Perform an audit of the flushing procedures that are completed by Estates' staff to ensure that all the required outlets are being flushed and that the detail of this process is being recorded.		
	Comments and Recommendations Cleaning and Disinfection Procedures		
	52. Should a contractor be used for any future cleaning and disinfection procedures, the contractor's method statements should be checked to ensure that they are acceptable to NHS Glasgow.		
	53. If cleaning and disinfection processes and procedures are to be completed with in house staff, then a suitable method statement requires to be produced.		
	54. If cleaning and disinfection processes and procedures are to be completed with in house staff, then suitable training should be given to the involved staff.		
Risk Assessment			
1	Is there a written risk assessment in place for the building water systems?	DMA Water completed the current and only risk assessment for the QEUH on 29th April 2015. This risk assessment was completed approximately two months before the hospital was formerly opened	

		for public use. No risk assessment, reflecting the actual operational characteristics of the water system now that the building is in full use, has been completed. It is recommended that a new risk assessment is completed as a matter of urgency on the QEUH.
2	When was the risk assessment completed and delivered to site?	Unsure of the risk assessment document handover date. The handover date is not noted on the current risk assessment document.
3	What are the site/organisation plans with regard to reviewing or redoing the risk assessment?	There are no specific plans detailed for re-assessing the property. As stated earlier in this report it is recommended that a new assessment is completed as soon as possible.
4	Does the risk assessment address all the water systems in the building? Are there any systems that are defined as being excluded from the assessment in the RA scope?	There are two renal dialysis water systems on site. These systems are operated by Medical Physics. There are a number of systems mentioned on site which were also included in the risk assessment. These systems include dental equipment, emergency showers, a hydrotherapy pool, irrigation systems, Whirlpool/Arjo baths, irrigation systems, Sprinkler/wet firefighting system, endoscopy wash system, water softeners, and adiabatic cooling systems. A short description of each system, and its likely risk implications are covered in section 8 of the risk assessment document. These systems should be revisited and reassessed when completing a new risk assessment. During the audit it was noted that there is a water storage tank in a Floor 12 plant room which serves the fire suppression system for the helipad. Water from this tank mixes with foam suppressant. It may be that the pumps from this tank are tested weekly and this may result in the creation of aerosol from an otherwise stagnant tank. This tank should be included in any new risk assessment.
5	Does the risk assessment review any previous risk assessment document, with particular attention being	There was no previous risk assessment to be reviewed as this was a new build project.

	paid to the completion of identified remedial tasks identified in the previous risk assessment?	
6	Does the risk assessment review the current risk reduction processes and procedures that are currently in use at the site?	n/a. There were no previous risk reduction processes and procedures in use on the site as this hospital was a new build project.
7	Does the risk assessment contain details of the people/organisations who are involved in the risk reduction processes and procedures? This should include comments on the Dutyholder, the responsible person, any deputy responsible persons and also service providers and contractors.	Section 9 of the risk assessment covers the details of management and responsible personnel on site. However the details in this section state that names of responsible people and duty holder are to be confirmed by NHS GGC. There is no indication that this task has been completed. There have also recently been a number of changes to the management structure within the hospital. The names and roles of the involved people should be identified and included in a new risk assessment. No contractors had been appointed at the time of the current risk assessment. Therefore all management and control information requires to be updated.
8	Is there an assessment of the competency of all involved parties?	No. No specific people identified and therefore it is not possible to make comments on individual's levels of competency.
9	Is there an assessment of the existing written scheme, including current risk reduction process and procedures in the risk assessment?	No – no existing written scheme was available as the site was a new build.
10	Does the risk assessment specifically address and comment on evidence of the current defect/remedial action processes and procedures?	No – there is no evidence that the current remedial requirements are being addressed.
11	Is there an assessment of the susceptibility of persons who may be affected by the building water systems?	It is stated in the assessment that there will be areas with particularly susceptible people in the hospital.
12	Is there a schematic diagram provided with the risk assessment?	There was a set of as fitted drawings for all the water systems in the hospital available at the time of the risk assessment.
13	Was the provision of a schematic diagram by the risk assessment company part of the scope of supply?	Unknown if this was part of the scope of supply.
14	Is there an assessment of the availability and validity of	Yes.

	an up to date schematic diagram?	
15	Is there a new written scheme provided as part of the risk assessment?	General guidance is given on what should constitute a written scheme in section 10 of the risk assessment document.
16	Does the assessment contain details of all the component parts of the water systems? This could include tanks, calorifiers, pipework and pipework layout, outlets, TMV's, expansion vessels etc etc etc.	Yes.
17	Is consideration given to system design, flow, temperature and the opportunity for bacteria to grow and develop in the water systems?	Yes. This covered in detail in the risk assessment.
18	Does the risk assessment identify any particular areas of spray and aerosol creation?	Yes – these areas are noted in section 7 of the risk assessment document.
19	Are areas of low use and low flow identified in the risk assessment?	Yes – these areas are noted in section 7 of the risk assessment document. It should be noted that as the building was not in full use at the time of the assessment, this information is likely to change when a new assessment is completed.
20	Are dead legs specifically detailed in the risk assessment?	Deadlegs are noted in section 7 of the risk assessment.
21	Is there a set of remedial actions clearly identified in the risk assessment?	Section 2 contains details of the recommended remedial actions. These are also assigned a remedial action urgency category to assist in prioritizing the required/recommended works.
22	Is there a clearly explained risk scoring system in the risk assessment?	The risk scoring system is explained at the beginning of section 2 of the risk assessment document.
23	At what level of risk is the building/property assessed to be at?	Various areas of the hospital are assessed as being areas of high risk.
Comments and Recommendations on the Risk Assessment		

1. **Complete a new risk assessment for the QEUH building.**
2. **Ensure the new risk assessment covers all the ancillary water systems on site such as renal dialysis.**
3. **There is a cold water storage tank in a floor 12 plant room which feeds the helipad fire suppression system. This tank should be included in the next risk assessment.**
4. **The names and positions of all involved management personnel, as well as those of the involved water contractors, should be included in the new risk assessment.**
5. **The competency of all named, involved personnel should be reviewed at the time of the new risk assessment.**

Schematic Drawings

24	Are schematic drawings available in the written scheme, or in some other place in the property?	A copy of some drawings was available in the folder entitled "Monthly Sentinal (this should be sentinel) Water Temps". They are in A3 format and are difficult to read. They are floor plan drawings and do not cover the water systems. Full sets of as fitted drawings are stored electronically. Although it was stated that there were very few changes or amendments made to the water systems, it is unlikely that any amendments have been made to the as fitted drawings. A set of up to date drawings, reflecting any changes in the water systems since they were brought on line, should be created. Given the size of the building and number of drawings involved, it would make sense to continue to store these electronically. If that is the case then access should be available to the responsible person and anyone else who may need it in order to complete work on the water systems.
25	Do the schematic drawings show all the components of the water systems?	The drawings show all the required components of the water systems.
26	Are there system deadlegs included in the schematic drawings?	No obvious dead legs will be shown in the in the schematic drawings.
27	Are the water system return legs shown on the schematic drawings?	The hot water return legs are shown on the as fitted drawings.
28	Are secondary and tertiary loops shown on the drawings?	The drawings are laid out by floor. There will be a number of secondary loops and these should be identified from the drawings

		to ensure that the correct outlets are being temperature monitored as directed in the HSG 274 guidance.
29	Have any amendments been made to the schematic drawings?	No.
30	If amendments have been made are they signed and dated?	Not applicable
31	Is there any indication that drawings are regularly inspected and updated if required?	No. It is recommended that drawings are amended as any changes are made to the pipework systems. An annual review of the drawings is also recommended.

Comments and Recommendations on Schematic Drawings

1. **Create an up to date set of schematics for the QEUH.**
2. **Maintain these in electronic format and ensure that they can be accessed by the responsible person and any others who may need access.**
3. **Secondary loops should be inspected on the drawings to ensure that the correct outlets are being monitored in the risk reduction programme.**
4. **It is recommended that as any pipework changes are made, that appropriate amendments are made to the site drawings.**
5. **It is further recommended that the drawings are reviewed annually to ensure that they are being kept up to date and representative of the systems on site. The annual inspection of the drawings should be added to the risk reductions ppm's.**

Management and Competency

32	Is there a duty holder and responsible person nominated in writing?	There is a folder entitled "Water Safety Log Book" in the Estates office. This folder has, as section 3, information titled "Management of Water Systems". There is a description of roles and responsibilities in this section. This section gives a generic description of the roles. It looks like the description of the roles is identical to what would be found in the NHS GGC policy document. It states in this information that details of all named persons for these roles are kept in the site written scheme. However none of

		this information could be found on site. A copy of the required detailed information should be added to the written scheme on site.
33	Is there a clearly defined management structure which includes the relevant on site personnel and also all service providers and contractors?	No named management structure available on site. One should be created and added to the written scheme on site.
34	Is there a clearly defined line of communication in the written scheme?	No. As in points 32 and 33 above, contact details and lines of communication should be clearly defined and added into the written scheme.
35	Are the responsibilities of all involved parties clearly defined in the written scheme?	A complete written scheme is not available on site. A full written scheme, in accordance with the requirements as outlined in Appendix 2 of the HSG 274 document should be created for the site.
36	Are copies of the involved on site personnel training records available in the written scheme?	All site Estates' personnel have a specific training file which lists details of all courses that have been attended. As a consequence of this, the details of training course attendance was available on site. There was no form collating the training records. A collated form such as this can be useful in identifying and planning future training needs. Consideration should be given to creating a form which carries the training details of the involved on site staff. The on site Estates' Manager who has day to day responsibility for the operation of the risk reduction processes and procedures has recently been appointed. The manager has not had any water or legionella based training. The manager is not an authorised person. Training, and the appropriate competency check, should be arranged as soon as possible fro the Estates' Manager.
37	Do all staff have relevant up to date training in place?	It was not possible to state as to whether all the relevant staff have received training as a full list of all the relevant staff was not available in the written scheme or any of the on site log books.
38	Is there evidence available in the written scheme of the	Evidence of the contractor competence was not available in the

	competency of service provider and contractor staff?	written scheme. There is not a formal written scheme available on site. However, DMA Water, the contractor who completed the risk assessment in April 2015, did include a copy of their Legionella Control Association accreditation in the risk assessment document. Copies of the training records of the DMA staff involved in the creation of the risk assessment were also included in the risk assessment document. It is recommended that any contractors who are working on the water systems on site are able to show proof of competency for the work being completed. This should, fro example, include plumbing contractors who may be used on the site. The on site involved Estates' staff should ask for copies of proof of competency for any contractor's staff who will be working with the water systems on site.
39	Are service providers and contractors LCA accredited or do they have other means of proving competence?	The risk assessment contractor is LCA accredited. No other contractors are currently used on site for the provision of risk reduction processes and procedures on the hot and cold water services.
40	Is there a formal contractor management process in place? If so what format does this take?	There does not appear to be a formal contractor management process in place. There was no evidence of contractor management in the on site records. The only contractor that appears to be used for risk assessment and cleaning and disinfection works appears to be DMA. There are no minutes or records of any review meetings having been held with DMA. NHS GGC should consider what contractor management processes should be introduced to ensure the quality and standards of the contractors are acceptable.
41	Is there evidence available in the written scheme of review meetings with service providers and contractors?	No.
42	Is there any evidence in the written scheme of management reviews of the data and results as	No. It is recommended that the outcomes from the risk reduction processes and procedures are reviewed regularly, and at least

	produced by the monitoring and control processes and procedures? In the healthcare sector is there evidence that authorised person competency checks have been completed?	annually. Part of the review should focus on the out of specification results, and the associated follow on remedial actions, to ensure that they have been appropriate and successful. There was no evidence available that authorised person checks have been completed on the relevant on site personnel. The relevant personnel for the role of authorised person should be defined, and they should receive adequate training prior to being competency checked by the AE. It was discussed during the audit that the Estates' Manager for QEUH, who has been recently appointed to the position, has not had any legionella training. Training, at the appropriate level, should be arranged for the newly appointed Estates' Manager as soon as possible.

Comments and Recommendations on Management and Competency

1. **A list of named management personnel, with the details of their responsibility should be created and added to the on site written scheme for the QEUH.**
2. **Lines of communication should be clearly defined and added to the written scheme.**
3. **A full written scheme, in accordance with the requirements as outlined in Appendix 2 of the HSG 274 document should be created for he site.**
4. **Consideration should be given to creating a form which carries the training details of the on site involved staff.**
5. **The involved Estates' staff should ask for copies of proof of competency for contractor's staff.**
6. **It is recommended that any contractors who are working on the water systems on site are able to show proof of competency for the work being completed. This would include plumbing contractors who may be used on the site.**
7. **NHS GGC should consider what contractor management process should be introduced to ensure the quality and standards of the contractors are acceptable.**
8. **It is recommended that the contractor management process should include review meetings with contractors. The details of these meetings should be recorded and added to the written scheme on site.**
9. **It is recommended that the outcomes from the risk reduction processes and procedures are reviewed regularly, and**

at least annually. Part of the review should focus on the out of specification results, and the associated remedial actions to ensure that they have been successful. **10. The relevant personnel, including the recently appointed Estates' Manager, for the role of authorised person on site should be defined, and they should receive adequate training prior to being competency checked by the AE.** **11. Training, at the appropriate level, should be arranged for the newly appointed Estates' Manager as soon as possible.**		
Written Scheme, Monitoring and Records		
43	Is there a written scheme in place?	There is no adequate written scheme, in terms of the requirements as detailed in the HSG 274 document, for the QEUH currently available on site. There are however a number of the required elements of the written scheme available. As examples of this we would state the following:- • There is a risk assessment available but it was completed prior to the facility being fully operational and as such may be considered to be pout of date. • There is a folder in the Estates' office titled water safety logbook. It contains some of the requirements of the written scheme including copies of some of the elements of the SHTM 04-01 document, some method statements, blank sheets that require to be completed covering the lines of communication and responsible persons. There is also an outline of the required tasks but this is in a generic form and not specific to the QEUH and a brief description of the water systems on site. The written scheme does not have the required level of detail for the site. It does not have incident plans. • There are a number of logbooks with recorded data from the risk reduction processes and procedures. However, there are elements of the required procedures missing. The missing elements include no records of TMV servicing, no

		flushing of expansion vessels. There are some gaps in the records. More details on the records are shown below. Overall, while it is pleasing to note that there is some of the required elements of a risk reduction programme available on site, this is not yet a comprehensive approach to water associated reducing risk at the QEUH.
44	Does the written scheme reflect the findings of the risk assessment?	It is unlikely that the written scheme fully reflects the findings of the risk assessment as the assessment was completed before the building went into full operation.
45	Is there a logbook, either paper or electronic, defining all the required tasks for the risk reduction processes and procedures?	There is a paper based log book system on site. It does not appear to define all the required tasks for the risk reduction processes and procedures for the site.
46	Are all tasks in the records signed and dated?	Although many of the records appear to be signed and dated, there are some record sheets with neither dates nor signatures. All records should be signed and dated.
47	What is the level of completion of the programmed tasks in the written scheme over the past twelve months?	There are a number of folders in the Estates' office containing records of the various risk reduction procedures that are completed on site. At the time of the audit the following folders were available:- • Monthly Sentinal Water Temps Folder – this folder contains records of temperature checks running from Jun 2015 to Oct 2016. Room reference numbers define where the temperatures should be taken. Records are not available for Jan, Feb, Mar 2016. Many of the record sheets are not signed and dated. Almost without exception the temperature records have a cold temperature recorded, and a mixed temperature recorded. There are very few measures made of stand alone hot water temperatures. Accordingly, in these records, it is difficult to know how the hot water system is

		performing in the hospital. It is recommended that temperatures are taken from the hot water pipework that supplies hot water to the Thermostatic Mixing Taps.
		
		• Legionella Folder – this folder contains the following:-
		  ○ Hot Water Calorifiers - Details on calorifier temperature testing. The temperatures are measured at the bottom and the top of the calorifiers. The records run from Mar 2015 until Mar 2017. The temperatures appear to be taken weekly. Results for Nov 2015, and Sep 2016 are missing. The test sheets are not signed. Flow and return temperatures to the calorifiers can be found in the BMS system. There may be a possibility therefore to discontinue taking manual temperatures from the top and the bottom of the calorifiers and instead look at the BMS trends on a monthly basis and note this in the log book.
		  ○ Cold Water Tanks - Details on cold water storage tank water temperatures are recoded on a minimum monthly basis. Records exist from Mar 2015 to Mar 2017. The records are not signed. HSG 274 calls for temperatures to be measured annually in the summer. SHTM 04-01 calls for temperatures of the tank water remote from the ball-cock, and for the mains water temperatures to be recorded on a six monthly basis. The temperature of the mains make up should also be measured and recorded. The condition of the tank both internally and externally should also be recorded. It can be useful to take internal photographs and add them to the records. There is

		again an opportunity to reduce the amount of measurements taken with this process to what is required in the SHTM 04-01 part B document. ○ CWS Tank Room checks – forms exist in the folder for this. This is not a requirement of the HSG 274 or SHTM 04-01 documents. ○ Hydrotherapy Shower Forms – There is a deluge shower at the hydrotherapy pool which is flushed weekly. Records exist for Jun 2015 to Mar 2016. It may be that this flushing procedure has now stopped. If this flushing procedure has been stoped it should be reinstated. ○ Outside Tap Forms – The unused forms in this section call for twice weekly flushing of outside taps/tradewater. There is no indication that this has been happening. This procedure should be reinstated on site. ○ It was noted that there is a water storage tank in a 12th floor plant room. There are no monitoring or risk reduction processes and procedures in place for this tank. The tank should be risk assessed and appropriate procedures put in place if required. ○ AHU Trap Monthly Check – this is a recording sheet for the condition of the glass traps on the AHU's. There is one entry for April 2016. From a legionella point of view this is a low risk. A decision should be made as to whether these checks should be reinstated. ○ Theatre Outlet Thermal Disinfection Forms – no records.

		◦ Flushing Water Outlet Forms – no entries. • A & C General Shower Disinfection Folder – Records exist in this file for disinfection procedures for showers throughout 2016 and 2017. The paperwork does not seemed to be filed in a way which allows for easy review with the months appearing to be filed in a random order. It does look however that shower cleans and disinfections are occurring. The filing of the records should be improved to allow for ease of reviewing. • Childrens Adults General legionella Folder – the following sections are held in this file:- ◦ 1 – Flushing Form Blank – no paperwork on file. ◦ 2 – Flushing Form Complete – no paperwork on file. ◦ 3 - Flushing Outside Areas – records exist for weekly flushing of outside taps from Apr 2016 to Dec 2016. ◦ 4 – Flushing Retest Area- no paperwork on file. ◦ 6 – Theatre Thermal Disinfection – no paperwork on file. ◦ 7 – Clinical Thermal Disinfection – one set of records exist for TMT testing in A and E Sick Kids for May 2016. It appears this is just a TMT function test. It records the mixed water temperatures. ◦ 8 – General Thermal Disinfection – one set of records for Adults Imaging GF TMT's. This test does record hot water temperatures to the TMT. ◦ There is then a range of records for TMT function tests at from various arts of the hospital. All of the

		records are for 2016. o 13 – Quarterly Cal and Exp Flushing – there are records for quarterly calorifier flushing running from September 2016 to March 2017. There are no records of any Expansion Vessel flushing. • High Risk Adults Thermal Disinfection – this folder contains records of "Function Tests" across the following areas o Critical Care Ward o Coronary Care Unit o Haemo Ward 4B o Renal Ward A o Renal Ward C o Renal Ward D o Theatres • High Risk Areas Shower Chlorination Record Forms folder – this is a further folder with shower clean and chlorination forms for other parts of the QEUH. • High Risk Childrens Thermal Disinfection folder - this is a further folder with shower clean and chlorination forms for other parts of the QEUH. • Standard Operating Procedure Folder – this folder contains a copy of the NHS GGC Standard Operating Procedure, WS01 along with some other forms. • Water Management System Fault Register folder – this folder has one fault recorded – tripped out boilers – on 10th

		February 2017. • Water Management General Alterations A and C folder – this folder has recorded four pieces of work including one removal of a wash hand basin, one move of a wash hand basin, replacement of a shunt pump and new whb in dialysis. It should be noted that there are amended drawings with some of the changes – this is good practice and should be continued. • Water Management End of Line & Miscellaneous Files & Registers forlder – this folder contains information on end of line sensors. I also has a flexible hose replacement register with some hoses having been replaced in Jan 2017. Finally it has details of certificates of calibration of thermometers. • Water Sample Populated Sheets Folder – this folder contains record of the legionella samples that have been taken in the QEUH. Samples are taken on a monthly basis and not from the same areas each month. The samples are sent to the Alcontrol laboratory at Bellshill. The sample detail form is supplied by Alcontrol. The form does not state whether the samples are taken on a pre flush or post flush basis. The samples are taken by NHS Estates' staff. It is not known if these staff have received specific training on how to correctly take legionella samples. The results are sent back to the QEUH electronically and are stored electronically. The samples appear to be taken from acute and high risk areas. • Water Management Pseudomonas Monitoring and Control

		folder – this folder contains a timetable for various actions as well as drawings of the affected areas. Temperature records for Jan 2017 are recorded in the folder. Records of Pa testing are included in the folder for March 2017. It is assumed that these samples are being taken at the request of Infection Control. Overall there are 13 folders containing information and records for the QEUH. Some of the records appear in more than one folder. Some of the records appear to be randomly filed. There has been a lot of work put in to create the records as they currently are. The records however require to be "tidied up" in order to make them more user friendly and easier to review.
48	Are there any TMV's on the site and are they serviced in accordance with manufacturers recommendations?	There are 1000's of TMT's on site. There are records indicating that they are being operationally checked. There are no records to suggest that they are being serviced. It is recommended that the service requirements are defined, and that the service programme is put in place and recorded.
49	Are the remedials actions from the previous risk assessment completed and are they signed and dated?	No evidence that the remedial actions have been completed. A new risk assessment should be completed, and the appropriate remedial actions from this assessment should be completed.
50	Does the written scheme contain any incident plans?	No. These require to be completed and added to the written scheme.
51	Is there a copy of the risk assessment in the written scheme?	A copy of the risk assessment was available with the records in the Estates' office.
52	Is there a copy of the training records in the written scheme?	Training records are held in individual personnel files. It is recommended that an overall register of the completed training course, and the required training course, is created for the on site staff

53	Is there a description of the correct and safe operation of the water systems in the written scheme?	No. A definition of the correct and safe operation for the water systems at the QEUH should be created and added to the written scheme.
54	Are non conformances addressed in a timely manner?	Unknown. There is one record of a non conformance having been addressed. However, as an example, there are temperature records from the shower cleaning and disinfection procedures which show out of specification cold water results. There are no records of this being raised as an out of specification situation. There is no record of any corrective actions having been taken. A response to out of specification situations should be recorded in the folder created for the purpose. The remedial actions should also be recorded.
55	Is there an escalation procedure for non conformances?	Yes.
56	Are legionella samples taken as part of the written scheme tasks?	Yes. There is a rolling programme of sampling monthly in the acute areas of the hospital.
57	Is there a specific escalation procedure for positive Legionella results?	Unknown. An escalation procedure for NHS GGC requires to be created and sent to all sites.
58	Who takes legionella samples and are they being taken in accordance with BS7952:2008?	Legionella samples are taken by Estates' staff. The question was asked as to their level of training and understanding regarding legionella sampling but there is no record that they have been trained. The competency status of the involved staff should be checked and training, if required, should be put in place.
59	Does the written scheme contain an "audit trail" for out of specification situations which allows for remedial actions to be tracked through to completion?	No. This has been commented on earlier.
60	Are there copies of method statements for any procedures that are completed in house or by external providers?	There are copies of method statements for shower cleaning. It should be checked that method statements for all in house tasks are in place in the written scheme.

Comments and Recommendations on Written Scheme, Monitoring and Records

1. **In future all records should be dated and signed.**

2. **There are very few hot water temperatures measured in the records. Most of the temperatures recorded are from mixed outlets. In future temperatures need to be taken of the hot water system and not from mixed temperature outlets.**
3. **Consider whether it is necessary to take temperatures manually at the top and bottom of the calorifiers, and instead, utilise the capabilities of the BMS system and monitor and record monthly.**
4. **Cold water storage tank, and mains water inlet temperature measurements could be reduced to twice yearly.**
5. **The internal and external condition of the tank should be recorded in the records.**
6. **Check and ensure that the flushing procedure for the hydrotherapy pool deluge shower is reinstated and recorded.**
7. **External taps and all outlets attached to the trade tanks should be flushed twice weekly and the action recorded in the log book.**
8. **It was noted that there is a water storage tank in a 12th floor plant room. There are no monitoring or risk reduction processes and procedures in place for this tank. The tank should be risk assessed and appropriate procedures put in place if required.**
9. **AHU Trap Monthly Check – a decision should be made as to whether these checks should be reinstated.**
10. **Review the shower cleaning processes and procedures to ensure that all showers are being cleaned and disinfected as required.**
11. **Records for shower cleans and disinfections should be filed in a way that allows for suitable reviews of the data to take place.**
12. **There are records for calorifier flushes running from Sep 2016. Expansion Vessels should also be flushed on an agreed basis and this needs to be included in the written scheme.**
13. **A check should be made to ensure that the Estates' staff who are taking legionella samples are adequately trained.**
14. **The Alcontrol sample form should indicate as to whether the samples were taken on a pre flush or a post flush basis.**
15. **Upgrade the records to make them more user friendly and easier to review.**
16. **Define the required service profile for the TMT's.**
17. **Implement the required servicing procedures for the TMT's.**
18. **No evidence that the risk assessment remedial actions have been completed. Once a new risk assessment has been completed a plan for addressing the remedial actions should be implemented.**
19. **If a new risk assessment is not to be completed, then a review of the risk assessments from the existing risk assessment should be made and the appropriate remedials should be completed.**

20. Create a register of individual's training courses attended and also of training requirements. **21. A definition of correct and safe operation of the water systems for the QEUH should be created and added to the written scheme.** **22. A response to out of specification situations should be recorded in the folder created for the purpose. The remedial actions that are completed should also be recorded.** **23. Create an escalation procedure for positive legionella results and ensure that all sites have a copy and understand the process.** **24. With regard to legionella sampling the competency status of the involved staff should be checked and training, if required, should be put in place.** **25. A check should be made to ensure that method statements for all in house tasks are in place in the written scheme.** **26. Incident plans need to be created for the written scheme. There may be a generic incident plan in the NHS GGC water policy, but site specific plans need to be created for the QEUH.**		
Correct and Safe Operation		
60	Is there a statement of "correct and safe operation" detailing targets for temperatures and other control measures?	No. This issue has been commented on earlier in this report. The HSG 274 guidance document recommends that this statement is part of the written scheme.
61	Is there evidence in the written scheme that any deadlegs are removed?	There is no evidence that any dead legs have been removed from the site. The risk assessment that was completed in April 2015 identified some deadlegs. These are detailed in the recommendations sections of the risk assessment report. If they have not already been removed the known dead legs in the risk assessment should be removed as soon as possible
62	What is the primary means of control within the water systems?	Temperature.
63	Is there any form of water treatment being applied to the water systems?	No chemical water treatment is being used on site. The water coming into the site goes through an ultra filtration membrane process. Elga services the membrane filtration system. On site Estates' staff check the pressure drop across the cartridge filter which is in front of each filtration unit. The membrane filtration system service records were not available at the time of the audit.

		Records are being kept of the pressure changes across the cartridge filtration unit. It is recommended that these records become part of the overall legionella risk reduction records.
64	Are little used outlets listed and are they then flushed?	Other than the flushing of outside areas, for which there are some records, there is no indication that any other outlets are being flushed. It may be that the cleaning staff are cleaning every wash hand basin and sink every day, and, as a result, technically these outlets will not be classed as little used. A check should be made to ensure that domestic staff are cleaning all wash hand basins and sinks in the appropriate manner.
65	Is the flushing of little used outlets recorded in the records system?	Where external taps and outlets are flushed by Estates' staff, then some of this has been recorded in the log books. The records however do not seem to be complete and it may be the case that there are little used outlets that are being flushed, but are not being recorded, or there could be little used outlets that are not being flushed at all. An audit of the flushing procesdures should be undertaken to ensure that all the required outlets are being flushed as required.
66	Is there any seasonal difference in the use profile of the water systems?	No.
67	Are any pieces of duty standby equipment that require to be switched on a weekly basis, and do the records show that they are being switched?	No.

Comments and Recommendations on Correct and Safe Operation

1. **Remove the dead legs that are identified in the 2015 risk assessment report and record this fact in the written scheme.**
2. **A check should be made to ensure that domestic staff are cleaning all wash hand basins and sinks in the appropriate manner.**
3. **Add the records of the pressure drop across the membrane pre-filters, as well as any service records of the filtration system, to the legionella records.**

4. Perform an audit of the flushing procedures that are completed by Estates' staff to ensure that all the required outlets are being flushed and that the detail of this process is being recorded.		
On Going Water Treatment		
68	Is there any form of water treatment in use on site?	No.
69	Is there any form of secondary disinfection in place on site?	n/a
70	What is the secondary disinfectant that is in use in the water systems?	n/a
71	Are the required checks for secondary disinfection levels being completed and recorded on site?	n/a
72	Are the required levels of disinfection being achieved in the water systems?	n/a
73	Is there a record of stock levels of biocide in the written scheme?	n/a
74	Is any of the water base exchange softened?	n/a
75	Are service records for the base exchange softeners available in the written scheme?	n/a
76	Is filtration in use in any of the water systems?	Yes.
77	Are service records for the filtration equipment available in the written scheme?	No. It is suggested that the service records for the water filtration system are made available as part of the written scheme.
Comments and Recommendations on Ongoing Water Treatment		
Not applicable		
Cleaning and Disinfection Procedures		
78	Are system cleaning and disinfection procedures in use on site?	There are no cold water storage tank cleaning and disinfection procedures currently being undertaken on site. Cleaning and disinfection would be undertaken on an "as required basis".
79	Are these procedures completed in response to sampling results or as a matter of procedure?	As required.
80	Is there a suitable method statement available in the	A contractor would undertake any cleaning and disinfection

	written scheme covering the cleaning and disinfection procedures?	procedures on site. While no method statements were available on site at the time of the audit, it is recommended that should any clean and disinfection procedures be required, then the contractor method statements are inspected and deemed to be suitable. If cleans and disinfections are to be completed by in house staff, then suitable method statements require to be completed. Training should also be given to the involved in house staff.
81	If chlorine is used, is the impact of pH considered on the disinfection process.	n/a
82	Are there completion certificates in the written scheme covering any disinfection procedures that have been undertaken?	No. No disinfections have been completed to date. There is therefore no need to have disinfection completion certificates in the records.
83	Are localised outlet disinfections in use on site?	Shower heads and hoses are disinfected on site by Estates' staff.
84	Is there a suitable method statement available in the written scheme covering the localised cleaning and disinfection procedures?	Yes.

Comments and Recommendations Cleaning and Disinfection Procedures

1. **Should a contractor be used for any future cleaning and disinfection procedures, the contractor's method statements should be checked to ensure that they are acceptable to NHS Glasgow.**
2. **If cleaning and disinfection processes and procedures are to be completed with in house staff, then a suitable method statement requires to be produced.**
3. **If cleaning and disinfection processes and procedures are to be completed with in house staff, then suitable training should be given to the involved staff.**

New Build and Refurbishment Projects – Capital Projects

85	Have any new build or refurbishment projects, which impacted on the water systems, been completed in the past 12 months	None as the hospital is essentially a new build property.
86	Were the implications of this work risk assessed.	n/a
87	Was the assessment added to the log book and water	n/a

	system records	
88	Was the written scheme amended to account for the implications of the new build/amended water systems	n/a
89	Were the details of the new systems discussed with the Estates Department and any other involved personnel	n/a
90	Are minutes of discussions regarding the new water systems recorded and entered into the log book	n/a
91	Was all new equipment commissioned in accordance with manufacturers recommendations	n/a
92	Are manuals with details of all new equipment available in the record systems	n/a
93	Were systems. if required, cleaned and disinfected.	n/a
94	Are records of all cleans and disinfections available in the record systems.	n/a

Comments and Recommendations on New Build and Refurbishment Projects – Capital Projects
None

ENERGY CENTRE

Forensic Analysis Report

Project Ref. : ME-171804
Issue Date : 10th May 2018
Revision : -
Prepared by : Matthew Lambert

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SECTION 1 – Executive Summary

1.01 Executive Summary

From our forensic analysis it would appear there was likely to be inherent irregularities in terms of the original MTHW heating primary circulation design philosophy. These may have subsequently resulted in system temperature control instability, and consequently led to the CHP system underachieving intended desired level of performance.

Whilst system modification documentation advises practical operation of the original differential pressure control strategy had proven to be problematic, causing errors to occur, we anticipate that post completion/commissioning alterations were primarily instigated with a view to enhancing probable CHP underperformance. However, the eventual influences of modifications on the MTHW heating system do not appear to have been thoroughly considered prior to implementation.

Alterations to the control systems included several amendments to the presumed original design intent, including functional operation parameters pertaining to CHP system, boilers, primary MTHW circulation pumps, and automatic control valve sequencing.

In relation to CHP system and boiler operation, the revised strategy appears to prioritise heat rejection to atmosphere over the presumed original intent of de-rating CHP unit outputs. On the presumption the CHP system was intended to operate on heat led basis, this does not appear to be an appropriate or efficient method of operation. Furthermore, temperature set point adjustments appear to have effectively resulted in an apparent continued rejection of heat to atmosphere, whilst up to three boilers are operational, and again raising concern with regards to efficiency from both energy and monetary perspectives.

In terms of primary MTHW pump operational modifications, we expect these were intended to afford a lesser degree of functionality. However, we anticipate the revised control methodology to be ineffective, thereby resulting in a significant fundamental divergence from the intended system operation in respect of primary and secondary circulation. A particular consequential effect of these pump control modifications appears to have caused lower secondary side temperatures (i.e. heating and domestic hot water services) than those originally proposed, adversely influencing thermal comfort and increasing the risks associated with legionella.

Variation to the functional operation of primary MTHW heating control valves appears to have been included as part of the system modifications. Circulation temperatures noted during our site observations tend to indicate the incidence of a primary MTHW circulation short-circuit, which could be a consequence of automatic control valve adjustments undertaken. In addition, there also appears to have been alterations made to lead plant sequence controls, and load diversion strategies, which may result in insufficient heat generation during periods of peak demand.

It would appear that the originally documented intention to afford 66% resilience was unlikely to be achievable, from either boiler plant or system viewpoints. We also anticipate that the subsequent system modifications have in all probability further reduced the level of resilience initially afforded.

Other significant observations noted during our analysis of the system are mentioned within the main sections of the report. These include inconsistencies relating to MTHW primary circuit commissioning flow rates, potential plant room heat load diversion inconsistencies, and sizing/selection of Laboratory Building plate heat exchangers.

In conclusion, we anticipate that there may well have been complications associated with the successful operation of the systems prior to implementation of system modifications. Post completion alterations do not seem to have successfully resolved recognised original system inadequacies, and appear to have created separate/additional detrimental operational problems.

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SECTION 2 – Introduction

2.01 Introduction

NHS Greater Glasgow & Clyde requested that we undertake a forensic analysis of record documentation contained within the Zutec electronic database pertaining to the medium temperature hot water heating system (MTHW) installation, providing comment with regards to probable design intent, and identifying any potential inconsistencies/inadequacies relative to same.

As a supplementary duty we were also asked to review, and provide comment on, any possible notable variations undertaken to the system that would appear to deviate from the anticipated initial design intent, together with our opinion regarding any potential anomalies related to same.

In order to complete this analysis exercise, it was necessary to hypothesise and speculate with regards to some particular aspects, especially where we considered there to be an absence of sufficient relevant information (i.e. discrepancies/irregularities in documentation, control system readings, temperatures, etc.). In view of this, we accept there is a potential that inaccurate, or incorrect, statements/opinions are made within this report document.

Should any discrepancies, or ambiguities, appertaining to the content of this report be discovered, we would be obliged if these were advised to the Author (Innovated Design Solutions Ltd) at the earliest opportunity, as to facilitate clarification/verification of any specific matter in question and enable the report to be revised as/if deemed necessary.

SECTION 3 – MTHW Heating System Operational Strategies

3.01 General Observations

We were unable to identify any documentation contained within the electronic Zutec record database referring to the original system design principles, or the associated intended functional operation of the mechanical services installations within the Energy Centre. For example, within the Energy Centre folder on Zutec, under General Project Information, there are no records pertaining to mechanical services within either 'Building Description', 'Design Consultants Information', 'Employers Requirements', or 'Principles of Design' archives.

Whilst there are numerous documents on Zutec relating to the operation of the MTHW heating system, these do not appear to have been produced by the system designers and were found to be contradictory, particularly in relation to primary MTHW heating circuit operational temperatures.

Examples of perceived inaccuracies, and inconsistencies, within the record documents have been included within the Appendices of this report (refer to Appendix 'A').

In the absence of any clear design philosophy, and due to the extent of inconsistent/contradictory information contained within record documentation in respect of the installed system, we were unable to accurately establish the intended design strategy, or associated functional operation of the system, with any level of certainty.

In particular, two of the documents contained within the project 'Health & Safety File' archives (both apparently produced by the same organisation) were found to be contradictory with details appertaining to fundamental key information. One of these documents specified the installation of 4Nr 4000kW boilers within each boiler plant room (i.e. 'A' side and 'B' side plant areas), with the boilers providing medium temperature hot water at 110°C flow and 75°C return. Whilst another document highlighted a residual risk associated with potential scalding due to a high system water temperatures of 105°C, which is assumed to be again referring to the MTHW heating primary flow temperature. Our analysis of record documentation indicates that 7Nr 5000kW output boilers were installed, with the primary MTHW heating circuit being designed to operate on the basis of a 105°C flow temperature.

Due to the deficit of clear record information it was necessary to undertake an in-depth appraisal of all documents contained within Zutec relating to system operation, and scrutinise findings in an endeavour to ascertain the probable system design intent, together with the associated operational strategies relative to same.

The current operation of the system indicates considerable divergence relative to the presumed original design philosophy. Whilst we were provided with a 'User Manual', which was deemed to afford an overview of the current system operation, this appeared to be inaccurate. In view of this, our assessment of the present system operation has of necessity been based on what we consider to be the original predicted design intent, the MTHW heating system 'User Manual' passed to us during our investigative works, and from site observations.

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3.02 Summary of MTHW Heating Installations

There are 7Nr 5MW heat output medium temperature hot water dual fuel natural gas/oil fired boilers, and 3Nr 1.2MW thermal output naturally gas fired combined heat and power units (CHP), located within the Energy Centre building. Boiler plant is subdivided into two separate plant room areas (‘A’ side and ‘B’ side plant rooms), which are both located on level 2 of the Energy Centre, with the CHP units located on ground floor level. The CHP installation also incorporates heat rejection emitters, which are installed on the roof of the Energy Centre.

Heat generators are currently utilised to provide MTHW to the Adult & Children’s Hospital, and Laboratory Building, via underground distribution pipework. There would also appear to be spare connections on the primary MTHW circuits for future use, located at both the Energy Centre and within the Adult & Children’s Hospital Basement area.

Each of the two boiler rooms (‘A’ and ‘B’) have separate reverse return header circuits, with all individual boiler return sub-circuits being equipped with a 2-port motorised valve, and duplicate shunt pump. A common primary MTHW flow header, within each plant room, serves 4Nr single head primary heating circulation pump units installed in parallel, with the outlets from each pump set merging into a secondary common flow header. This common MTHW circulation pump flow header is equipped with a 2-port motorised and a volume flow meter. There would also appear to be a pressure differential sensor installed between this flow header and the associated system return header.

The ‘A’ and ‘B’ side plant rooms common pumped primary flow and return headers are hydraulically interconnected by ‘cross-link’ circuits, with their use being controlled by multiple 2-port motorised valves. An absorption chiller circuit is also connected into this MTHW primary ‘cross-link’ circuit.

Flow and return pipework from the CHP units is routed to both ‘A’ and ‘B’ side boiler plant rooms, and connects into common headers within each. 2-port motorised valves are also installed on both the flow and return circuits.

'A' side plant room flow and return pipework exits the Energy Centre, via underground pipework, to the Basement area of the Adult & Children's Hospital. 'B' side plant room primary MTHW flow and return circuits serve 2Nr MTHW/LTHW plate heat exchangers located within the Energy Centre prior to leaving via underground distribution to the Basement area of the Adult & Children's Hospital. These two plate heat exchangers, located on the ground floor level, convert MTHW to LTHW to service the Laboratory Building, via separate dedicated LTHW underground heating distribution from the Energy Centre. The Laboratory Building secondary side LTHW heating circulation pumps are also located within the Energy Centre, these being situated on the ground floor level.

Within the Adult & Children's Hospital Basement area, the pipework from 'A' and 'B' side plant rooms connect into common MTHW flow and return headers. These circuits connect in at either end of each common header and are separated by 'normally closed' isolation valves. These remote plant areas house numerous MTHW/LTHW plate heat exchangers, with the primary side MTHW flow circuit to each heat exchanger equipped with a 2-port pressure independent control valve (PICV), and a flow rate balancing valve on return circuit.

The secondary side LTHW heating circuits from the MTHW/LTHW heat exchangers serve space heating and supply air ventilation systems (via low variable temperature, normal variable temperature, or constant temperature heating distribution to the various emitters as appropriate). It would appear that the domestic hot water generation is being achieved directly via MTHW / DHWS plate heat exchangers located at storage buffer vessels to afford rapid recovery.

3.03 Presumed Original Operational Intent

It would appear that the CHP units were intended to act as the lead heat generation source, with boilers utilised to subsequently assist in meeting requirements whenever the heating load exceeded the CHP plant thermal output capabilities. Therefore, we anticipate that the CHP installations were likely designed on a heat led basis, and selected to satisfy the baseload heating demand for the facilities served.

The CHP unit heat reclaim system was designed to deliver MTHW at 105°C, when receiving a return temperature of 75°C, with automatic load output diversion switched to either 'A' or 'B' side plant rooms dependent on the selected lead plant room. This alternation of flow direction to either 'A' or 'B' plant room being automatically achieved via the BMS system by switching 2-port motorised valves on each interconnection circuit.

Whenever the CHP system was enabled, the primary MTHW heating return circuit temperature would be monitored against a set point of 74°C. In the event the return circuit temperature exceeded 75°C, the CHP unit integral automatic control system would lower its output by 20% duty, for a minimum duration of 20 minutes, via diversion of return water. Should the return circuit temperature rise above 76°C, the CHP duty would be reduced by 40% for a further 20 minute minimum duration, and maintain diversion of water. This strategy was intended to protect the CHP units from receiving elevated return water temperatures above the apparent 75°C maximum, this presumably being to enable the excess heat load within the system to dissipate until the CHP primary return circuit temperature had fallen below the 74°C set point.

Roof mounted dry air coolers have also been installed to facilitate heat rejection from the MTHW heating return circuit serving CHP units. It is presumed that these are intended to operate in the event of return water temperature exceeded a predetermined set point limit. The undesirable diversion of water flow to these roof mounted emitters via the heat rejection circuit is achieved automatically via a 3-port motorised valve. This heat rejection installation appears to be designed to allow a maximum flow rate of 9.6l/s (although it is not pumped), equating to a thermal heat output of approximately 1.2MW (based on a 30 deg C circuit temperature differential), thereby theoretically enabling the heat rejection facility to dissipate the thermal output of a single CHP unit operating at 100% duty. Heat rejection was likely not intended to occur regularly, in view of the obvious inefficiencies associated with wasting energy, and as the CHP system was presumably designed to suit system heat base load requirements given the absence of a buffer vessel.

Whilst there are differing primary MTHW heating circuit flow and return temperatures detailed within system descriptions, we anticipate that the intended primary MTHW heating system flow and return temperatures to serve the Adult & Children's Hospital were designed on the basis of 105°C and 75°C respectively, thereby affording a temperature differential of 30 deg C. We also expect that the Laboratory Building MTHW primary heating flow circuit was designed on the basis of 105°C, however, and unusually, with a 85°C return circuit temperature, thus affording a lesser temperature differential of 20 deg C.

The boilers were programmed to maintain a flow temperature of 105°C, and operate on a lead/lag, timed, step sequence control basis. Specified controls strategy proposed the controlled use of a maximum of 3Nr boilers within each plant room at any one time, with the switching of individual boilers being restricted by means of a 30 minute delay. We presume this automatic delayed action was aimed at affording adequate time for a boiler output to be fully realised prior to enabling further boilers, to ensure stress on the plant was minimised, and to prevent the consequences associated with inadvertently overheating the common primary MTHW return circuit. Each boiler appears to be controlled to operate for a minimum period of 30 minutes, with an automatic overrun facility to extend operation of the shunt pump and keep the motorised valve open for a 10 minute duration after shutdown, as to dissipate residual heat.

It appears that the operation of boilers, and the CHP units, were to be controlled by the variation of primary MTHW volume flow, achieved by measuring circulation rate in conjunction with the flow and return temperatures within the primary MTHW circuit. The measured volume flow rate was converted into a heat load (in kW's), which was then automatically utilised to determine the number of boilers required to satisfy demand. The heat load calculated from the measured volume flow rate was apparently reduced to take cognisance of the number of CHP units in operation (i.e. by 1200kW per unit), automatically adjusting boiler output requirements accordingly.

Furthermore, it would also appear that boiler operation was intended to be controlled on the basis of primary MTHW return temperatures, recorded via numerous sensors installed on circuits within the Adult & Children’s Hospital. This additional control strategy enabled one additional boiler to operate in the event of primary return circuit temperature falling below 71°C, and a further boiler in the event circuit temperature falling below 69°C. The boilers would then remain operational until the primary return circuit temperature increased above 75°C.

Two alternative methods for operating the MTHW heating system on a variable volume control strategy appear to have been proposed, both of which include the automatic sequencing of primary circulation pumps on a lead, lag 1, lag 2, and standby basis, and their speed adjustment as necessary.

The first method incorporated 3Nr differential pressure sensors located on pipework distribution within Plant Rooms 21, 22, and 41 of the Adult & Children’s Hospital. These sensors being utilised to measure the pressure difference across the distribution circuits, automatically sending signals to sequentially switch, and speed regulate, the primary circulation pumps in a timed manner to maintain a particular set point differential pressure accordingly.

The second method incorporated differential pressure sensors located on main distribution pipework located within ‘A’ and ‘B’ side boiler plant rooms within the Energy Centre, to automatically control primary circulation pump sets in the same manner as the first option.

It would appear that either of these control methods was selectable at system commissioning stage, however, there does not appear to be any indication in respect of method finally adopted within record documentation.

In order to achieve a differential pressure across the distribution the 2-port pressure independent control valves (PICV's), installed on the primary side flow pipework to each plate heat exchanger, would modulate open or closed as required to satisfy the secondary side heat load requirements. The opening and closing of these valves was intended to create a pressure difference within the primary side distribution, which would effectively communicate any necessary increase or decrease flow requirement to the primary circulation pumps.

Successfully achieving a variable volume control strategy within the MTHW distribution, to satisfy secondary LTHW heat load demand, should enable a constant primary side operational temperature differential to be maintained.

'A' and 'B' side boiler plant rooms appear to be intended to operate automatically dependent on system heat load demand, when CHP units are unable to adequately sustain requirements. During a lower heat demand period (i.e. < 15MW), only one of the two plant room systems would be called to provide MTHW to both 'A' and 'B' side primary distribution circuits via the utilisation of the 'cross-link' interconnection pipework. This would necessitate both 'A' side and 'B' side 'cross-link' 2-port motorised valves automatically opening to facilitate interconnection of circuits. During a higher heat demand period (> 15MW), it would appear that each plant room system was intended to serve their respective separate primary MTHW heating distribution, with the 'cross-link' circuit motorised valves in the closed position.

The record drawings indicate that the primary MTHW heating headers within the Adult & Children's Hospital Basement area are equipped with 'normally closed' isolation valves, to separate the flow and return circuits from each plant room to ensure that they only feed certain dedicated heat exchangers within the building during normal operation. We presume these isolation valves were intended to be manually opened in the event of failure of a particular underground distribution circuit, thereby allowing the remaining operational underground service to maintain supply to all plate heat exchangers within the building.

As defined within record documentation shown below (typical for each MTHW / LTHW plant room plate heat exchanger), the primary MTHW service temperatures were intended to facilitate achieving secondary side LTHW temperatures within the Adult & Children's Hospital of 75°C flow, and 60°C return, on a constant temperature basis.

MERCURY MECHANICAL — FACILITIES MANAGEMENT INFORMATION NSGH A&C HOSPITALS

2. General Operation

2.1. Plate Heat Exchangers

Plate heat exchangers located within plant room 21 convert medium temperature hot water (MTHW) to Low Temperature Hot Water (LTHW) which in turn serves ventilation plant and perimeter heating systems. The purpose of the plate heat exchanger installation is to positively separate the primary MTHW and secondary LTHW circuits to create smaller strategic load centres in a manner which improves system integrity and operational requirements.

The plate heat exchangers selected provide one unit as complete standby so that in the event of planned maintenance or breakdown the heating requirements can still be met. Plant room 21 has 3 No plate heat exchangers each providing 50% of the heating requirement for the areas served from here.

The sizing of the plate heat exchanger is on the basis of primary side flow and return temperatures of 105ºC and 75ºC respectively and secondary side temperatures of nominally 75ºC/60ºC flow and return.

From the plate heat exchangers installed within plant room 21, the secondary heating

The MTHW/DHWS plate heat exchangers were controlled in order to maintain a domestic hot water flow temperature of 60°C, as defined with the record documentation illustrated below.

4 Environmental Controls

4.1 DHW Temperature Control (Typical For Each Packaged Unit)

Once the system has been enabled and the high limit immersion thermostat is below its high limit, the DHW flow temperature is monitored and compared with the set point of 60°C. A proportional and integral control loop adjusts the MTHW control valve accordingly.

The DHW flow temperature is monitored for a mismatch between the temperature set point and the actual temperature. Should the temperature deviate +/-5°C of

3.04 Presumed Current System Operation

Specific sections, and associated screenshots, contained within the 'QEUH MTHW User Manual' document are shown below, together with a summary of the key points identified within same provided in Blue.

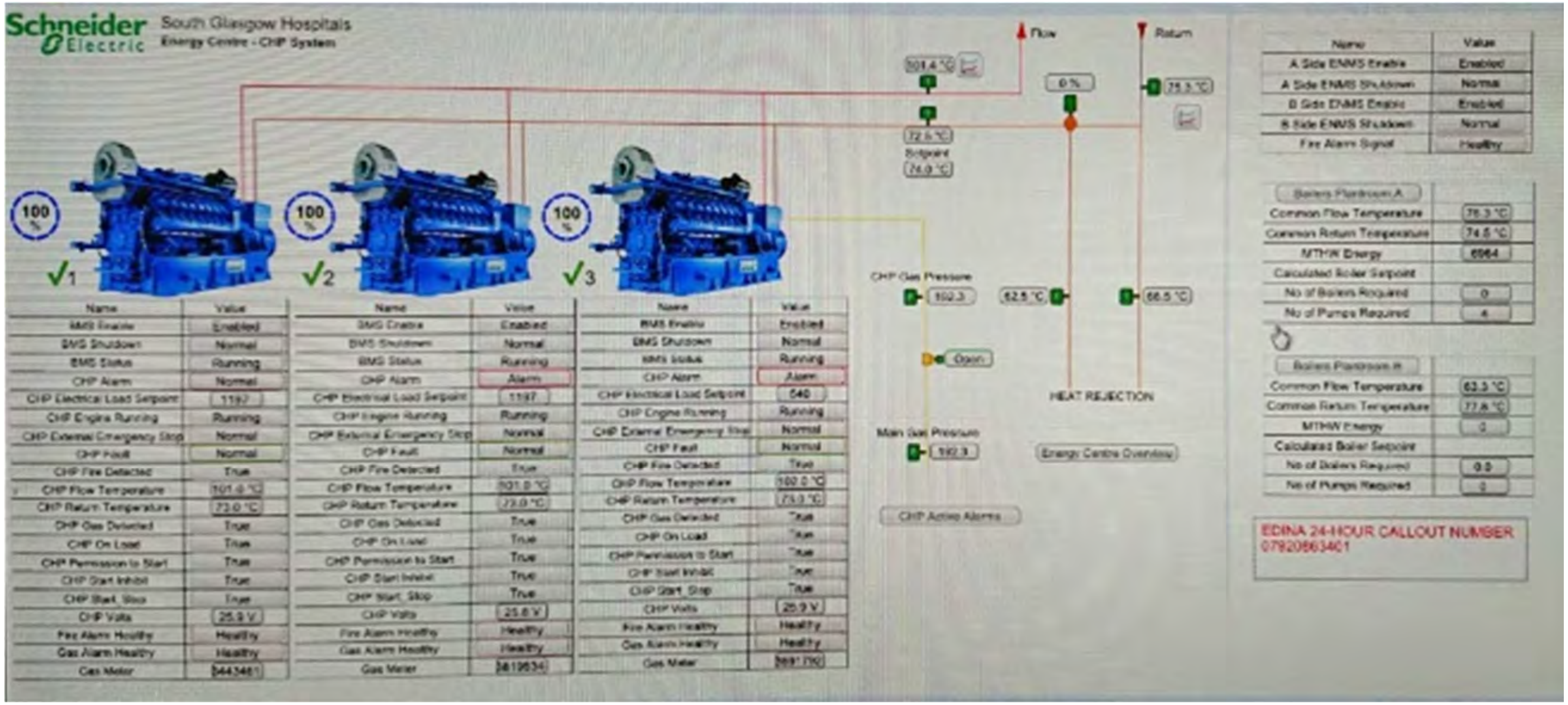
Please note, a full version of the User Manual is provided within the Appendices of this report for further reference (Appendix 'B').

---

1. *"The QEUH MTHW system has been changed since August 2017, to operate differently from initial design. The 3 x CHP's take the lead of the full MTHW system, and everything is controlled via CHP Common Return Temperature. This new Philosophy is more simpler and allows the CHP's to run at 100% efficiency. The system is more user friendly, as more functions have been created to allow set points to be changed during Summer or Winter periods."*

    - CHP acting as lead heat generating source.
    - Everything (i.e. boilers & CHP's) controlled under influence of CHP common return temperature.
    - CHP units now able to operate at 100% duty/efficiency
    - New summer/winter mode selection facility added.
    - Modifications made are deemed to be simpler and more user friendly.

2. *“The first tab to select is typically CHP System, as this shows both Common Flow and Return Temperatures, Dump Valve Position, status of CHP’s and the actual Temperature flowing to each Engine. From the 6th of December 2017, I have changed the Dump valve Set Point to 74DEG Celsius which is assisting the system a lot more during the colder periods. Screenshot below:-“*



- Heat rejection valve set point was changed to 74 Deg C.
- Common MTHW return temperature shown as 75.3°C.
- CHP common return temperature shown as 72.5°C.
- Heat rejection valve indicated as being at 0%.
- Heat rejection flow routed to roof mounted emitters shown as 66.5°C.
- 4Nr primary pumps indicated as operational within Boiler Room A.
- Boiler Room B flow temperature shown as 63.3°C, and return as 77.8°C.

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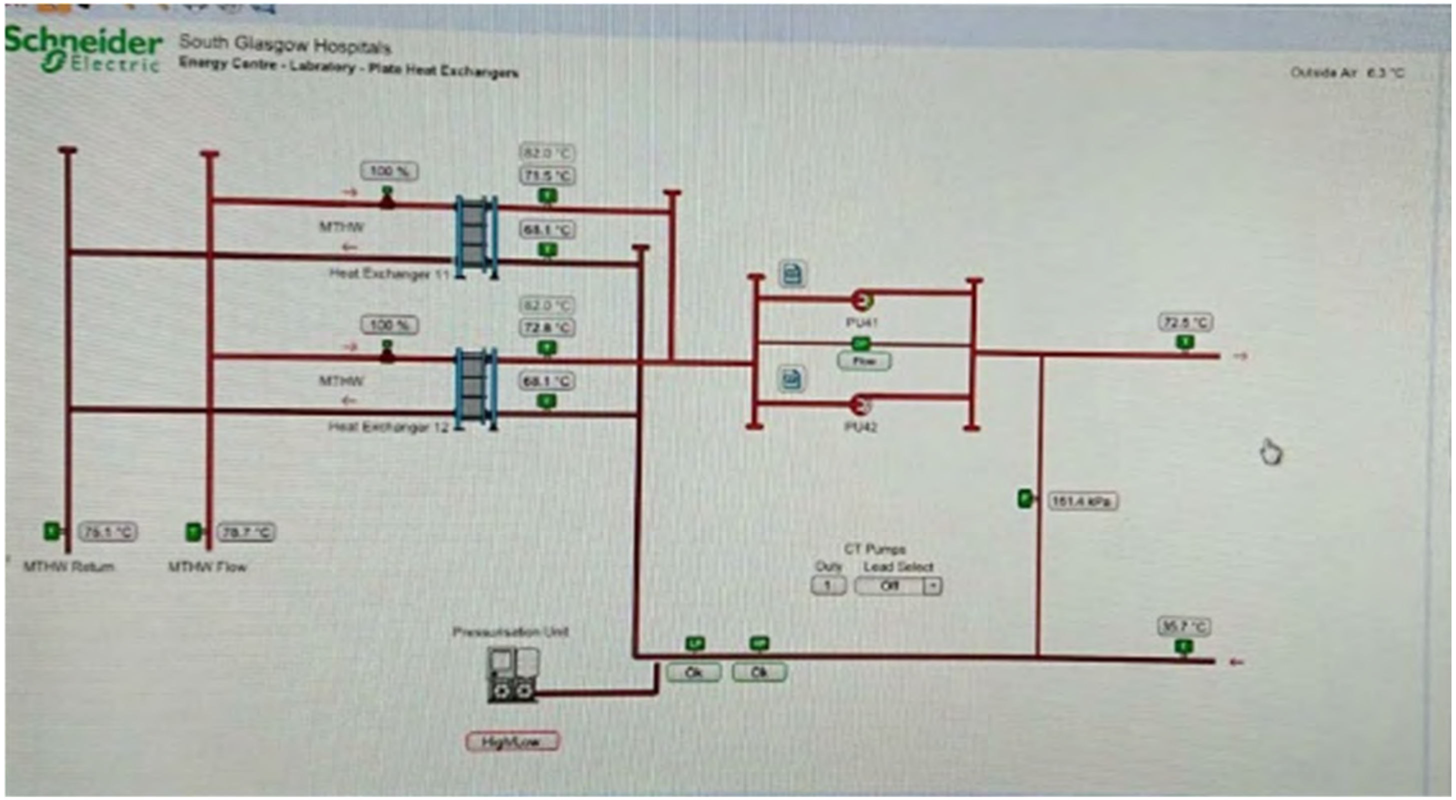
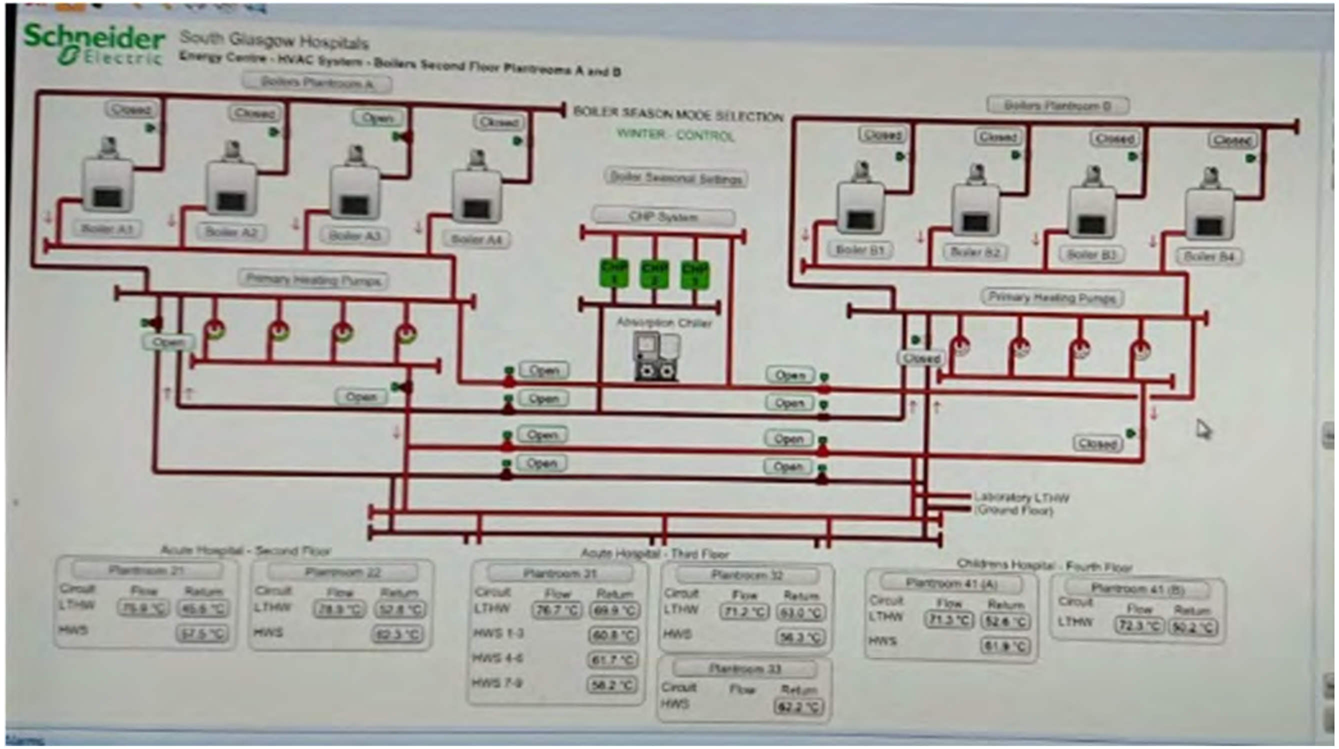
3. *"The next tab to select is Lab Block PHX, from here you can see the PHE Temperatures on the Primary and Secondary circuits. Screenshot below:-"*



- Primary MTHW flow and return temperatures shown as 78.7°C and 75.1°C respectively.
- Both primary side PICV's at 100% (i.e. fully open).
- Secondary side LTHW flow set point temperature shown as 82°C, for both plate heat exchangers.
- Actual secondary side LTHW flow circuit temperatures indicated as being 71.5°C, and 72.8°C.

4. *"The next tab to select is Boiler System, from here it allows you to visually see which side the system is operating, which Boilers are firing, Which pumps are running and all the PHE Secondary Flow and Return Temperatures. Screenshot below:-"*



- Secondary side LTHW heating system distribution circuit temperatures shown are inconsistent.
- 1Nr 2-port motorised valve on primary MTHW return to boiler within Plant Room A is shown as open, although boiler is not operational.
- All 4Nr primary circulation pumps within Plant Room A are shown to be operational.
- 2-port motorised valves, on primary MTHW heating circuits from CHP system indicated as being open to both A and B side Plant Rooms.
- Motorised valves on 'cross-link' interconnecting circuit shown open, Plant Room B flow and return motorised valves closed.

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5. *"From the Boiler tab, you select Boiler Seasonal Settings (Top Centre of Graphic), and this allows you to see the set points for each season. Summer has already been tried and tested with an average external air temperature of 16DEG to 18DEG and the system operated well. Winter is currently being tested and seems to be operating well over the last two days, with an average external air temperature of Zero Degrees Celsius. You can see the Winter set points are a lot higher than that of Summer, and this is to keep the system volume to maximum efficiency and does not allow the system volume to cool down. If for any reason, the settings require altering (Cold snap during Summer period), this is achieved by pressing the + or – buttons either side of the set points. Preferably I would leave these, as they are, as I have tested these and quite confident they work well. Screenshot below:-"*

(Relevant screenshot & associated notes are shown on the following page)

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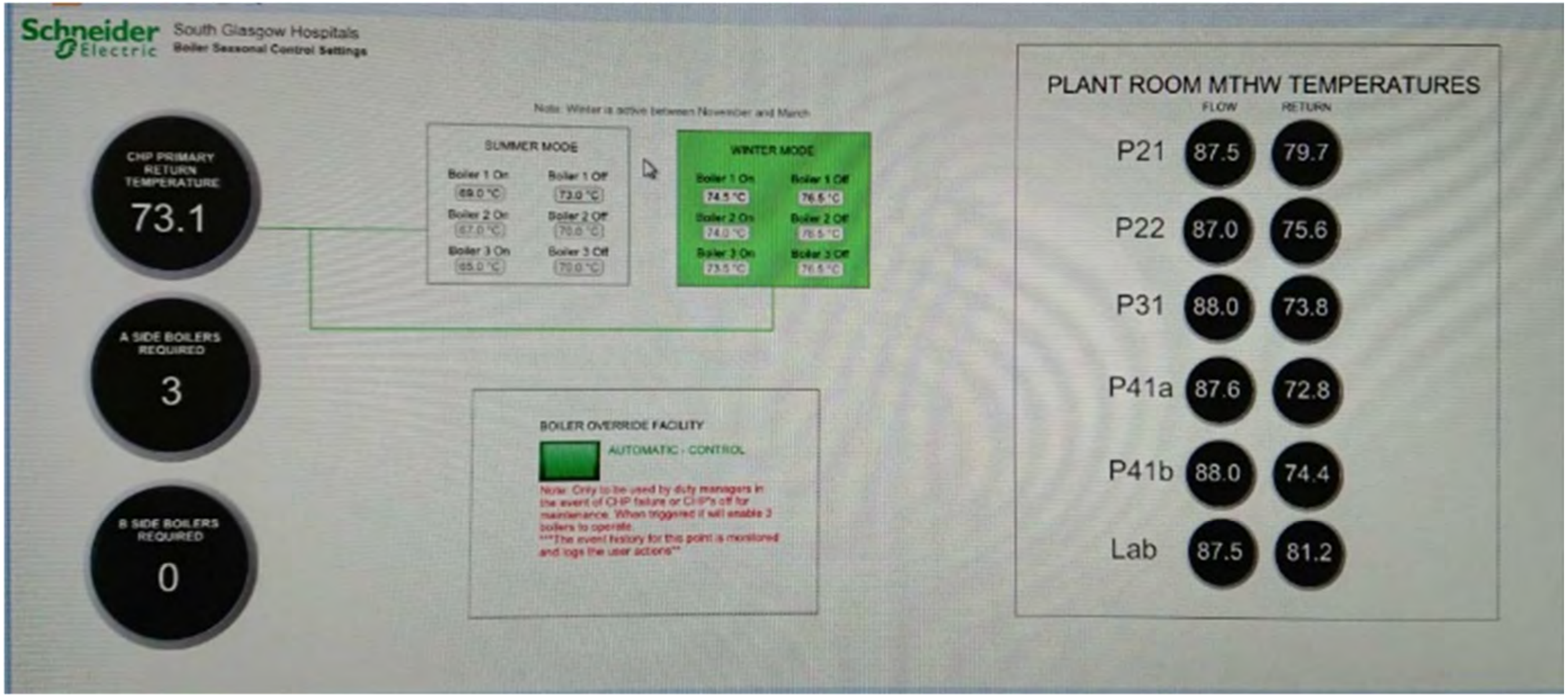


- Summer/winter mode selection added, which necessitates manual set point adjustment in event of a 'cold snap during summer period'.
- Summer mode boiler 1, 2, and 3 'ON' temperatures shown as 69°C, 67°C, and 65°C respectively.
- Summer mode boiler 1, 2, and 3 'OFF' temperatures shown as 73°C, 70°C, and 70°C respectively.
- Winter mode boiler 1, 2, and 3 'ON' temperatures shown as 74.5°C, 74°C, and 73.5°C respectively.
- Winter mode boiler 1, 2, and 3 'OFF' temperatures shown as 76.5°C, 76.5°C, and 76.5°C respectively.
- 'Automatic' control override switch provided to enable 3Nr boilers in the event CHP's being inoperative.
- Primary MTHW heating circuit temperatures indicated range between 88.0°C flow and 72.8°C return.
- CHP primary return temperature indicated as 73.1°C.
- 3Nr boilers within Plant Room A indicated as being required.

6. *“**Summer Settings***

Operation – 1st April to 30th September

1 x Boiler is only enabled if the CHP Return Temperature falls to 69DEG, and then the Boiler operates until the CHP Return Temperature reaches 73DEG. If we lose a CHP, and suffer a cold spell in Winter, Boiler 2 is enabled when the CHP Return falls to 67DEG and goes off at 70DEG Return. Boiler 3 is enabled when the Return falls to 65DEG and goes off at 70DEG. If in the event of a cold snap (During Summer Period), or total CHP loss I am pretty confident that 1 x Boiler could deal with the QEUH but is still to be demonstrated (3 x CHP’s load = 3.6MW and 1 x Boiler = 5MW).

Note:- *During this period, the Absorption Chiller runs 24/7 assisting with Energy Performance on the PME. 1 x Boiler is only activated once a day for typically an hour, due to the external air temp being in our favour so you should notice a greater saving on Gas usage during this period.”*

- Boilers ON/OFF operation detailed corresponds with statements made within Item 5 above.
- Assume “cold spell in winter” is intended to mean a cold spell in summer.
- In the event of a “cold snap” during summer mode operation, or complete loss of all CHP unit heat generation, it is suggested that a single 5MW boiler would possibly be capable to “deal with” the Queen Elizabeth University Hospital heating requirements.

7. *“**Winter Settings***

Operation – 1st October to March 31st

1 x Boiler is only enabled if the CHP Return Temperature falls to 74.5DEG, and then the Boiler operates until the CHP Return Temperature reaches 76.5DEG. If we lose a CHP, and suffer a cold spell in Winter, Boiler 2 is enabled when the CHP Return falls to 74DEG and goes off at 76.5DEG Return. Boiler 3 is enabled when the Return falls to 73.5DEG and goes off at 76.5DEG.

Note:- *During this period, the 3 x Boilers are activated approximately 50% to 75% of the day.”*

- Boilers ON/OFF operation detailed corresponds with statements made within Item 5 above.

8. "***A Side to B Side Changover***

   I would like to see this changed over every 3 months, as I think every month would be time consuming and this still allows each side to have an equal share of the two seasonal periods."

   - Identifies boiler plant rooms are manually sequence controlled at present, and recommended to occur every 3 months.
   - Indicates that present control strategy only considers the use of either A or B side plant room at any one time.

9. "***Pump Settings***

   The PHE two ports now control the pump flow, If all 20 x PHE's are at 100% (2000% Total), then 4 x Pumps run at 50Hz. Once any 4 x PHE's close (1600% Total), then the 4 x pumps reduce to 40Hz and decrease in similar settings which are on BMS Graphic. We no longer run on differential as the DP's were quite problematic and caused to many errors on the system. Running with this same Philosophy, the Flow Meter has no longer an input on how the CHP operates, this is now only used as a visual element (This will still requires topping up of the Conductive Gel)."

   - Plate heat exchanger 2-port PICV's now control pump flow.
   - If the PICV's serving "all 20" plate heat exchangers are at 100% (i.e. fully open), all 4Nr primary MTHW circulation pumps operate at full speed (i.e. 50Hz).
   - If any 4Nr plate heat exchanger PICV's close, 4Nr primary circulation pumps reduce in speed to 40Hz, and decrease in similar manner
   - Using PICV's to monitor differential pressure deemed problematic and caused errors on the system.
   - Differential pressure control of the system is no longer utilised.
   - Primary MTHW volume flow meters (i.e. on both A and B side circuits) no longer form part of the system control strategy, and are utilised for visual reference only.
   - Volume flow meters require use of a conductive gel, which will require refilling albeit meters provide no purpose with regards to system operation.

10. "***Edina Service Intervals***

    If for any reason the CHP's are required to be switched off, Oil changes/General Maintenance, 32,000 or 64,000 hours service regimes etc, then no action is required. When the CHPs are isolated, the two port valve closes and stops water flowing so the Boilers kick *in when they are required due to the set points trying to achieve the CHP Common Set Point which if all 3 x CHPs are isolated then this leg becomes isolated and cools down."*

- There is no action deemed required when CHP units are switched off.
- Once CHP's are isolated, the associated 2-port motorised control valves close and prevent water flowing from CHP's to/from A and B side plant room headers.
- Boilers are enabled if CHP's are isolated, as the common CHP MTHW return circuit would cool down.

11. *"**CHP Override***

We do have a function to override the CHP, which basically is only to be used if the CHPs are isolated or have broken down. This button is a last resort function, which turns on 3 x Boilers and runs 24/7."

- Control override provided to enable 3Nr boilers in the event CHP's being inoperative, with boilers set to run 24/7.

12. *"**Problem Solving***

Step 1 – Check Alarm History and see which element is low on Temperature, ie, Primary or secondary. If it is AHU's, check the AHU trends to see if this is a persistent problem or has only occurred recently, AHU's are more likely to be doors being left open or external air temps affecting FA inlet. DWS is only affected during peak times, so should be easy to pin point on trends.

Step 2 – Check the CHP Flow and Return Temperatures on the BMS Graphic. The ideal range should be 105DEG Flow to about 74DEG Return on the common sensors. There is a mixing valve after the Common Return sensor so the mixed return sensor does generally show 2DEG less. If the temperature on the Common F&R is low, it would mean that the CHP's have been limited to a lower percentage. If the Mixed Return sensor is above 74DEG, the 3 port will modulate allowing more cooler water flow to the engine but if this rises above 75DEG, when the Boilers are on Hand, the CHP's will most likely back off to 80%/60% as per their safety parameters.

Step 3 – Physically check the Front End screens on each of the CHP's, as these are independent from the BMS Front End. The BMS Front End is only from a MODBUS so does not cover all the functions of the CHP's. These will show alarms that the BMS cannot sense *and as Edina can operates these via server, they can change set points whenever they see a potential fault occurring. If in doubt phone Edina as G59 faults are common.*

Step 4 – Load up the Trends for all the Primary PHE's. This further proves if the PHE's are meeting temperatures, and at what time they are failing. All PHE's set points have been increased to 82DEG Flow, so they are within a better operating range to keep temperatures on the secondary side.

One of the above steps should assist with pin pointing what is at fault, Ideally the trends should be printed off weekly showing the data meeting criteria and when it failed. Example if Edina are in completing Engine overhaul, then I would expect the Temperatures to be higher as the Boilers will have been put into override mode. If there was suddenly a loss of a CHP or more, then I would expect the trend to curve a lot more, or persistently decreasing, as the Boilers would only kick in every so often when the CHP's struggled to cope. These service visits or faults, can be written by hand on the charts so it is logged what affected the system and is required to monitor PME charts etc.

Note:- I am still making changes to the MTHW operation, so this narrative is only a brief description."

- Domestic hot water service temperatures only affected at peak times.
- Ideal primary MTHW CHP common circuit temperatures are 105°C flow, and 74°C return.
- If primary MTHW CHP common return circuit temperature rises above 75°C, when boilers are on hand, CHP's will reduce output to 80% or 60% in accordance with their safety parameters.
- BMS front end does not provide all functions associated with CHP units, including alarms that will not be shown on the BMS front end.
- CHP unit manufacturer is able to change operational set points.
- All plate heat exchanger temperatures have been increased to 82°C, which is deemed better at keeping temperatures on the secondary side.
- If CHP's undergoing maintenance, it would be expected that temperature would be higher as boilers would be put into override mode.
- If there was a sudden loss of CHP unit(s), the trend (assume to mean temperatures) would curve more or persistently decrease, as boilers would only operate infrequently when CHP's are not meeting demand.
- Service visits, or faults, should be recorded to identify fault and is also required to monitor energy performance.
- Changes are still being made to the operation of the MTHW system.

In terms of the revised system function, the key points identified from the User Manual document, and from our subsequent observations, have been considered in conjunction with the presumed original design intent. A summary of findings is provided below, which essentially note our opinion in terms of the revised/current system control strategy.

Whilst this section of the report gives an overview of the apparent present control methodology, it is not intended to provide an analysis of potential inconsistencies, or problems, associated with same.

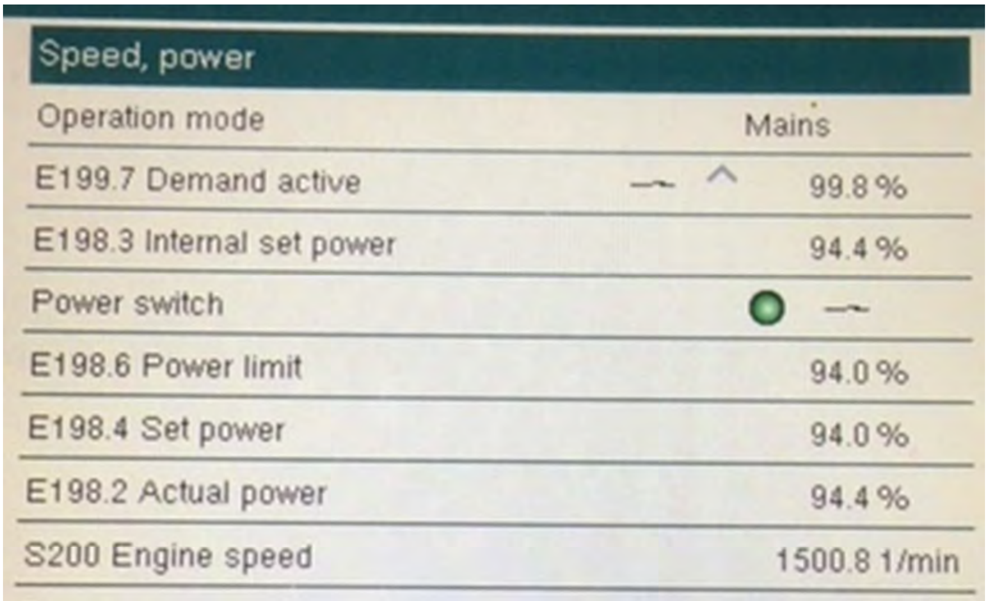
The operation of CHP units as lead heat generating source appears to have always formed part of the original design strategy, and we note from the User Manual that this remains the case.

The User Manual notes that achieving the initially intended heat generator sequence control by variation of primary MTHW circuit volume flow rates, and monitoring of boiler common return temperatures, was considered to be problematic and caused faults within the system. In view of this, it was apparently deemed necessary to implement changes to the control system. As a consequence of the subsequent modifications, the volume flow meters and pressure differential facilities were effectively rendered redundant as they would no longer provided any meaningful control function.

The latest strategy, as defined within the User Manual, states that the heat generators are to be controlled to the dictates of the primary MTHW return temperature to the CHP units. In accordance with this, the CHP units and boilers are now enabled as necessary to control/maintain this particular return temperature.

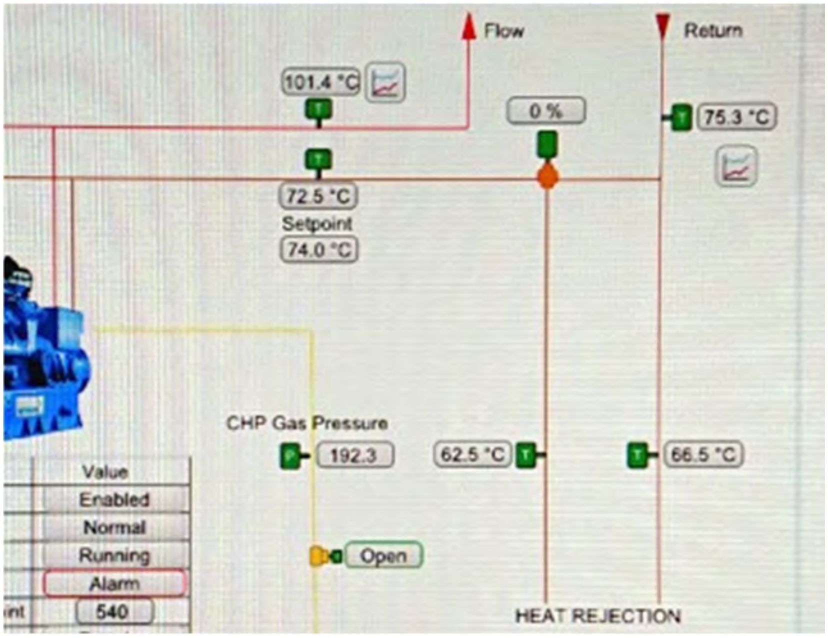
Whilst the volume flow meters can still be utilised as a visual feature, however, the associated conductive gel will still need to be replenished in order to maintain their operation.

As described within the User Manual, the revised strategy was intended to ensure that CHP units were able to operate at 100% efficiency. Therefore, this implies the original control strategy was unable to ensure this level of performance, and that deviation from original intent was in all probability implemented to enhance CHP output/running hours. However, the control panels mounted on the fascia's of each CHP unit (as indicated below) appear to indicate otherwise.



The User Manual states that the CHP heat rejection valve set point was changed to 74°C in December 2017. This heat rejection facility should still operate in a similar manner to that originally intended, by opening the 3-port motorised valve and enabling circulation to roof mounted heat rejection emitters whenever the primary MTHW CHP common return water reached/exceeded set point temperature. However, we consider that the actual operation of the heat rejection cycle has changed by the implementation of subsequent control modifications (i.e. revised set point temperature), given that heat rejection to atmosphere would now appear to be prioritised over the originally intended automatic de-rating of CHP units. As such, this appears to be a significant deviation from the initial system design philosophy, and is not clearly clarified within the User Manual.

Below is an enlarged section of the CHP heat rejection circuit screenshot, as included within the User Manual.



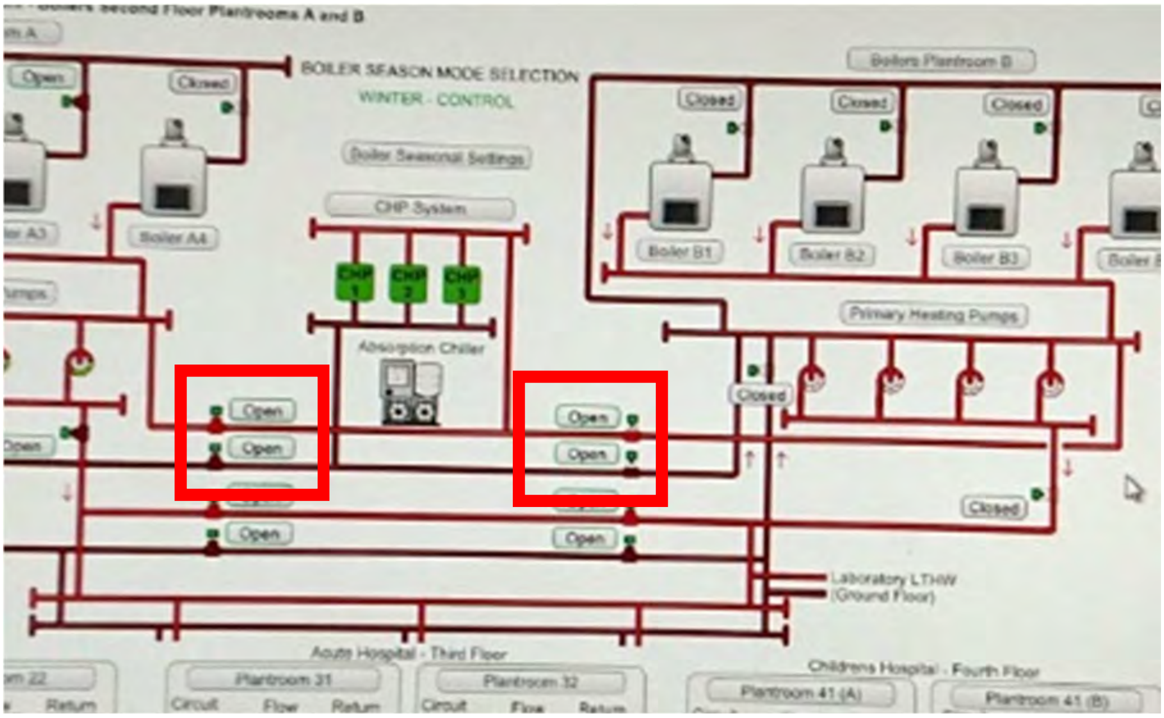
Analysis of the information contained within this screenshot indicates that a 0% heat rejection valve position signifies that the 3-port valve is open, thereby allowing circulation to the heat rejection emitters and heat dissipation to atmosphere. This corresponds correctly in terms of the revised 74°C heat rejection valve set point stated within the User Manual, and is in accordance with record documentation relating to initial valve operation, as noted below.

The Dry Air Cooler maximum design flow is (9.6 l/s) the CHP System design flow is (28.8 l/s). The maximum flow to the Dry Air Coolers is (33%) the flow of a single CHP.

- Valve 100% (10Volts) = Full flow to CHP
- Valve 0% (5 Volts) = 66% flow to CHP/33% flow to Dry Air Cooler

The CHP system was originally designed to deliver MTHW at 105°C, when receiving a return temperature of 75°C. As indicated within the enlarged screenshot above, the return circuit temperature post heat rejection valve is 72.5°C, with the common flow temperature from CHP units being 101.4°C, illustrating a variance from the original design. Furthermore, the User Manual also defines "*the ideal*" temperature range of 105°C flow, and 74°C return, and it is evident from the screenshot that this is not occurring at all times.

The CHP system was originally intended to divert heat load generation to either 'A' or 'B' plant room at any one point, depending on selected lead plant room, via automatic control of 2-port motorised valves. As illustrated below, from an enlarged section of a screenshot within the User Manual, the revised strategy appears to permit flow circulation from the CHP system to both plant rooms at the same time (i.e. via the 'open' valves highlighted in RED).



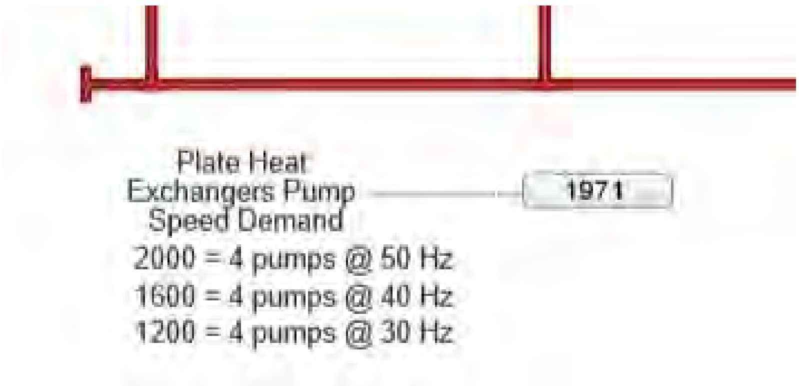
Other control modifications that have been implemented included the addition of a summer/winter mode selection, allowing differing MTHW operational temperature set point parameters to be applied at certain times of the year. The User Manual states that system operation under dictates of the new winter set point temperatures had not been fully tested, nor does it clarify the basis for the establishment of programmed set points.

These particular set points effectively enable each individual boiler based on differing primary MTHW return temperatures, as defined within the User Manual. The switching from summer/winter mode would appear to be an automatic process, with the winter operation set to occur between November and March. However, there would also appear to be a requirement to manually adjust set points in the event of a "cold snap" in summer. According to the User Manual, the supplementary summer/winter function was deemed to be simpler and user friendly.

Whilst the User Manual describes the revised method for enabling boilers, it does not clarify if the boilers are still to operate for a minimum 30 minute period, as per the original intent.

In terms of primary MTHW circulation pump control, the originally intended differential pressure method is no longer utilised as it was deemed problematic and caused too many errors within the system, as stated within the User Manual. Whilst primary circulation pumps were still intended to vary volume flow rate based on heat load demand, this was now intended to be achieved by speed modulation only, with the continued operation of all four pumps within either plant room.

The variation of speed from the 4Nr operational pumps was to be controlled based on the number of remote PICV's in the open, or closed, position. The User Manual describes this strategy based on 20Nr heat exchangers being installed, with all primary pumps reducing speed simultaneously in three fixed stages, as and when any 4Nr associated heat exchanger PICV's close. This proposed methodology of utilising 4Nr pumps in a fixed staged sequence is demonstrated within the image shown below.



As shown within this image, there would appear to be the requirement for all 4Nr primary pumps to operate at almost full speed, therefore delivering approximately 170l/s flow rate within the primary distribution circuit.

The following screenshots were taken during our inspection works, at times indicated above each.

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(21.03.18 @ 12:01pm)

Location	Plantroom	Circuit	Flow	Return
Acute Hospital - Second Floor	Plantroom 21	LTHW	74.9 °C	60.0 °C
		HWS		56.9 °C
	Plantroom 22	LTHW	85.7 °C	67.2 °C
		HWS		62.3 °C
Acute Hospital - Third Floor	Plantroom 31	LTHW	76.7 °C	69.9 °C
		HWS 1-3		61.0 °C
		HWS 4-6		62.0 °C
		HWS 7-9		59.6 °C
	Plantroom 32	LTHW	76.0 °C	66.7 °C
		HWS		56.9 °C
	Plantroom 33	HWS		62.4 °C
Childrens Hospital - Fourth Floor	Plantroom 41 (A)	LTHW	75.9 °C	46.8 °C
		HWS		62.2 °C
	Plantroom 41 (B)	LTHW	75.5 °C	61.3 °C

(21.03.18 @ 12:37)

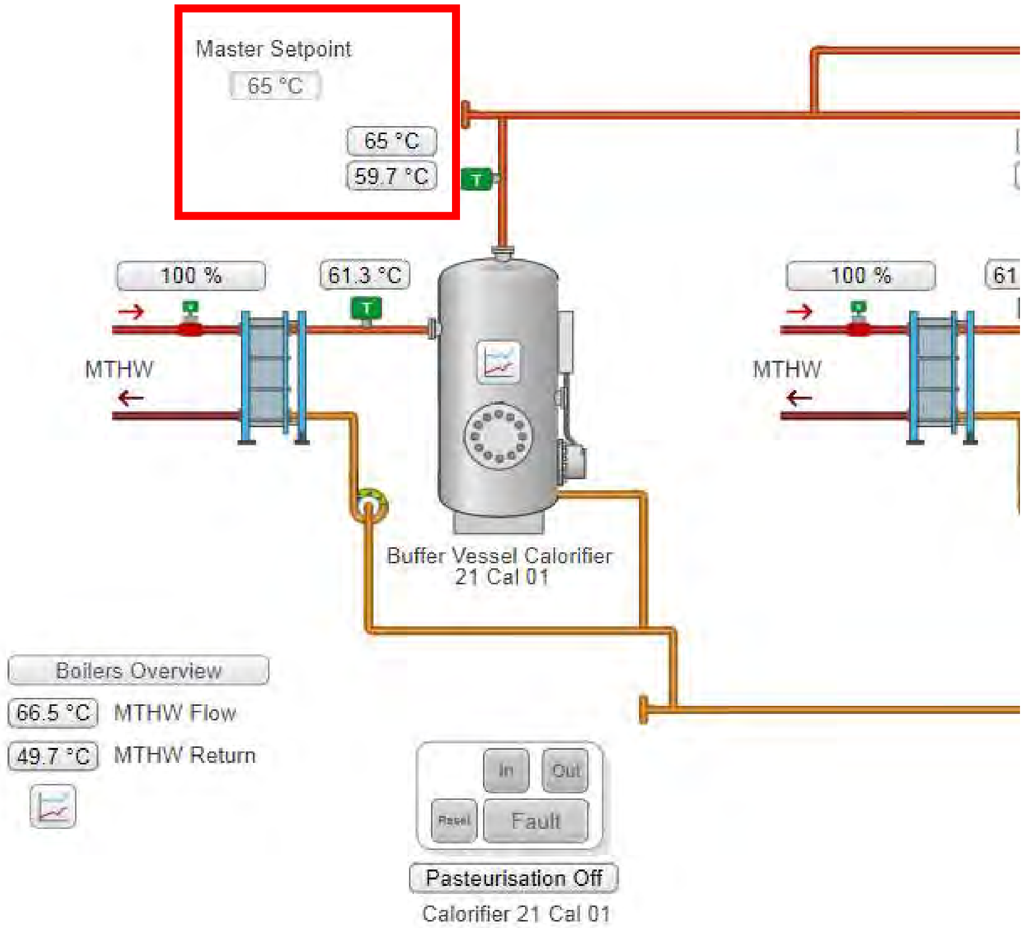
Location	Plantroom	Circuit	Flow	Return
Acute Hospital - Second Floor	Plantroom 21	LTHW	69.4 °C	54.2 °C
		HWS		57.6 °C
	Plantroom 22	LTHW	75.1 °C	61.7 °C
		HWS		61.1 °C
Acute Hospital - Third Floor	Plantroom 31	LTHW	76.7 °C	69.9 °C
		HWS 1-3		60.5 °C
		HWS 4-6		61.4 °C
		HWS 7-9		59.8 °C
	Plantroom 32	LTHW	66.5 °C	60.7 °C
		HWS		56.7 °C
	Plantroom 33	HWS		61.9 °C
Childrens Hospital - Fourth Floor	Plantroom 41 (A)	LTHW	71.8 °C	46.8 °C
		HWS		61.1 °C
	Plantroom 41 (B)	LTHW	71.1 °C	57.1 °C

(21.03.18 @ 12:49pm)

Location	Plantroom	Circuit	Flow	Return
Acute Hospital - Second Floor	Plantroom 21	LTHW	75.3 °C	54.4 °C
		HWS		57.4 °C
	Plantroom 22	LTHW	82.3 °C	59.3 °C
		HWS		61.0 °C
Acute Hospital - Third Floor	Plantroom 31	LTHW	76.7 °C	69.9 °C
		HWS 1-3		60.3 °C
		HWS 4-6		61.2 °C
		HWS 7-9		59.7 °C
	Plantroom 32	LTHW	71.3 °C	62.0 °C
		HWS		56.7 °C
	Plantroom 33	HWS		62.0 °C
Childrens Hospital - Fourth Floor	Plantroom 41 (A)	LTHW	76.8 °C	46.8 °C
		HWS		61.7 °C
	Plantroom 41 (B)	LTHW	75.2 °C	57.9 °C

As shown within these screenshots, secondary side LTHW temperatures are not in accordance with the original design temperatures of 75°C flow, and 60°C return. In addition to this, the User Manual states that all secondary side LTHW heating flow circuit set point temperatures were increased from 75°C to 82°C, and therefore, this was evidently not being achieved in the majority of remote plant rooms within the Adult & Children's Hospital at the time of our site visit.

It would also appear that the domestic hot water service set point temperature has been raised from the originally intended temperature of 60°C to a higher set point of 65°C, as indicated below. This control adjustment is not identified within the User Manual, and as with the case of LTHW heating circuit temperatures, the secondary domestic hot water system would also not appear to be capable of achieving this revised set point.



The apparent recommendation within the User Manual to rotate 'A' and 'B' plant rooms on a 3 month basis infers that the original automatic lead plant room switched control is no longer active/utilised. It also intimates that the revised strategy only allows one plant area to operate at any time, irrespective of heat load requirements.

This revised system strategy is apparent from the open position of 2-port motorised valves located on the 'cross-link' interconnecting circuit between plant rooms, as illustrated in Red on the screenshot shown on the following page (taken during site investigation works), particularly as there are 3Nr boilers operational (i.e. load > 15MW).

In addition to the above, and as illustrated in Blue on the following screenshot, it appears that the controlled operation of other 2-port motorised valves has been changed from the originally intended method. In this particular instance, with plant room 'A' acting as the lead, the circuits to plant room 'B' were initially intended to be closed, circuits to CHP units from the 'B' side plant room would have been closed, and the boiler isolation valves within plant room 'B' would also have been in the closed position.

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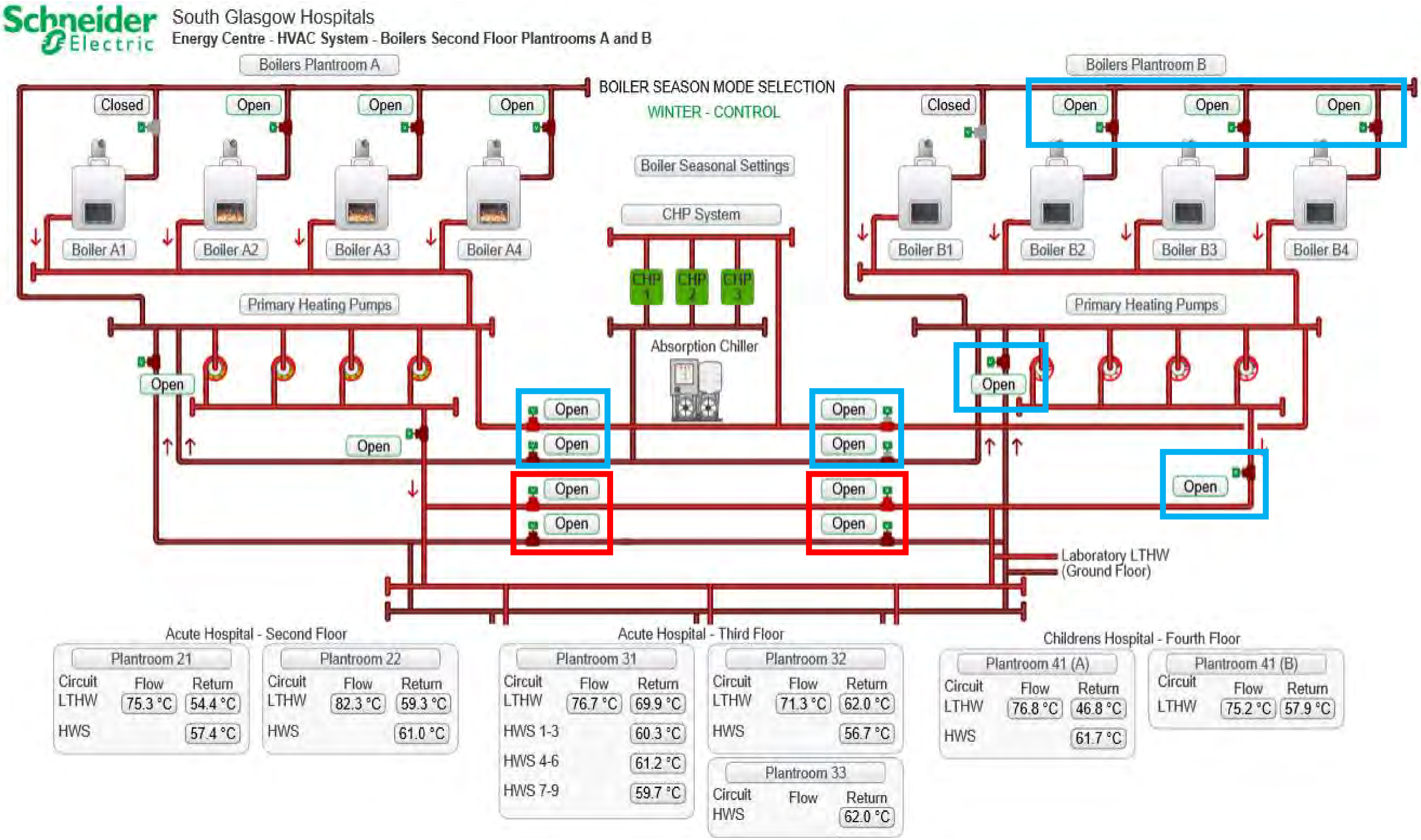

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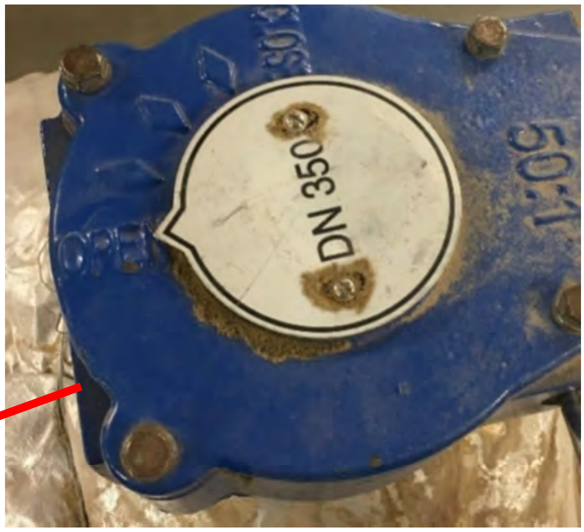
Furthermore, during our site investigation works we noted that the 'normally closed' isolation valves located on the primary MTHW heating circuit headers within the Adult & Children's Hospital were in the open position. Photographs taken during our site inspection works are shown below to demonstrate this.



SECTION 4 – Analysis of System Operational Strategies

4.01 Boiler Control

As detailed within the presumed operation section of this report, boiler enabling was originally intended to be communicated by either an increase in primary circulation volume flow rate (due to differential pressure), or via one of the numerous primary MTHW return circuit temperature sensors located within the Adult & Children's Hospital. We assume the principal control method was intended to be based on primary volume flow, with the return temperature sensing facilities provided as a supplementary feature to safeguard against inadvertent localised 'cold spots' occurring within remote sections of the distribution.

In respect of the original boiler enabling primary return circuit temperature signalling set points, these were shown as being 71°C, and 69°C, with the boiler(s) operating until the primary return temperature had risen above 75°C. This would suggest there to be discrepancy in terms of the boiler(s) deactivation set point temperature, given that the Laboratory Building primary return circuit temperature (operating at 85°C) would inevitably increase the primary return circuit temperature from the Adult & Children's Hospital (operating at 75°C) above the set point of 75°C defined. Furthermore, the CHP units were programmed to automatically de-rate in the event of incoming water temperature being above 75°C, which would again suggest the likelihood of system instability.

To augment potential system performance complications associated with the irregularities noted above, the boilers were also programmed to operate for a minimum period of 30 minutes, with a further 10 minute heat dissipation cycle. Therefore, it would be reasonable to assume that the stated original boiler deactivation temperature (i.e. 75°C) will effectively result in a higher primary return circuit temperature above 75°C.

As defined within the User Manual, boilers are now controlled based on the common CHP return circuit temperature, with differing return circuit set point enabling temperatures, determined by the supplementary programmed summer/winter settings. The boiler enabling common CHP return circuit set point temperatures for winter mode are stated within the User

Manual as 74.5°C, 74°C, and 73.5°C, with a common boiler deactivation set point temperature defined as 76.5°C.

In view of the winter mode set points, and revised heat rejection valve set point temperature (i.e. 74°C), it would appear that subsequent control modifications were consciously programmed to enable 2Nr 5MW boilers to increase primary MTHW distribution circuit temperatures, whilst simultaneously allowing heat being generated by the boilers to dissipate to atmosphere via the CHP heat rejection emitters. This does not appear to be an effective or energy efficient method of controlling the system.

Given the close tolerances associated with the winter mode boiler enabling temperature set points, and the inevitable undesirable occurrence of excessive reduction in return water temperature via the heat rejection cycle, we anticipate that all 3Nr boilers would be signalled to assist within a very short space of time (i.e. minutes). An example of this problem was witnessed during our site investigation works, as within a period of 2 minutes (i.e. 12:19pm to 12:21pm), the control system signalled the requirement for 3Nr boilers, prior to the first boiler even completing ignition cycle (i.e. before generating any heat into the system). This enabling control would appear to indicate a significant deviation from the original intent of operating 1Nr boiler for a 30 minute period before permitting the use of further boilers.

As the boilers are now programmed to operate until the common CHP return water temperature rises above 76.5°C, and undesirable rejection of heat is occurring from a temperature of 74°C, this would appear to be a fundamental oversight in terms of control strategy. Furthermore, if the originally programmed 30 minute minimum boiler run time, and 10 minute heat dissipation cycle, have been retained during control modifications, this will probably exacerbate system control instabilities, increasing level of heat rejection, extend the duration of heat rejection, and potentially also cause automatic de-rating of CHP plant.

The supplementary user functions created to facilitate set point adjustment for summer/winter periods were deemed to be simpler, and more user friendly. However, we anticipate that the original system operational philosophy would not have necessitated a summer/winter mode adjustment, and in our experience, affording more control set point adjustments than are necessary would only tend to complicate system management and increase the risks associated with potential manual user errors occurring.

As implied by statements within the User Manual, it would appear that the original intention of automatic operation of 'A' and/or 'B' side plant areas does not appear to be incorporated within the revised system control strategy. There would now appear to be the recommendation to manually rotate 'A' or 'B' side plant rooms on a 3 monthly basis, which thereby suggests that only one of the plant rooms is now intended to be operational at any time. This seems to be a significant deviation from that of the original design intent, ignoring the potential requirement for both plant areas to operate separately, in a simultaneous manner, during periods of high heat load demand. This would also imply that either plant room is able to satisfy the entire Adult & Children's Hospital, and Laboratory Building, heat demand.

Based on the estimated peak heat load prediction (i.e. 27MW), as detailed within the resilience section of this report, we anticipate there could potentially be heat generation inadequacies by operating the system in this way during periods of high demand.

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4.02 CHP System

Utilising the CHP system to provide a base heat load to the Hospital without the installation of a buffer vessel would seem unusual, unless an accurate base heat load assessment was undertaken during the detailed design stage to ensure that the combined CHP system thermal output would be less than the minimum requirement for the proposed facilities. Without undertaking this form of detailed study, the CHP system would be at risk of not achieving the desired operational running hours, and/or discarding surplus heat energy to atmosphere.

Whilst there does not appear to be record documentation contained on Zutec relating to any base heat load assessment, we anticipate that this process was in all probability undertaken. We also presume that the combined CHP thermal output proposed/installed was deemed to be suitable by the system designer. The installation of an absorption chiller system would further suggest that a detailed heat load assessment was likely carried out, as this would be necessary to ascertain the probable surplus heat generation during summer months, and to ensure this could be utilised to enhance overall system efficiency.

The design intent of the MTHW distribution was to operate on the basis of a 105°C flow temperature, with a 75°C return temperature, this being identical to the initially intended CHP operational temperatures. CHP units were initially monitored against a primary MTHW return circuit set point temperature of 74°C, which enabled their automatic de-rating of output in the event that return circuit temperature exceeded 75°C

In view of inconsistencies previously noted, in terms of primary MTHW distribution design temperatures, we anticipate these irregularities potentially caused an increase in water temperature returning to CHP units above the maximum intended limit of 75°C, thereby inadvertently causing the CHP units to automatically de-rate until return temperature has fallen below 74°C. Unintentional de-rating of CHP output probably occurred on a regular ongoing basis, and likely raised concern regarding any associated lower operational running hours of the units.

In view of the original programmed minimum boiler operating period, residual heat dissipation cycle, and planned shutdown of boilers based on primary MTHW return temperature reaching 75°C, these control aspects probably contributed to any temperature instabilities/overshoot, thereby potentially adversely influencing the performance of CHP system.

Lowering of heat rejection valve set point temperature to 74°C was probably instigated in an endeavour to mitigate inadvertent decrease in CHP performance, by effectively prioritising heat rejection to atmosphere over the presumed original primary method of reducing thermal output of the heat generators. This would not appear to be a very efficient method of controlling any heat led CHP system.

The screenshot provided on the following page was taken on 21st March 2018, at 12:52pm. Specific key elements from this screenshot have been enlarged for clarity, and colour coded Green, Red, and Blue to facilitate reference with text.

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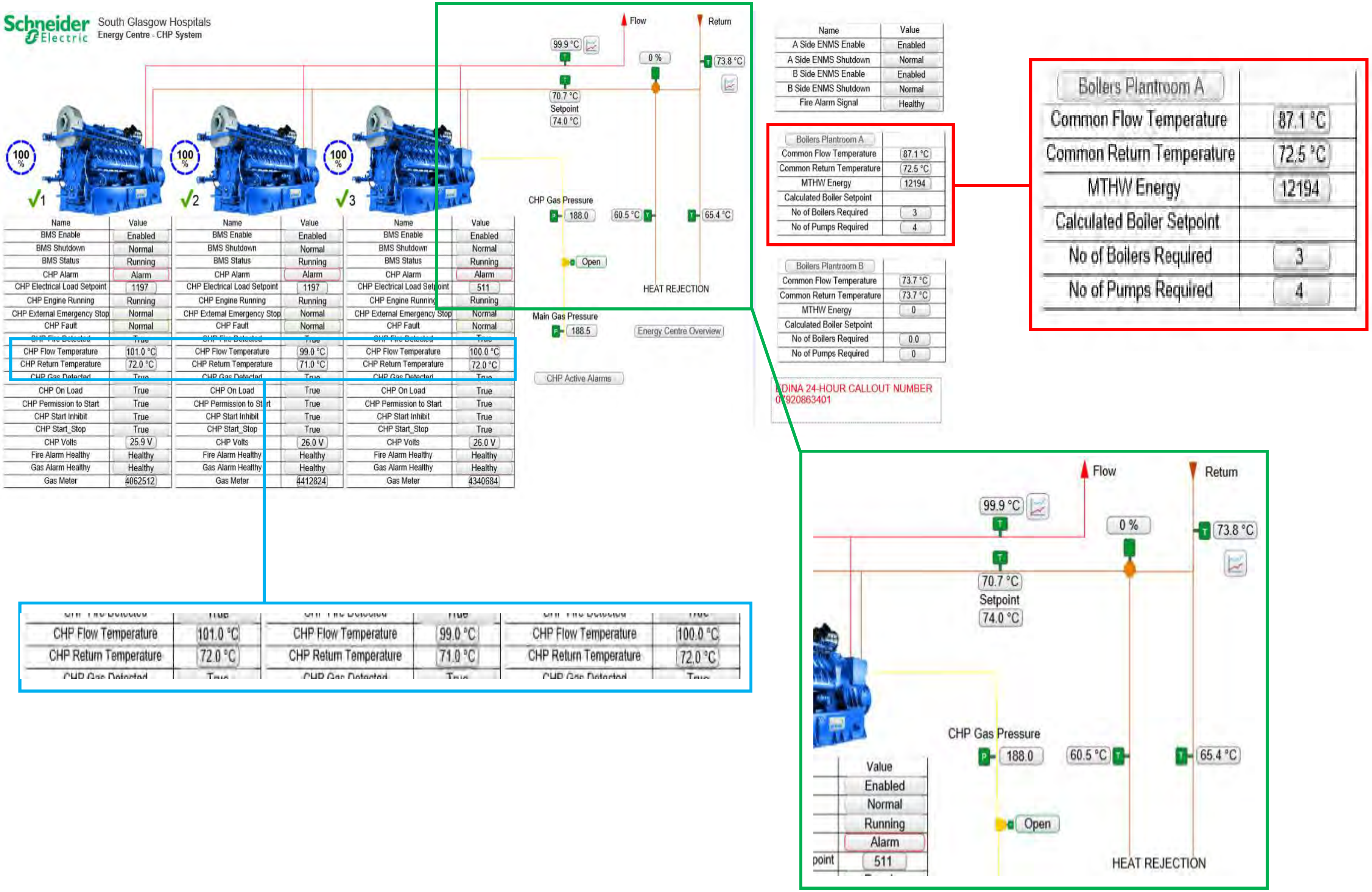

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As shown within the enlarged Green image of the CHP diagrammatic screenshot, the heat rejection valve is shown in the open position (0%), the primary MTHW return circuit temperature is 73.8°C, and the temperature of common return circuit to CHP units is 70.7°C. Based on these parameters, and combined flow rate from CHP pumps, the extent of heat rejection at this particular point in time was calculated to be in the region of 376kW.

This estimated heat rejection load could be verified by utilising the heat rejection circuit temperature differential, and associated rejection circuit flow rate. However, the heat rejection circuit does not appear to be pumped, and the temperature sensor on the flow circuit to rejection emitters was deemed to be inaccurate, given that it differs considerably from the primary MTHW return temperature shown.

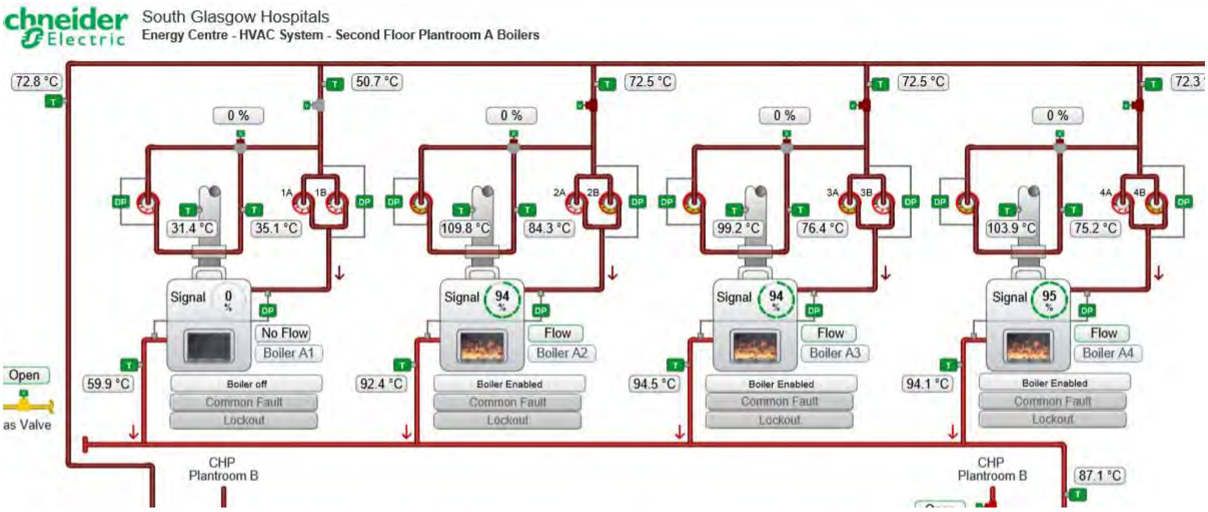
To verify the probable inaccuracy in heat rejection flow circuit temperature, and confirm the above estimated rejection load, we determined the proportions of flow rate circulating through heat rejection emitters, and that passing directly through the heat rejection valve back to CHP units. These flow rates were then utilised in conjunction with the primary MTHW return temperature of 73.8°C (i.e. disregarding rejection flow circuit temperature stated on BMS), and the return circuit temperature from heat rejection emitters (60.5°C). Based on these parameters, the extent of heat rejection was found to be approximately 375kW.

In view of the above, it would appear that the temperature sensor located on the flow circuit to heat rejection emitters is inaccurate, and therefore, the level of heat rejection at any point in time is likely to have been significantly higher than would be perceived by simply reviewing the temperature differential across the rejection circuit indicated on the BMS screen.

As shown within the screenshot, the primary MTHW return temperature of 73.8°C was below the revised heat rejection valve set point of 74°C, and therefore heat rejection should not have been occurring. In this instance, heat rejection unnecessarily lowered the common CHP return temperature to 70.7°C (i.e. 3.3°C below desired revised set point), plus in all probability enabled the operation of a third boiler under the dictates of the new winter mode set points

(73.5°C). As the return temperature received by the CHP units was lower than intended, the flow temperature from the units was consequently lowered accordingly.

Furthermore, the table highlighted in Red within the CHP screenshot below indicates that 3Nr 'A' side plant room boilers were operation, whilst there was presumably 375kW being rejected to atmosphere. The screenshot below further serves to illustrate the actual boiler operation at this particular time, as both screenshots were taken at 12:52pm on 21st March 2018.



In addition to the foregoing, the revised heat rejection valve set point temperature, and winter control strategy maintaining boiler operation until a common CHP return temperature of 76.5°C is achieved, would suggest there to in all probability be constant heat rejection and continuous unnecessary cycling of boilers.

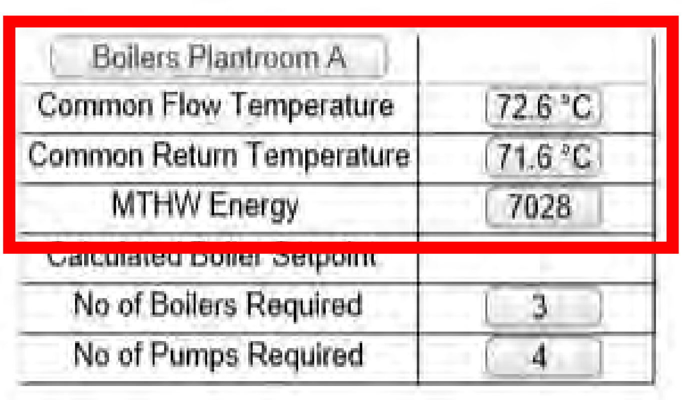
The temperatures highlighted in Blue within the CHP screenshot confirm that the CHP units were only operating at 94.4% output at this particular time, and therefore, below the 100% efficiency stated within the User Manual. This would demonstrate that control modifications were apparently unable to achieve the 100% targeted.

4.03 Primary Circulation

We believe that the design of the primary MTHW circulation system was originally based on a constant temperature principle, with heat load generation controlled by the variation of primary circuit volume flow rate, as necessary to maintain a constant primary MTHW flow temperature of 105°C, and return temperature of 75°C. We anticipate that the revised control strategy endeavoured to replicate the volume control system, whilst disregarding boiler enabling, and the necessary automatic pump switching and speed modulation involved appears to ineffective.

There would appear to be inadequate regulation of primary pump speeds, resulting in the primary MTHW distribution operating on a constant volume flow rate basis, regardless of the system heat demands. This seems to have effectively resulted in the primary distribution system operating on a variable temperature basis, and due to the absence of varying volume flow rate, it would appear to have created a significant fluctuation in flow temperature, increasing/decreasing to suit the apparent system load demand.

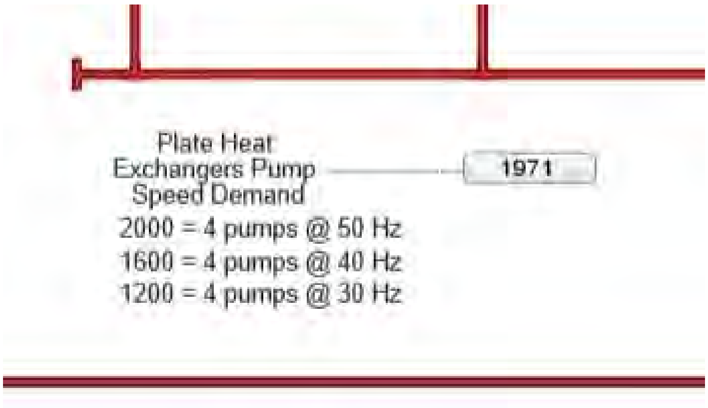
The following image was taken from the CHP Page on the BMS during our site investigation works, with plant room 'A' operational. As noted above, we presume the intention was to maintain a constant temperature differential within the primary distribution of 30 deg C, as per the original design intent. However, it would appear that the system was unable to maintain this differential given the temperatures highlighted.



Boilers Plantroom A	
Common Flow Temperature	72.6 °C
Common Return Temperature	71.6 °C
MTHW Energy	7028
Calculated Boiler Setpoint	
No of Boilers Required	3
No of Pumps Required	4

These close flow and return temperature readings indicate the incidence of a fundamental problem with system control, or operation, as it would not appear viable to achieve the indicated level of MTHW Energy generation with temperatures tabulated.

As shown within the images below (which were also obtained during our site investigation works on 21st April 2018, at 12:28pm), there was a requirement for the 4Nr primary pumps to operate at full speed at this particular point in time, thereby providing a flow rate of 171l/s within the primary circulation as indicated from the Primary Flow Meter shown adjacent.



Endeavouring to utilise a variable volume flow rate within the primary distribution to maintain a constant temperature differential within the circuit, as originally intended, does not appear to have been occurring given that the flow rate indicated would equate to a heat load requirement within the system of approximately 21.5MW. This tends to indicate a potential discrepancy in terms of primary pump control as the revised strategy only enables the use of 3Nr boilers and 3Nr CHP units at any time (which was the case in the above instance), and therefore, the maximum load available to the system would have been in the region of 17.5MW (guesstimating the reduction in output from boilers and CHP units operating below 100% duty).

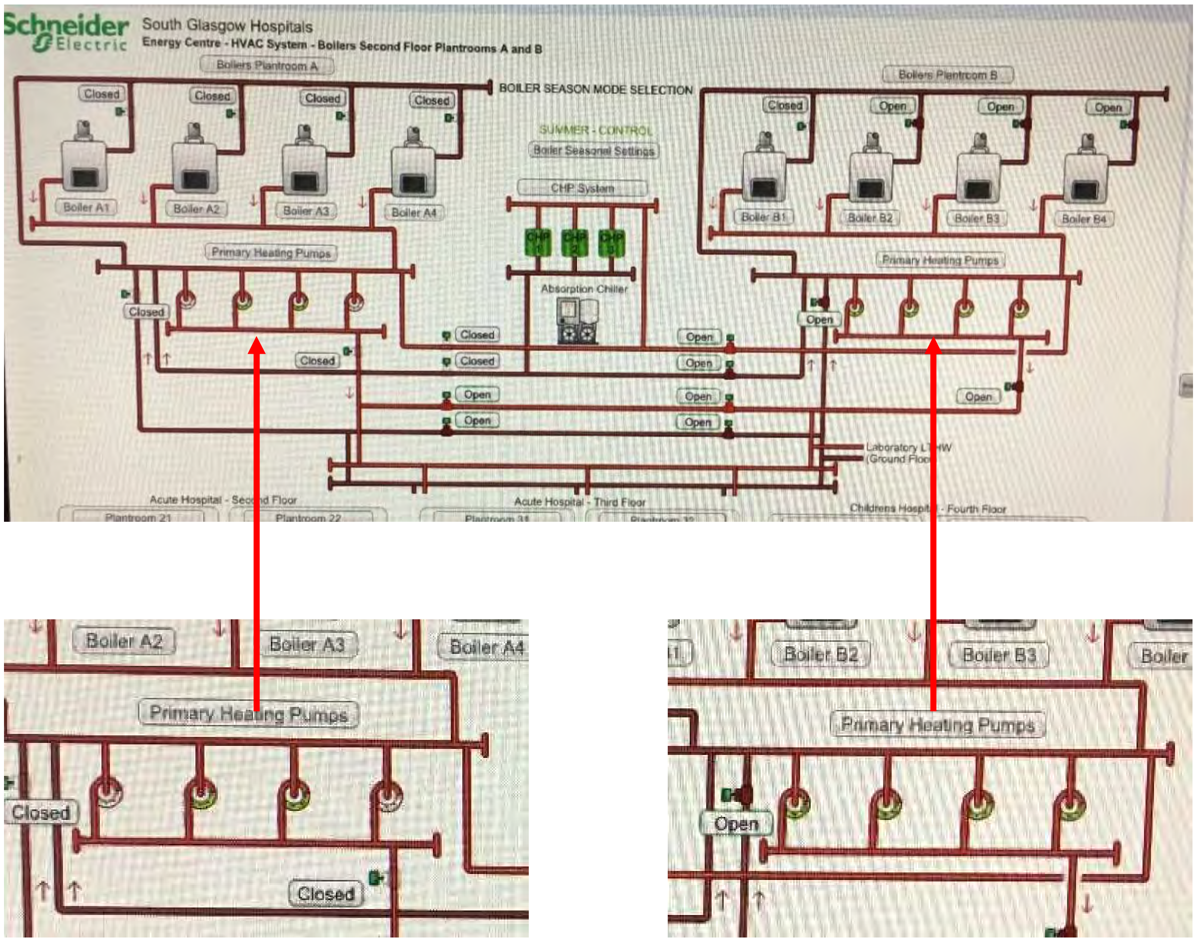
Assuming the intention was to maintain a constant temperature within the primary circuit, the corresponding flow rate based on the available heat generating capacity would be in the region of 139l/s. The consequence of delivering an unnecessarily higher volume flow rate than required to meet actual heat demand is that the circuit temperature differential would be reduced. It would also appear that as the system is now controlled via a CHP return temperature sensor with a set point of 74°C, the temperature variation is occurring predominately within the primary flow circuit.

As described within the User Manual, the revised primary pump control strategy was based on the installation of 20Nr heat exchangers, however, from our analysis there would appear to be 44Nr heat exchangers installed with a corresponding load requirement for 28Nr active at one time, disregarding any of the heat exchangers intended for resilience purposes. This inconsistency may influence the primary pump stepped speed variations, presumably determined as part of the system modifications.

Furthermore, the minimum volume flow rate achievable via the primary pumps appears to be based on 4Nr pumps operating at 30Hz. In the event that the system heat load requirement is below the corresponding minimum volume flow rate achievable by the primary circulators (i.e. during periods of low heat demand), it could result in the temperature differential decreasing below the intended 30 deg C, and thereby reducing flow circuit temperature accordingly.

A consequence of operating the primary MTHW circulation system with a lower flow temperature is that the originally intended constant temperature secondary system circulation from plate heat exchangers would also subsequently operate on lower flow temperature basis, which would again fluctuate similarly as it is influenced directly by the primary flow circuit. This is analysed in further detail within the following 'Operating Temperatures' sub-section of the report.

With regards to energy usage, it would appear that the probable inability to vary primary circuit volume flow rate as intended has resulted in all 4Nr pumps operating at full duty, and on a constant basis. This is a variance in terms of initial intent, and seems to be significantly less efficient in comparison. Furthermore, the screenshots shown below illustrate the simultaneous operation of 6Nr pumps (during summer mode setting), which only augments concerns with regards to control inadequacies, and efficiencies, in terms of both energy and monetary perspectives.



Please note, from the primary pump record information contained on Zutec, it would appear each primary pump consumes 22kW at 50Hz, and therefore, the above would identify a continuous operational electrical load of 132kW.

Furthermore, and again as illustrated within the screenshot, it would appear the 2Nr primary pumps within ‘A’ plant room are pumping against a closed 2-port valve, which is concerning given that all 4Nr pumps are now deemed to be required to facilitate the revised system control function. It would also be noted that the simultaneous operation of all 4Nr pumps disregards the original intention of retaining a standby for contingency purposes, in the event of a pump failure, and thereby appears to undermine the original level of system resilience provision.

4.04 Operating Temperatures

As previously described, the system was designed with the intention of varying volume flow rate within the primary MTHW distribution circuit as necessary to suit heat load requirements within the Adult and Children's Hospital, and the Laboratory Building (i.e. to suit demand on the secondary side of heat exchangers). In order to achieve this variable volume strategy, record documentation indicates that the Adult and Children's Hospital primary MTHW circuit was designed to operate on a constant temperature basis of 105°C flow, and 75°C return, with the Laboratory Building primary MTHW circuit being designed to operate on a constant temperature basis of 105°C flow, and 85°C return. These primary distribution temperatures would afford a mean water temperature at each plate heat exchanger of 90°C and 95°C respectively, and therefore, the associated plate heat exchangers should have been designed and selected to suit these varying mean water temperatures.

The apparent design decision to operate the primary MTHW circuit serving the Laboratory plate heat exchangers on a differing basis of 105°C flow, and 85°C return, appears to be unusual as this would inevitably result in an increased mixed common primary return temperature above the 75°C indicated on record drawings. This would in all probability have resulted in system temperature control instability, particularly as the CHP operation was noted as being monitored against a set point temperature of 74°C (as detailed in foregoing CHP section).

From examination of record documents it would appear that the original strategy in terms of operational temperatures has been modified from that initially intended (i.e. fundamentally deviating from the design principle). System modifications have included an alteration to monitor and control the common MTHW primary circuit return temperature to the CHP units, apparently endeavouring to restrict this temperature to 74°C (i.e. new dump valve set point, and noted as "*ideal*" return temperature within User Manual). This alteration appears to have been deemed necessary to maintain performance of the CHP units, however, implementation of this modification does not seem to have taken any cognisance of the associated potential consequential effects.

System alterations essentially appear to cause variation in primary MTHW flow temperature, lowering it considerably below the original design intent of 105°C. An inevitable effect of this is that it presents the potential for secondary side heat output availability being reduced significantly below intended capacity, in view of the reduction in mean water temperature at heat exchangers.

The revised strategy appears to be reliant on any secondary side heat load requirement (i.e. LTHW / DHWS) being communicated by a decrease in the primary side MTHW return circuit temperature, which in turn would eventually signal a demand for additional heat load generation (i.e. to enable boilers). Given the probably quantity of system water content, and diverse functions of the various facilities being served via heat exchangers, there would seem to be the potential for a minor increase in heat load demand to be undetected, in view of the insignificant deviation a minor load would likely create in terms of difference in primary side MTHW return temperature being monitored remotely within the Energy Centre.

If a secondary side heat demand requirement was sufficient to create the necessary temperature differential within the common mixed primary MTHW return circuit, the time taken to effectively convey this via the primary distribution (i.e. be detected/acknowledged/processed by the controls system, acted upon by the boilers, and circuit temperature raised to the necessary level) would in all probability be prolonged. This may extend underperformance/inadequacy experienced by the associated facilities served within the Adult and Children's Hospital.

In particular, the domestic hot water services appear to have been originally designed on the basis of direct heating utilising MTHW/DHWS plate heat exchangers, as to afford rapid recovery of domestic hot water temperatures, and minimise risks associated with legionella. Given the lower than originally intended operational temperatures observed during our investigation works, and temperatures indicated within the User Manual, the revised control strategy would appear to have resulted in the primary distribution operating on a low temperature hot water basis, and unlikely to afford rapid heat recovery.

Due to the above, not only do we anticipate there to be a potential risk in relation to relatively low secondary side heat demands being undetected (i.e. from 1 or 2 plate heat exchangers), but the practical duration necessary to rectify the associated thermal inadequacies would appear to be likely prolonged due to the inability of the system, and associated plant, to react (effectively). If the foregoing is found to be transpiring, this would be of particular concern in relation to the domestic hot water services as the subsequent control modification would have potential to increase the risks associated with legionella growth within the system.

The screenshot shown on the following page would appear to further substantiate our theories.

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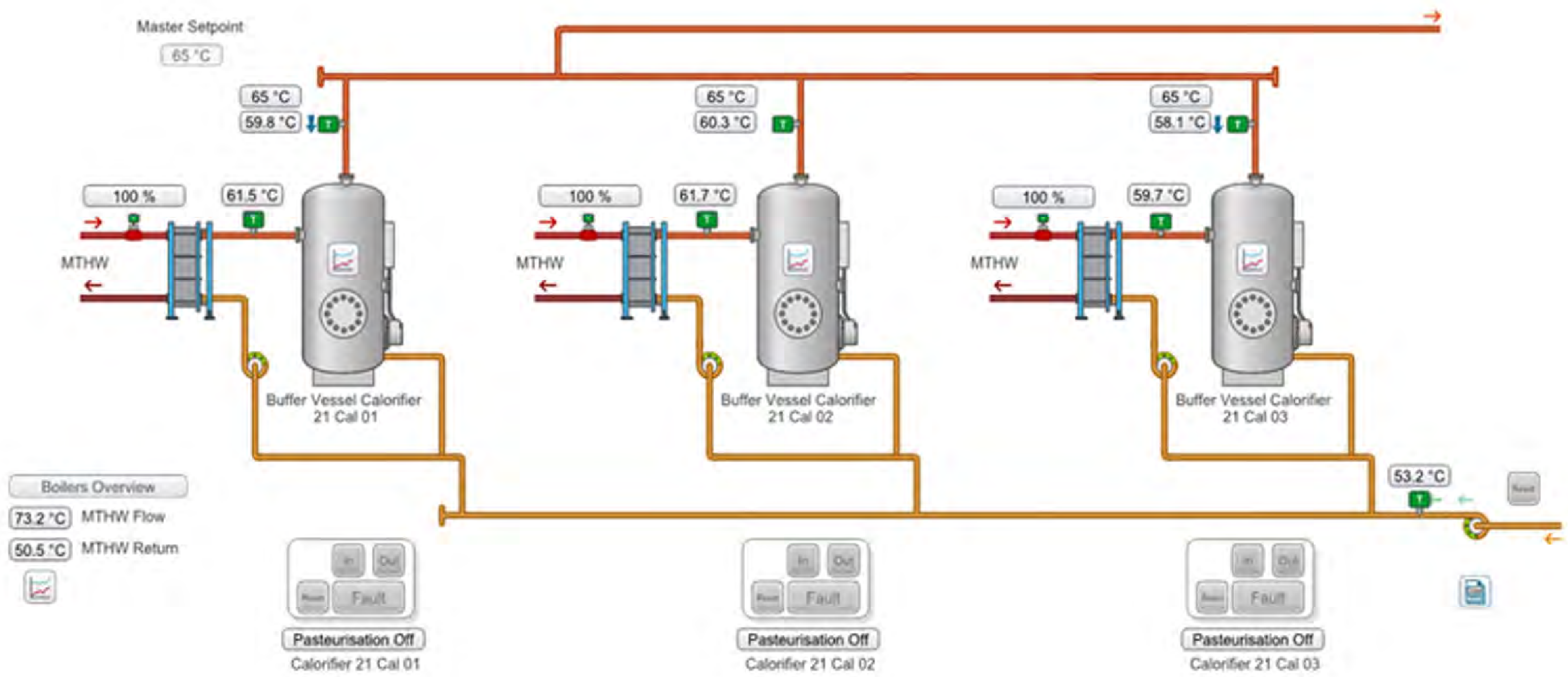

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As shown on the above screenshot, the primary 'MTHW' circuit temperatures at this particular point in time are 73.2°C flow, and 50.5°C return. These low MTHW operational temperatures would result in heat exchanger mean water temperature in the region of 62°C, significantly lower than the original design intention of 90°C. In view of this, we expect that the heat output available from plate heat exchangers serving the secondary side facilities would be reduced, which in this instance are the domestic hot water calorifiers within Plant Room 21.

Also as indicated within the previous screenshot, the domestic hot water 'Master Setpoint' of 65°C contradicts the 60°C set point temperature defined within record documentation. This would typically suggest that either problems were identified in achieving the original set point temperature initially, or that difficulties achieving the original set point temperature transpired following the subsequent control modifications. Moreover, whilst the revised system control would appear to be programmed in order to achieve a domestic hot water flow temperature of 65°C, the system is clearly unable to satisfy this requirement as all three buffer/calorifier outlet temperatures are shown to be approximately 5 Deg C below the desired set point.

Whist the adjustment to the domestic hot water service 'Master Setpoint' temperature does not appear to be effectively increasing outlet temperatures above the original set point, this modification in control is not identified within the User Manual. This would appear to be abnormal given that any increase in the flow temperature would increase the risks associated with inadvertent scalding.

We expect the probable inability to achieve desired set point temperature is due to subdued primary 'MTHW' temperatures with heat exchangers unable to transfer sufficient heat energy to the domestic hot water service. This inability appears to have resulted in lower than programmed/controlled domestic hot water flow temperatures, and the domestic hot water recovery period would also appear to be adversely effected, given the return/circulation temperature shown in the screenshot. Furthermore, as both the domestic hot water flow and return temperatures are below 60°C, it would be assumed that water within the buffer/calorifier is also below 60°C in this particular instance.

The screenshot provided below was taken on 26th April 2018, and serves to demonstrate that domestic hot water service temperature shortfalls are potentially occurring on a regular basis.

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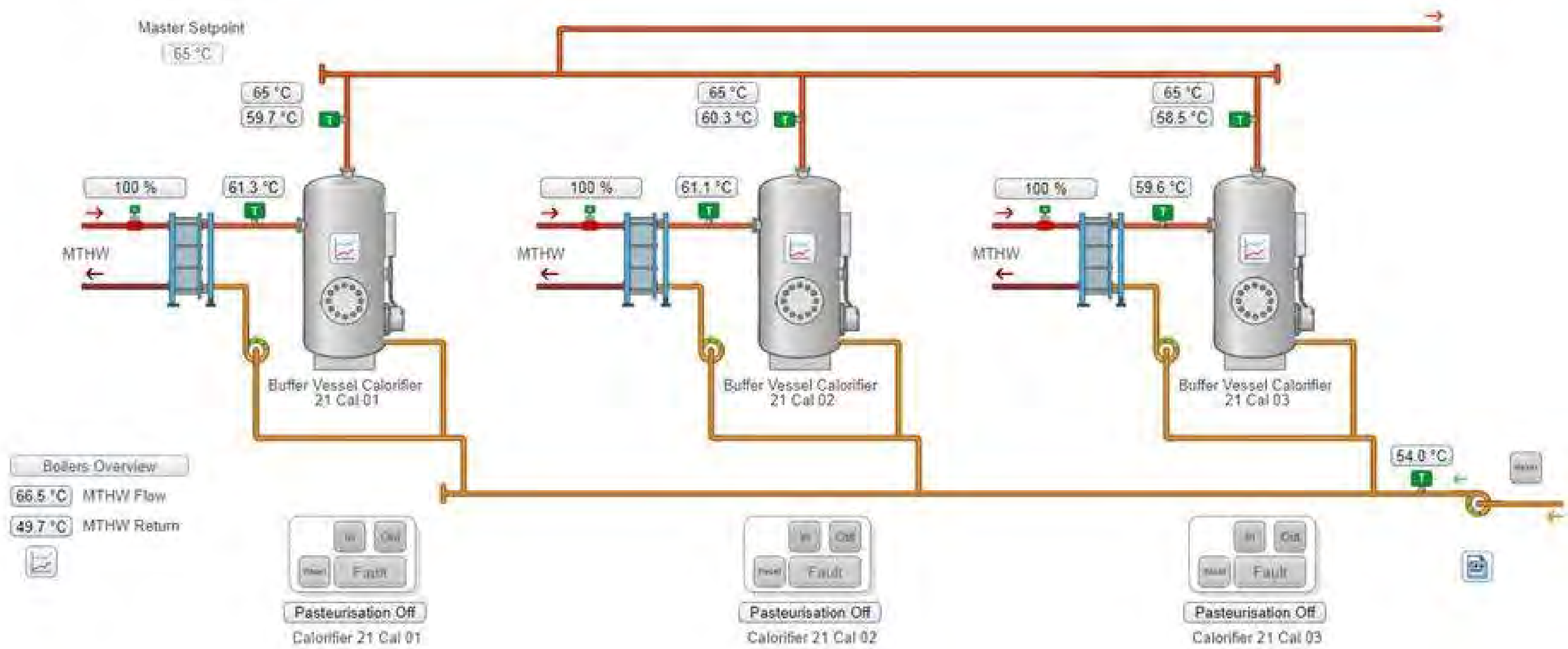

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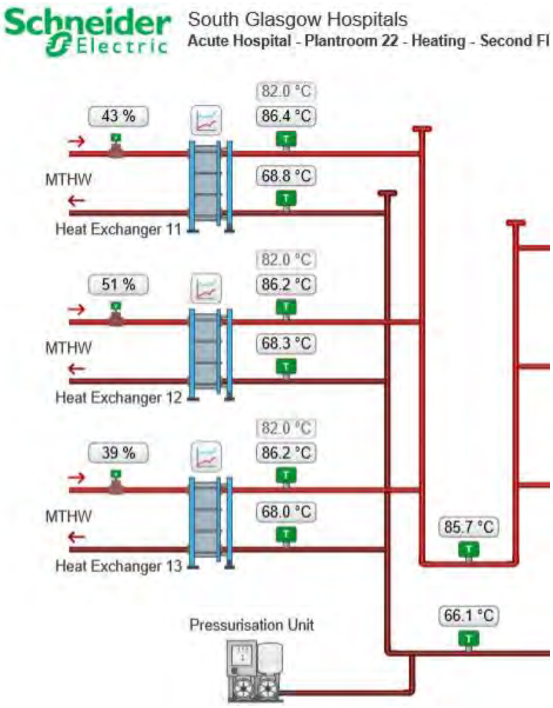
As illustrated above, the domestic hot water flow and return/circulation temperatures are similar to those indicating within the first screenshot, again below desired levels.

The foregoing descriptions identify that the current operation of the system is resulting in domestic hot water temperatures that are not in accordance with the Health and Safety Executive Guidelines, in respect of minimising the risks associated with legionella bacteria growth.

It should also be noted that screenshots only reveal probable temperature inadequacies within a particular plant room of the Hospital at two specific points in time, which could be during periods of low demand/draw-off. Therefore, temperatures could be lower during period of higher demand/draw-off, and be occurring in different plant rooms.

Whilst potential low secondary side water temperatures are of obvious concern, it should also be noted that the present control strategy appears to be incapable of managing desired set points during periods when the primary circulation temperatures are higher. The image shown below is from a screenshot taken during our investigation works at 12:03pm on 21st April 2018, serving to demonstrate the extent of this particular control instability.



As indicated, all three secondary side LTHW flow circuits considerably exceed programmed revised set point temperature of 82°C. We assume this scenario would also probably occur in relation to the MTHW/DHWS systems, which is obviously concerning given that the set point temperature on the domestic water services was increased to 65°C, and any relative overshoot (i.e. to that indicated above) would only further compound the risks associated with inadvertent user scalding.

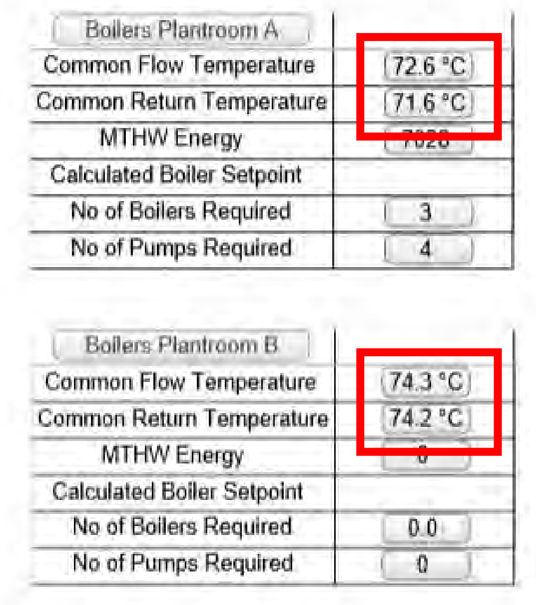
The change in LTHW secondary side set point temperature, from the originally intended 75°C to the revised of 82°C, is noted within the User Manual with associated rational for this adjustment being defined as to keep secondary temperatures within a better operating range. This set point adjustment does not appear to be having the desired effect since temperatures have been found to be significantly higher, and lower, than the revised set point(s).

Given the fluctuation in primary and secondary side temperatures, we also have reservations with regards to the domestic hot water pasteurisation facility. The temperature required to undertake this process does not appear to be afforded at all times, and therefore, this would suggest there to be another potential problem associated with control modifications carried out.

4.05 MTHW Heating Control Valves

It was found that heat load diversion from the CHP units to either ‘A’ or ‘B’ plant rooms does not appear to form part of the revised system control strategy, and given the positions of 2-port motorised valves, this would appear to potentially create a short-circuit within the distribution system. A short-circuit may lead to inadvertently increased return water temperatures to CHP units/rejection valve.

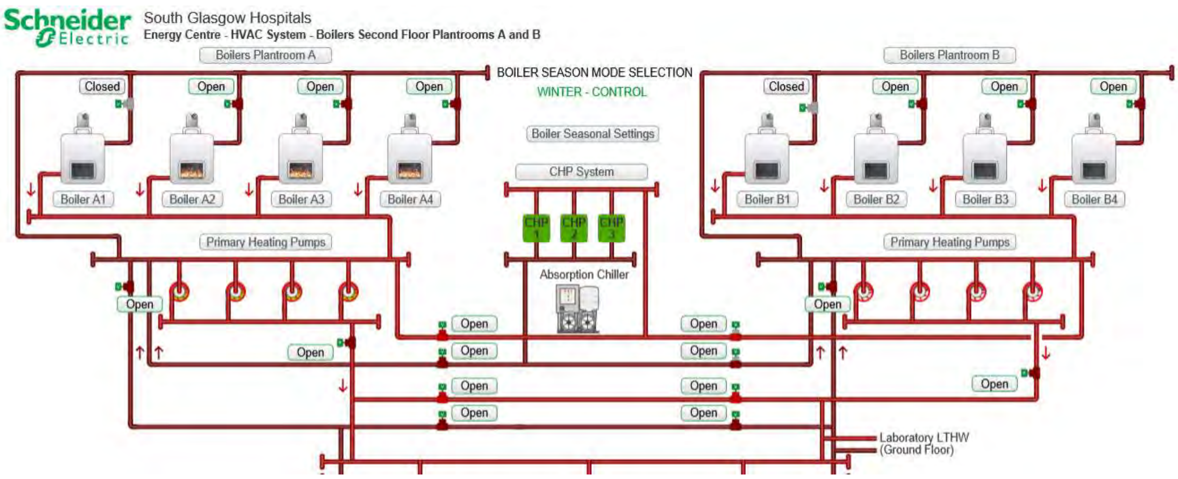
The screenshot shown below would also appear to indicate the incidence of a potential primary circulation short-circuit, given the temperatures as indicated.



Boilers Plantroom A	
Common Flow Temperature	72.6 °C
Common Return Temperature	71.6 °C
MTHW Energy	7028
Calculated Boiler Setpoint	
No of Boilers Required	3
No of Pumps Required	4

Boilers Plantroom B	
Common Flow Temperature	74.3 °C
Common Return Temperature	74.2 °C
MTHW Energy	0
Calculated Boiler Setpoint	
No of Boilers Required	0.0
No of Pumps Required	0

As illustrated, plant room ‘A’ was operational with 3Nr boilers firing, whilst ‘B’ side plant room was inoperative. However, the common flow and return circuit temperatures recorded within the inoperative boiler plant room were notably higher than those registered within the operational plant room. At this particular point in time, the majority of 2-port motorised valves within both plant areas were found to be in the open position, as shown below.



The revised control strategy intimates that only one plant room is intended to be operational at any particular time. If this is found to be the case, it would appear to completely disregard the presumed original design intention to facilitate the use of both plant rooms to satisfy higher heat loads (i.e. > 15MW). This could consequently result in insufficient simultaneous boiler heat generation to meet peak demands. Moreover, it would appear that the original automatic lead plant room changeover facility may now have been changed to a manual function, which would be more onerous for estates personnel, and likely increase the risk of human error (i.e. opposite of that defined within User Manual).

In addition, there would appear to be notable deviation in function of the other automatically controlled 2-port motorised MTHW primary diversion valves, relative to original strategy, which could potentially lead to system temperature instabilities.

As detailed within the original system operational intent section of this report, we anticipate the ‘normally closed’ isolation valves, located on MTHW primary headers within the Adult & Children’s Hospital basement, were only intended to be opened in the event of an emergency failure of either underground distribution circuit. As these valves were found to be open, this would again suggest there has been a fundamental deviation from the original design intent, which could lead to system temperature control instabilities.

SECTION 5 – Heat Generating Capabilities & Resilience

5.01 General

Whilst other system descriptions have been provided in earlier sections of this report, the following notes are intended to summarise the envisaged plant heat generating capacities and functional operation of the MTHW heating system, specifically in terms of relative resilience.

It should also be noted that as this section of the report is intended to be comparative in terms of the original system design, it does not take cognisance of any potential adverse influence subsequent system modifications may have caused. In view of this, we have endeavoured to identify any possibly undesirable reduction in perceived levels of resilience within the relevant earlier sections of the report (i.e. within system analysis sections).

5.02 Notes from Record Documentation

The Hospital site heating load was assessed to be 28MW, with heat generators installed within the Energy Centre intended to provide all space heating, supply air ventilation, and domestic hot water generation heat load requirements accordingly.

To afford resilience, heat generating equipment was subdivided into two plant areas, with each capable of supplying a minimum load of 14MW. ‘A’ side plant room contains 4Nr 5MW output boilers giving a total available capacity of 20MW. ‘B’ side plant room contains 3Nr 5MW output boilers giving a combined available capacity of 15MW output, with space provision for an additional boiler.

There are also 3Nr CHP units located elsewhere within the Energy Centre each capable of providing 1.2MW heat output, and therefore, giving a supplementary heat output capacity of 3.6MW. This CHP system heat generation can be routed to either ‘A’ or ‘B’ plant rooms, depending on the lead plant room selected, thereby increasing their heat generating capacities to 23.6MW and 18.6MW respectively.

In the event of a catastrophic failure within one of the boiler plant rooms, the remaining operational plant room would be capable of meeting 66% of the total heat load requirement. This was deemed adequate to allow the site to continue, albeit in conjunction with some emergency heat conservation measures implemented.

The primary MTHW heating circuit distribution is arranged in a ‘A’ side and ‘B’ side format, served from their respective boiler plant rooms, and routed separately from the Energy Centre to the Adult & Children’s Hospital. Primary MTHW pipework from ‘A’ and ‘B’ plant areas can also be hydraulically interconnected to facilitate the ability of maintaining distribution to both circuits from one boiler room in the event of failure.

When heat load demand is below 15MW, the heating requirement can be provided by either ‘A’ or ‘B’ plant rooms, with the non-lead plant room inoperative, and lead plant room supplying flow to both 'A' and 'B' side distribution circuits. When heat demand is higher than 15MW, both plant rooms would be operational and utilised to serve their own respective MTHW primary pipework circuit.

As-Fitted record drawings also indicate that there are two manually operated 'normally closed' isolation valves located on the main MTHW primary flow and return headers in the Basement area of the Adult & Children's Hospital.

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5.03 Analysis of Information

Whilst record drawings indicate the installation of 6Nr medium temperature hot water (MTHW) heating boilers with space provision for 2Nr future boilers (1Nr 'A' side and 1Nr 'B' side), there are actually 7Nr boilers currently installed with space provision for 1Nr future boiler in plant room 'B' (i.e. in accordance with one of the various system descriptions, and as detailed in notes above). The installed boilers are each rated to provide a heat output of 5MW, and therefore, afford a combined heat output capacity of 35MW when all boilers are operational at full duty.

3Nr combined heat and power units (CHP's) are installed within the Energy Centre, each with a thermal heat output of 1.2MW. With all CHP's operating at full duty these have the potential to provide a further 3.6MW of heat output, which if added to the boiler outputs, would increase the combined total heat generating capacity to 38.6MW from installed plant. Heat load generated from the CHP units can be distributed to either 'A' or 'B' side common primary MTHW flow headers, via automatically controlled 2-port motorised valves, to the selected lead plant room.

'A' side and 'B' side primary MTHW heating circuits are hydraulically interconnected by a 'cross-link' circuit, to facilitate flow from one plant room area to the other plant area distribution circuit, with operation controlled via 2-port motorised valves. During periods when the heat demand on the system is below 15MW, it would appear that either 'A' or 'B' plant room is intended to be the lead boiler room, supplying flow to both underground distribution circuits, and Laboratory Building, with the other boiler room inoperative. This would be achieved by the automatic opening of 2-port motorised valves located on the 'cross-link' interconnecting MTHW pipework leaving both boiler rooms, whilst simultaneously closing the 2-port motorised valves on flow and return circuits to/from the associated non-lead plant room.

When system demand is above 15MW it would appear both plant rooms were intended to be operational, and serve only their respective distribution circuits, with the 'cross-link' interconnecting pipework automatically isolated via 2-port motorised valves on same.

The primary MTHW pipework distribution from each main plant room within the Energy Centre to Adult & Children's Hospital does appear adequately sized to accommodate the stated total heat load of 28MW, which may potentially become necessary in the event of a failure to either of the underground pipework circuits. However, to allow flow through the main headers within the Adult & Children's Hospital in the event of an emergency (i.e. underground mains failure), it would be necessary to isolate defective mains and manually open the 'normally closed' isolation valves, in order to achieve circulation to all plate heat exchangers / plant areas within the building.

As-Fitted record drawings and H&V commissioning schedules both indicate the installation of 44Nr MTHW/LTHW plate heat exchangers, 2Nr within the Energy Centre serving the Laboratory Building, and the remaining 42Nr located within numerous remote plant room areas in the Adult & Children's Hospital. Plate heat exchangers within the Adult & Children's Hospital are reportedly sized/selected to afford localised system resilience, with the installation of supplementary plate heat exchangers able to assist in meeting heat demand in the event of a unit failure. For instance, record drawings indicate the installation of 3Nr plate heat exchangers each providing 50%, thereby, effectively providing a spare heat exchanger as resilience. Record drawings indicate the two Laboratory plate heat exchangers are sized/selected on the basis of 50% duty, thereby apparently not affording any resilience.

Individual plate heat exchanger thermal outputs do not appear to be detailed within any record documentation, with exception to those serving the Laboratory Building (specified within manufacturers technical selection data). In view this, it was considered necessary to utilise H&V commissioning schedules in conjunction with As-Fitted record drawings to approximate their outputs and the peak heat demand for current installations. In order to achieve this we utilised the design flow rates through balancing valves located on return circuits from each plate heat exchanger to estimate intended maximum demand for heat exchangers, whilst taking cognisance of resilience in respect of each localised arrangement.

Estimated peak demand loads calculated were based on a MTHW primary side system operating temperature differential of 30 deg C (i.e. 105°C / 75°C) for the Adult & Children’s Hospital, and a 20 deg C (i.e. 105°C / 85°C) operating temperature differential in relation to the Laboratory Building, as defined within record documentation.

From this analysis, it would appear that the combined design flow rate to operational plate heat exchangers within the Adult & Children’s Hospital is in the region of 194kg/s, with Laboratory Building combined design flow rate being in the region of 30kg/s. The approximate peak heat loads based on these flow rates was then assessed to be 24.5MW in relation to the Adult & Children’s Hospital, and 2.5MW for the Laboratory Building. These loads indicate an estimated total system heat load requirement of 27MW.

Record drawings and H&V commissioning schedules indicate that each primary MTHW heating pump handles a maximum of 44l/s, with pumps arranged in parallel, and operating on the basis of 3Nr run and 1Nr standby. Ignoring possible flow rate reduction due to the parallel pumping arrangement, this would equate to a peak flow rate of 132l/s with only 3Nr pumps in operation, as specified. This combined flow rate could effectively provide a heat carrying capacity in the region of 16.7MW from ‘A’ side distribution, and a slightly lower heat carrying capacity of approximately 15.6MW from ‘B’ side, due to approximations taken with regards to the Laboratory Building primary circuit operational temperatures.

5.04 Summary of Findings

Installed heat generator load capacities, including the maximum heat generation ability of CHP units, provide a potential total heat output of 38.6MW. Based on our estimated peak heat load analysis for the Adult & Children's Hospital, and Laboratory Building, of 27MW, this total potential heat output would appear to afford in the region of 30% resilience. However, excluding heat generation from the CHP units, in view of possible reliability/maintenance, the approximate total potential heat output would be reduced to 35MW, thereby consequently reducing heat generating plant resilience to in the region of 23% (i.e. circa 8MW).

It would typically be assumed that there will also be some level of diversity in terms of resilience percentage as the actual simultaneous heat load demand imposed on heat generating equipment will inevitably be lower than the total peak demand (i.e. dependant on secondary side control strategies). However, given the absence of potential building heat load requirements within record documentation, and the uncertainty relating to any potential load diversity being applied during system design, it would appear that the current heat generating plant capacities would not facilitate any significant level of further additional load without detrimentally affecting resilience, as would probably be necessary to subsequently serve retained estate properties.

In addition, should the future 5MW boiler be installed within 'B' side plant area we would still hold reservations with regards to adequacy of total system plant capacity resilience, albeit this being dependent on the eventual additional loads proposed.

With regards to the system resilience, in the event of 'A' boilers being inoperative, 'B' side boilers would appear to be able to satisfy approximately 69% of the total heat load requirement in conjunction with CHP generation. However, if the CHP system is disregarded 'B' side plant room resilience would reduce to approximately 56%. In the event of 'B' side plant area boilers being inoperative, 'A' side heat generators would be able to provide approximately 87% of peak load heat requirements, and 74% if the CHP system heat load generation is disregarded.

In view of the foregoing, 'B' side plant room heat generating capacities would appear to be inadequate to provide the stated 66% resilience, due to potential reliability issues with the CHP system.

Regardless of the foregoing, in the event of the loss of either 'A' or 'B' boiler plant rooms, it would appear that the primary pumps would be unable to provide an adequate flow rate to facilitate the above noted levels of system resilience. Three operational pumps (i.e. as per the strategy stated within record documentation) would afford a combined maximum flow rate of approximately 132l/s, which equates to approximately 16.7MW based on a 30 deg C temperature differential.

This maximum heat output from primary pumps relative to total peak heat demand results in an approximate system resilience of 62%. As such, we do not deem the stated system resilience of 66% to be viable unless the fourth 'standby' primary pump was utilised to assist flow rate requirements in the event of an emergency, and detailed within emergency procedures accordingly. Furthermore, any additional heating demand imposed on the system, such as to serve retained estate properties, would obviously further reduce system resilience below the 62% approximated.

In the event of an underground mains failure, and as part of the primary MTHW heating circuit resilience strategy, it would become necessary to manually open two 'normally closed' isolation valves positioned on main pipework headers within the Basement of the Adult & Children's Hospital. Failure to open these valves would appear to result in complete loss of service to a large portion of the Adult Hospital. This would seem to present a potential risk associated with user error, particularly given that the necessity to manually open valves would occur during an emergency.

As noted within the analysis sub-section above, the As-Fitted record drawings indicate that Laboratory Building plate heat exchangers located within the Energy Centre were selected on the basis of 2Nr rated @ 50%. This implies that each plate heat exchanger would be capable of providing 50% load to the system, thereby apparently not affording any resilience. There would also only appear to be one underground pipework circuit distributed between the Energy Centre and Laboratory building, which again does not afford any provision for resilience in the event its failure.

5.05 Additional Significant Observations

During our analysis of the estimated peak heat load, potential discrepancies were noted in relation to the MTHW sub-circuit distribution flow rates, the 'B' side plant room heat load requirement, Hydrotherapy Pool Plant heat exchanger sizing, flow rate / duty of Laboratory Building plate heat exchangers, and filling method for MTHW heating system. These observations are as detailed below.

- Sub-Circuit MTHW Flow Rates;

  As-Fitted record drawings and H&V commissioning schedules both define the installation of 3Nr separate primary MTHW heating sub-circuits emanating from the main flow and return headers in the Basement. These circuits are distributed throughout the Adult & Children's Hospital to various localised plant areas containing numerous plate heat exchangers. Whilst totalling individual design flow rates for each heat exchanger we discovered substantial inconsistencies between our totals and the recorded common 'Sub' circuit flow metering station readings contained within commissioning schedules.

  For example, the flow rate detailed within H&V commissioning schedules for a particular 'Sub' circuit metering station is 24.25kg/s, whereas, the total flow rate from the associated individual plate heat exchangers equated to 42.4kg/s (disregarding resilience loads). This seems to indicate a possible significant discrepancy in relation to distribution circuit balancing, which could result in low secondary side temperatures, and therefore, would inadvertently increase the risks associated with legionella in terms of the domestic hot water services.

  Whilst temperatures within the system are being monitored, given the nature/use of facilities, and the associated elevated risk to occupants, we recommend this potential issue be reviewed in further detail as a matter of importance.

- <u>'B' side plant room heat load requirement;</u>

  Whilst undertaking heat load analysis estimations (i.e. from As-Fitted drawings & H&V records) we noted from the location of 'normally closed' valves on main MTHW headers within the Basement that 'B' side plant room is intended to serve the Laboratory Building, one of the Adult Hospital 'Sub' circuits, and the Children's Hospital 'Sub' circuit. The effective total heat carrying capacity of this circuit based on the associated plate heat exchanger flow rates (after deducting exchanger resilience) would appear to be in the region of 19MW. This is both higher than installed boiler plant and CHP system heat generation capacity combined (i.e. circa 18.6MW), and more than the associated primary pumps can provide (i.e. circa 15.6MW).

  This appears to indicate that 'B' side plant installations are potentially unable to adequately provide sufficient load to installations served, during periods of peak heat load demand.

  It should also be noted that the Laboratory Building heat load utilised in load estimations was based on the stated commissioned flow rates within H&V documentation, which appear to be lower than the design flow rate. If the design flow rate had been utilised, the total peak circuit heat load carrying capacity requirement would increase further, and therefore exacerbate potential inadequacies.

- <u>Laboratory Plate Heat Exchangers;</u>

  Whilst there does not appear to be any record documentation available to verify selection parameters in relation to the Adult and Children's Hospital plate heat exchangers, Laboratory Building plate heat exchanger technical literature is contained within the electronic Zutec records database. A particular section from this technical literature is shown within the screenshot below.

INNOVATED
DESIGN SOLUTIONS

Sondex A/S PHE - Design & Datalist

QuotationNo : 715 | Att : Brendan Coffey | Ref : Energy Centre Building | Item :1 | V10B32 | Monday, October 08, 2012

PHE-Type	S22-IG10-50-TKTM19-LIQUID	Hot side	Cold side
Flowrate	(m3/h)	71.45	81.32
Inlet temperature	(°C)	105.00	60.00
Outlet temperature	(°C)	82.00	80.00
Pressure drop	(bar)	0.20	0.26
Heat exchanged	(kW)	1850	

As indicated, the Laboratory heat exchangers were selected on the basis of primary side flow and return temperatures being 105°C and 82°C respectively, affording 1850kW in terms of heat exchange rate. The necessary flow rate to achieve this heat exchange, based on these primary side temperatures, is noted as being 71.45m^3/hr (i.e. 19.84l/s).

The first obvious inconsistency noted is the differing primary side temperatures, between those detailed within the plate selection criteria above, and as defined on As-Fitted record drawings. The second notable inconsistency is related to the primary side flow rate defined above, and that as scheduled within H&V record documentation contained on Zutec.

H&V commissioning data appears to identify that the Laboratory Building plate heat exchangers were each balanced to afford a flow rate of 14.68kg/s, effectively equating to approximately 1236kW based on a 20 deg C temperature differential (i.e. assuming temperatures on As-Fitted drawing are correct). This would suggest there to be a considerable deficit with regards to the intended/actual load availability from these particular heat exchangers (i.e. 2472kW, in lieu of intended 3700kW). This would also appear to suggest that in the event of failure to one of these plate heat exchangers, only 33% of the associated peak heat load requirement would be available.

Whilst the aim of this report is not to establish the source of any potential issue, we believe the inconsistency noted above is related to flow rate(s) detailed within the H&V commissioning data. Flow rate(s) of 14.68kg/s seem to correspond with a temperature differential of 30 deg C, whilst this particular sub-circuit flow rate appears to have been designed/commissioned on the basis of operating with a 20 deg C differential, and should therefore be considerably higher.

- <u>Hydrotherapy Pool Plant;</u>

  Hydrotherapy Pool Plant technical literature contained within record documentation indicates that the system plate heat exchanger was designed/selected on the basis of 105°C flow and 70°C return primary water temperatures, as indicated below.

2.1.1.4 HEAT EXCHANGER

No. Off:	1 No. 100% duty
Model:	UK Heat Exchangers – UKE-1A (8 No. Plates)
Type:	Non Storage water to Water Bypass
Duty:	50 kW
Primary Water Temperature:	105°C Flow / 70°C Return
Pool Temperature:	34°C - 40°C
Primary Pressure Drop:	21 kPa
Heat-up Rate:	0.5°C/hr
Material:	316St. St.
Connections:	Inlet: 1" BSP Male outlet: 1" BSP Male

The primary MTHW heating system distribution appears to be intended to operate with a closer temperature differential of 30 deg C.

- <u>MTHW Heating System Fill Facilities</u>

  Whilst it is in all probability feasible to gradually fill the MTHW heating distribution via the pressurisation system, there does not appear to be any installations facilitating the potential need to quick-fill large sections of the system.

SECTION 6 – Appendices

6.01 Examples of Contradictions within Record Documentation

Should both pumps fail then an alarm will be generated at the BMS.

The pump duties are arranged to changeover on a weekly time schedule or a manual selection at the BMS.

Indications of VSD fault conditions are obtained from the VSD and displayed at the BMS. A list of these alarms can be found in section 12.

3.2 MTHW/LTHW Plate Heat Exchangers

When the 'Auto' button on the BMS graphic is enabled, each MTHW/LTHW plate heat exchanger system is enabled, subject to the following interlocks being satisfied:

- The system has been enabled from the BMS
- The associated hardwired high temperature thermostat is healthy

*Please note all hardwired interlocks are also programmed in software.

A high limit immersion thermostat, manual reset type, is located in the flow temperature from each heat exchanger. If the temperature should rise above 90°C (set on instrument) then an alarm will be generated on the BMS. The associated MTHW control valve is hardwired to drive to the fully closed position via a spring operated actuator.

When the fault has been cleared, and the manual reset on the thermostat has been reset, the system can be reset at the BMS or the control panel reset button

4 Temperature Controls

4.1 Secondary Constant Temperature Heating Control (Typical For Each Plate Heat Exchanger)

Once the system has been enabled and the high limit immersion thermostat is below its high limit, the secondary constant temperature flow temperature is monitored and compared with the set point of 82°C. A proportional and integral control loop adjusts the MTHW control valve accordingly.

The secondary flow temperature is monitored for a mismatch between the temperature set point and the actual temperature. Should the temperature deviate +/-5°C of the set point then a mismatch alarm will be generated at the BMS.

The secondary constant temperature heating return temperature on each plate heat exchangers are monitored by the BMS.

4.2 Temperature Monitoring

The common secondary constant temperature heating flow and return temperatures are monitored by the BMS.

The common primary medium temperature hot water flow and return temperatures are monitored by the BMS.

1 MTHW Primary Heating Overview

There are two medium temperature hot water (MTHW) heating circuits between the Energy Centre and the main adult's and children's hospitals. Circuit A emanates from A Side Plantroom and circuit B emanates from B Side Plantroom.

The MTHW heating in the A and B Side Plantrooms are provided in each by four 5000kW dual fuel boilers operating on the basis of 3 duty/1 standby, per plantroom. The Boiler plantrooms are on Level 2 of the A and B Side

Three CHP units are also being used to generate Medium Temperature Hot Water. The CHP units can provide 1200kW of MTHW each, therefore a total of 3600kW of heat. The CHP Units are located on Level 0 of the A Side Plantroom.

The boilers and CHP units shall feed the primary heating circuits which shall serve:

- plate heat exchanger units to provide secondary LTHW to the A&C
- plate heat exchanger units to provide secondary LTHW to the Laboratory/FM Building
- HWS Calorifiers to the A&C
- the absorption chiller
- future connections to serve the existing buildings on the hospital site

The primary side boilers and pumps of each plantroom are hydraulically linked to the primary pipework circuits of both A&B, so that the boilers/primary pumps of Plantroom A can serve both the A&B pipework circuits and also the boilers/primary pumps of Plantroom B can also serve both the A&B pipework circuits.

The strategy of the controls is as follows:

1 Where possible the heating capacity required by both pipework circuits A & B is to be provided by either Plantroom A or Plantroom B. There shall be times, however when the heating requirement is sufficiently high, that both the plantrooms shall need to operate independently and serve their own pipework circuits.

2 The CHP units are to be used as the lead boilers, whichever plantroom is considered as the lead, and are to provide the MTHW requirement for the heating whenever possible.

3 If it is between the 1st April and 30th September and there is a chilled water requirement then MTHW shall be provided to the absorption chiller, provided that there is 1200kW of spare heat available from the CHP units. The heating and hot water system shall take precedence over the absorption chiller for utilising the MTHW generated by the CHP.

4 Owing to both the complexity of the system, together with the size of the system, the CHP and boilers are to be enabled primarily by sensing the heat

seconds), the status feedback indicates no pump flow, a pump flow failure alarm will be generated on the BMS for the associated pump.

When a pump flow failure is detected the associated pump will be disabled and will remain disabled until the alarm has been reset at the BMS or the control panel reset button. Once the duty pump flow failure has being detected the standby pump will be enabled.

Should both duty and standby pumps fail then the system will be disabled and a crtical alarm will be generated at the BMS.

The pump duties are arranged to changeover on a weekly time schedule or a manual selection at the BMS.

Indications of VSD fault conditions are obtained from the VSD and displayed at the BMS. A list of these alarms can be found in section 12.

4.1.3 MTHW Boiler Enable

When the boiler isolation valve is open and the primary pump and economiser pump flows are established the boiler differential pressure is monitored for flow.

Once the boiler differential pressure switch flow is established the boiler will be enabled to operate under its own integral controls to maintain the required set point of 105ºC. The boiler setpoint can be manually adjusted but is initially set at 10 Volts. The signal is scaled as shown

- 0-Volts = 55ºC
- 10-Volts = 105ºC

If the boiler differential pressure switch is not established within a time delay (30 seconds) a boiler differential switch failure alarm will be generated on the BMS.

The MTHW flow temperature for each boiler is monitored for a mismatch between the temperature set point and the actual temperature. When a boiler has been enabled for 30 minutes and the temperature deviates +/-5ºC of the set point then a mismatch alarm will be generated at the BMS.

Each boiler is monitored for a common fault. When a common fault is detected an alarm will be generated at the BMS.

Each boiler is monitored for high temperature lockout. When a high temperature is detected an alarm will be generated at the BMS.

4.1.4 MTHW Economiser Circuit

An economiser unit is provided at each boiler to increase boiler efficiency. The economizer pump is enabled when the boiler primary pump has been enabled

The boiler flue temperature is monitored. When the boiler is enabled and the boiler flue temperature is greater than 110ºC the economiser three port valve is driven fully open.

coil in an air duct. Both the jacket and intercooler circuits are protected against frost by a 35% glycol/water mix. The two dump radiator are on the LTHW system and are sized for 600kWt each

6.2.6.1 Jacket water system with heat recovery

The jacket water system consists of a circulating pump, LTHW heat exchanger, and an electric water heater.

After the engine the pipework goes to the plate heat exchanger for heat recovery purposes which is built into the pump skid inside the container. This heat exchanger is sized to recover the quantity of heat recovered from the engine jacket.

On the secondary side of the LTHW heat exchanger there will be clients LTHW pump and a 3-port valve, controlled by the TEM. This allows the LTHW to be bypassed to allow the engine to reach working temperature, and then allows the TEM to control the water temperature returning to the clients system.

The heat recovery has been sized to provide 612 kW of heat from the jacket and 584kW of heat from the EGHE to deliver LTHW at 105 °C when the LTHW has a return temperature of 75°C. The parameters might be adjusted during commissioning to achieve CHP optimum operating settings. The client is responsible to maintain the LTHW return temperature to the CHP at 75C by either utilising heat or by dumping it using the dump radiators. Each dump radiator is sized to reject 600kW of heat. The LTHW system recovers Jacket heat from the Jacket plate heat exchanger and the passes through the exhaust gas heat exchanger to reach 105C temperature.

While the engine is not running, the electric water heater is used to keep the engine block warm enough for an immediate start.

6.2.6.2 Intercooler water system

The intercooler water system consists of a circulating pump and a 3-port valve across the intercooler water dump coil positioned in the ventilation duct.

The intercooler water is diverted by the valve through the dump radiator, and is cooled to meet the required on-engine temperature. The dump radiator is sized to reject the maximum total intercooler water heat.

6.2.7 Roof-mounted silencer

The engine exhaust silencer is mounted on the roof of the container and positioned in such a way to optimise the exhaust system layout to minimise back pressure. The silencer will be fitted with a bursting disk and flame

MTHW/ LTHW Heating System Description

The main heating source for the site is a Medium Temperature Hot Water (MTHW) heating system, derived from 7 no. MTHW dual fuel shell & tube boilers and 3 no. Combined Heat & Power (CHP) units located in the Energy Centre Building. The system operates at 105°C flow and 82°C return temperatures.

The maximum heating load for the hospital site has been assessed at 28.0MW. For resilience purposes the boiler plant has been installed as two systems in Plantroom 'A' and Plantroom 'B' on Level 2 of the Energy Centre. There are 4 no. boilers installed in Plantroom 'A', and 3 no. boilers installed in Plantroom 'B'. There is space for a fourth boiler to be installed in Plantroom 'B' at a future date, if required. Pipework and associated valves & pump sets have been provided for this future boiler.

3 no. natural gas fired CHP units located on Energy Centre Level 0 Plantroom 'B' act as the main heat source on site and provide 'free' heat to reduce overall CO2 emissions. These units are sized at 1200MW each, giving a total heat output of 3600MW. Further details on the system operation of the CHPs is located in the CHP Section of the O&Ms.

Each boiler has an output of 5MW and they are manufactured by Bosch (type UT-M34) with a Riello fully modulating burner (RLS-800/EV MX) which operates on dual fuel light oil or natural gas. Natural gas is the main fuel which is fed from the gas rig located externally on the site next to Govan Road, via the gas governor room on the Energy Centre ground floor. Light fuel oil is fed from the main oil tank room located in the Energy Centre Level 0 Plantroom 'A' and is pumped up to Level 2 via pump skid no. 2 (serving Plantroom 'A'), and pump skid no. 3 (serving Plantroom 'B'). Both gas and oil supplies to the boilers have solenoid shut off valves linked to the fire detection system.

Maximum operation is on a 3 No. run and 1 No. stand-by basis. In the event of a catastrophic failure of either the 'A' or 'B' plantrooms, the remaining plant will be able to provide 66% of the total load which should allow the site to continue. Connections are provided to each main plant header to allow a temporary boiler plant to be connected to boost the available heating capacity to each boiler system in the event of a long term outage.

The boilers shall be arranged with reverse return flow and return headers and each boiler has its own primary circulating pump. A back end protection bypass has been incorporated into each boiler assembly. Each boiler has a matched in-line gas economiser fitted in the stainless steel twin wall insulated flue system to improve heat output efficiency. Attenuation hoods are used to minimise noise breakout from each burner, in line with the acoustic specifications.

Safety valves are installed on each boiler which are rated to the maximum design pressure (6 bar), and the maximum design temperature (120°C). These safety valves are piped directly into individual flash trap vessels which allow the hot water to flow to drain, and allow any blow off steam to vent to high level.

Primary heating circuits from the Energy Centre arranged as 'A' and 'B' circuits are fed from their respective boiler system. Each of the 'A' and 'B' pipework circuits is sized to provide the full hospital heating requirement.

The flow and return pipework is routed from the Energy Centre via pre-insulated buried pipework (Starpipe), and enters the A&C Building Basement where they connect to the

MTHW header which for resilience purposes, allows either 'A' or 'B' circuits to feed the hospital.

Valved connections have been provided at the Energy Centre Level 0 Plantroom 'B' service pit to serve the retained estate and other proposed developments at some point in the future.

Each primary MTHW heating system (A and B) includes the following elements:

- Pressurisation units (type Flamco FLUKSSSF) c/w associated expansion vessels to maintain the 4.2 bar pressure in the primary MTHW System (level 2 plantrooms 'A' & 'B')
- Multiple secondary circulation pumps to distribute the water across to the A&C Building (level 2 plantrooms 'A' & 'B')
- Combined air/ dirt separators on the main flow pipework for each plantroom (level 2 plantrooms 'A' & 'B').
- Primary twin head shunt pumps (level 2 plantrooms 'A' & 'B').
- Manual dosing pots located on level 2 plantrooms 'A' & 'B' so the system can get treated with corrosion inhibiting chemicals

Two port control valves are installed on all of the major load centres to allow the use of variable volume control of the primary heating circuit. The circulating pumps are controlled by the BMS in sequence as needed to match the varying load demand. This maintains the pressure differential between flow and return pipework within set limits with sensors located within the main sub-distribution pipework. The system incorporates a number of three port constant volume valves to act as bypasses so that the minimum flow shall not be less than 40% of a single pump in operation.

In times of a boiler requirement of less than 15MW, one of the two Energy Centre Boiler Rooms shall act as the lead boiler room and with the CHP system provide heat to both the 'A' & 'B' circuits. The switching of one boiler room, to the other, to act as lead, including the switching of the CHP units from feeding once circuit, to the other, is achieved by the opening and closing of various 2 port motorised valves. This is described in more detail within the BMS system description.

Plate heat exchange units (type Sondex S22) convert MTHW to Low Temperature Hot Water (LTHW) to serve the Labs Building. This is located on Energy Centre Level 0, Plantroom 'B'. The purpose of the plate heat exchanger installation is to positively separate the primary MTHW and secondary LTHW circuits to create smaller strategic load centres in a manner which improves system integrity and operational requirements. The units selected provide one unit as complete standby, in the event of planned maintenance or breakdown.
The sizing is on the basis of primary side flow/ and return temperatures of 105°C and 82°C respectively and secondary side temperatures of nominally 80°C flow and 60°C return.

The Energy Centre is located adjacent to the laboratory block. This single building consists of ground, first, second floors and the roof. The main plant in the building is as follows:

- Ground Floor – Oil Storage & Combined Heat & Power (CHP)
- 1st Floor – Standby Generators and Transformers
- 2nd Floor – Boilers, an Absorption Chiller and the main pumps. Also electrical MV panels
- Roof – Air Cooled Chillers and Dry Air Coolers. Also transformers and electrical switch gear

The building is split into two halves, along a vertical line and separated via a four hour fire wall.

Each half of the upper floors is capable of independent operation. Together N+1 is provided for the boilers, chillers and generators.

Ground Floor

The ground floor contains tanks for approximately 1.4 million litres of diesel which is to provide standby fuel for the boilers, should there be a problem with the gas supply and also to provide fuel for the generators, should there be a problem with the grid electricty supply.

The gas fired CHP plant is also located on the Ground Floor to provide approx 3000kW of electrical power and 3600kW of heat.

1st Floor

The Generators, with their associated day tanks are located on the 1st floor. Each half of the Energy Centre houses five generators, with space allowed for a sixth generator to be installed at a later date. Each generator will provide 2000kW at 11kV/3phase.

The associated transformers, controls etc are positioned on this floor.

2nd Floor

Each half of the Energy Centre houses four 4000kW boilers. The boilers provide Medium Temperature Hot Water at 110oC flow and 80oC return. 1000kW of absorption chilling is also located on one side of the energy centre. The MTHW is distributed to the plantrooms in the main hospital, where it will be stepped down to Low Temperature Hot Water, for Air handling Units, Domestic Hot Water and space heating. Low Temperature Hot Water will be provided direct to the Laboratory Building. Electrical MV panels are also positioned on the 2nd floor

The installation has been installed to mitigate risk however it is noted that the following should be considered:

- The increased floor to ceiling heights in the Energy Centre pose an increased risk to personnel working at height; permanent platforms have been installed where practical, for instance to access high level boiler valves. The residual risk should be managed by using appropriate access platforms/towers.

- To minimise the risk of shock from HV cabling, cables on segregated cable ways are provided with barriers where appropriate, along with identification and danger signage. Controlled access is also provided via unique key control suite. Access to and operation of high voltage switchgear should be restricted to "Authorised Persons" who are HV certified.

- When carrying out future removal & replacement of plant, reference should be made to the Major Plant Replacement Strategy elsewhere in this manual (ZBP-XX-XX-DC-800-501). The document gives guidance on cranage locations and access routes. Goods lifts should be used where possible to minimise the need for cranage.

- There is a danger of serious injury to personnel working on plant which has the facility for automatic start without warning, for example standby generation plant. A permit to work system may be considered during maintenance and reference should be made to the O&M record documentation to identify the method of effectively isolating the plant.

- A competent contractor should be employed for any future de-gassing and removal of oil storage tanks to mitigate any risk of explosion. The contractor must provide a certificate of de-gassing prior to removal works commencing.

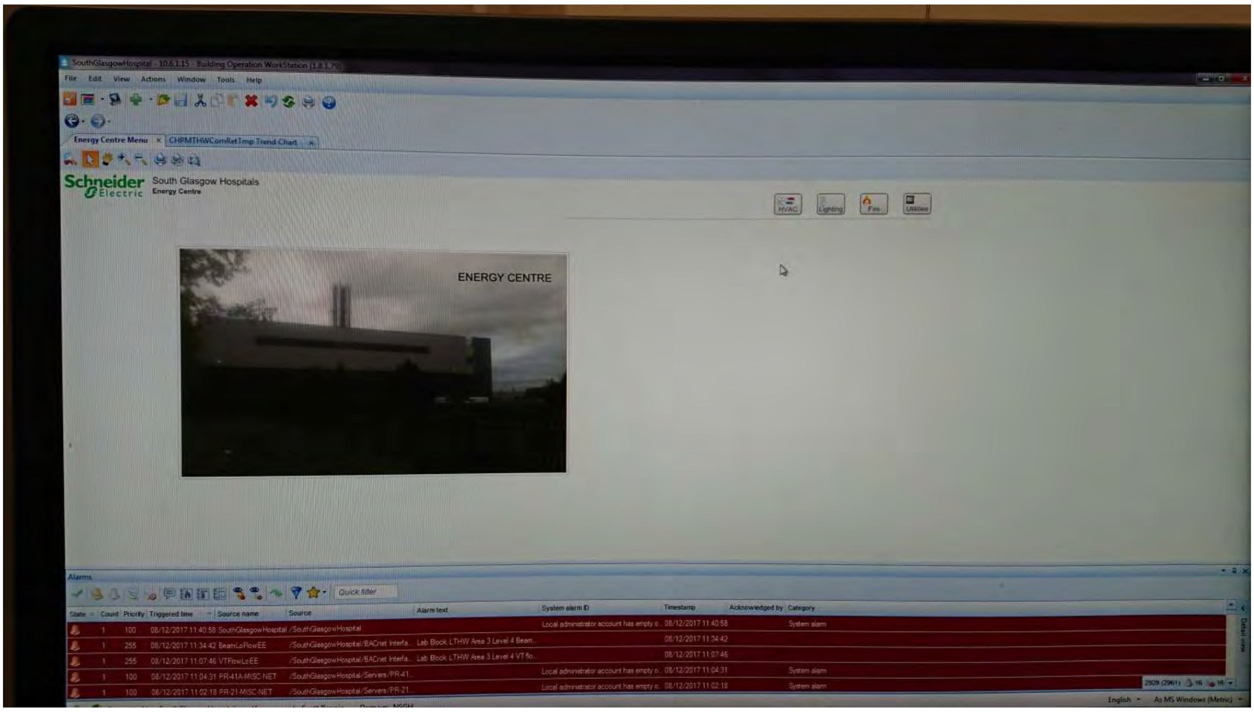
- During future maintenance, operation or demolition, there is a risk of scalding due to the elevated hot water temperature (105ºC) in the building. Equipment and sub circuits have been double valved to eliminate potential valve let-by during maintenance procedures and the residual risk should be further managed by ensuring works are carried out under permit and under considered conditions (eg method statements incorporating use of suitable tools, procedures, equipment and replacement parts).

6.02 Copy of Information from ‘QEUH User Manual’ Document

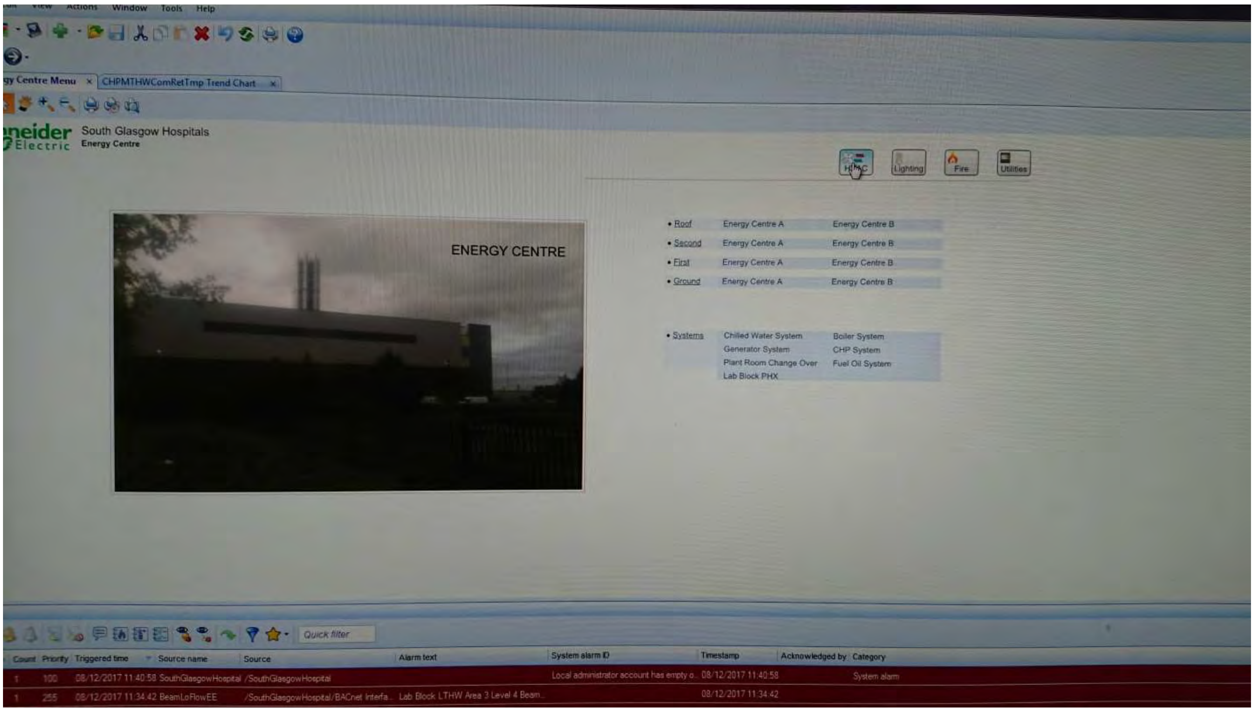
Operation

The QEUH MTHW system has been changed since August 2017, to operate differently from initial design. The 3 x CHP’s take the lead of the full MTHW system, and everything is controlled via CHP Common Return Temperature. This new Philosophy is more simpler and allows the CHP’s to run at 100% efficiency. The system is more user friendly, as more functions have been created to allow set points to be changed during Summer or Winter periods.

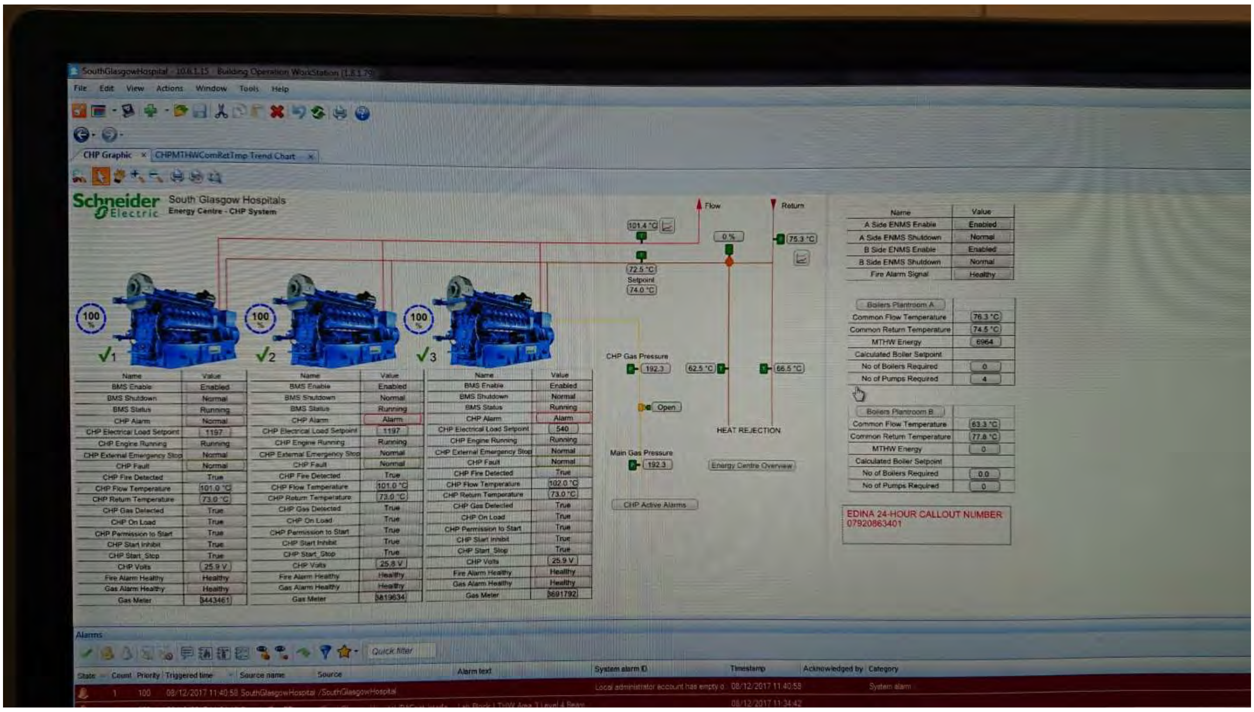
To access the MTHW, login in to the Schneider BMS Front End and select Energy Centre tab, which brings up the screen below:-



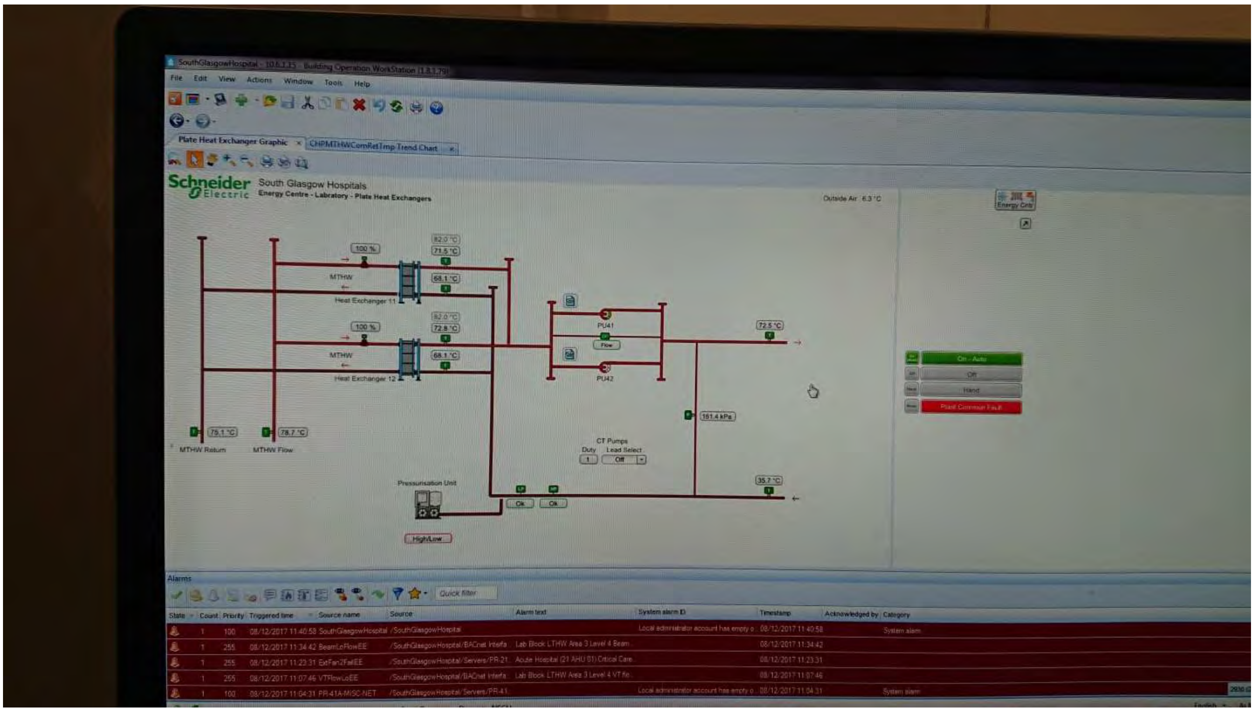
From here you then tick the HVAC tab, which brings up the following screen:-



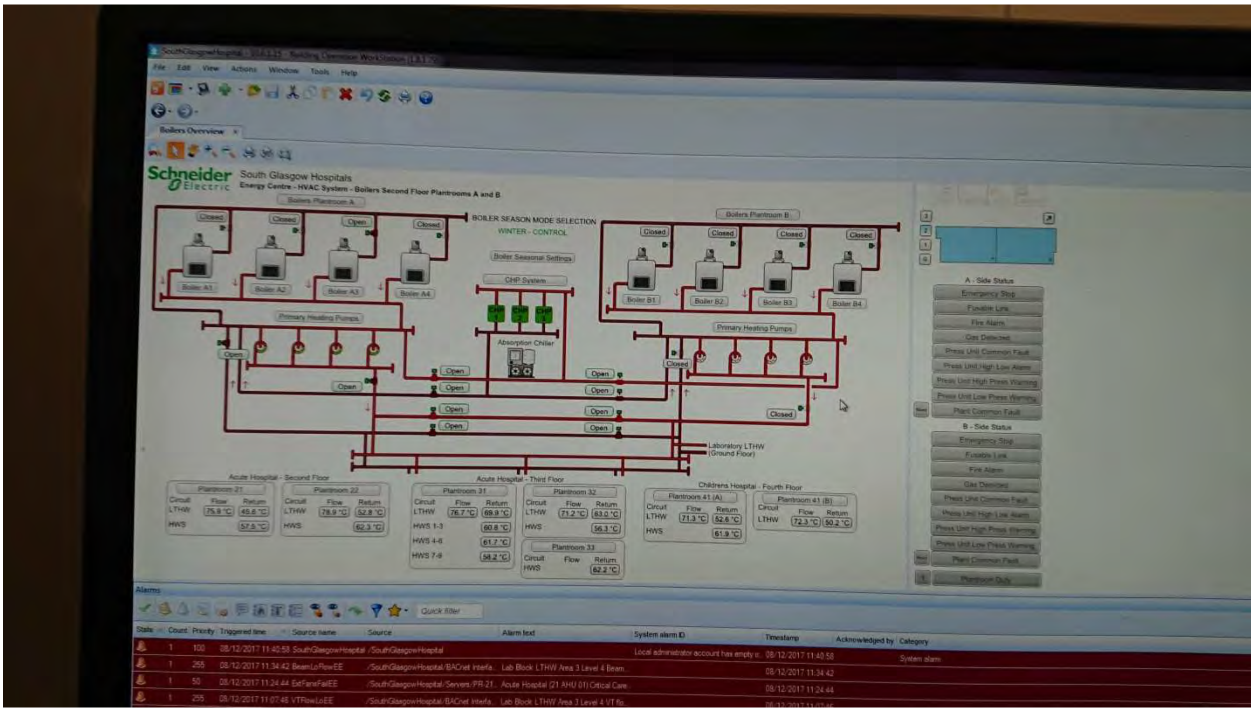
The first tab to select is typically CHP System, as this shows both Common Flow and Return Temperatures, Dump Valve Position, status of CHP's and the actual Temperature flowing to each Engine. From the 6th of December 2017, I have changed the Dump valve Set Point to 74DEG Celsius which is assisting the system a lot more during the colder periods. Screenshot below:-



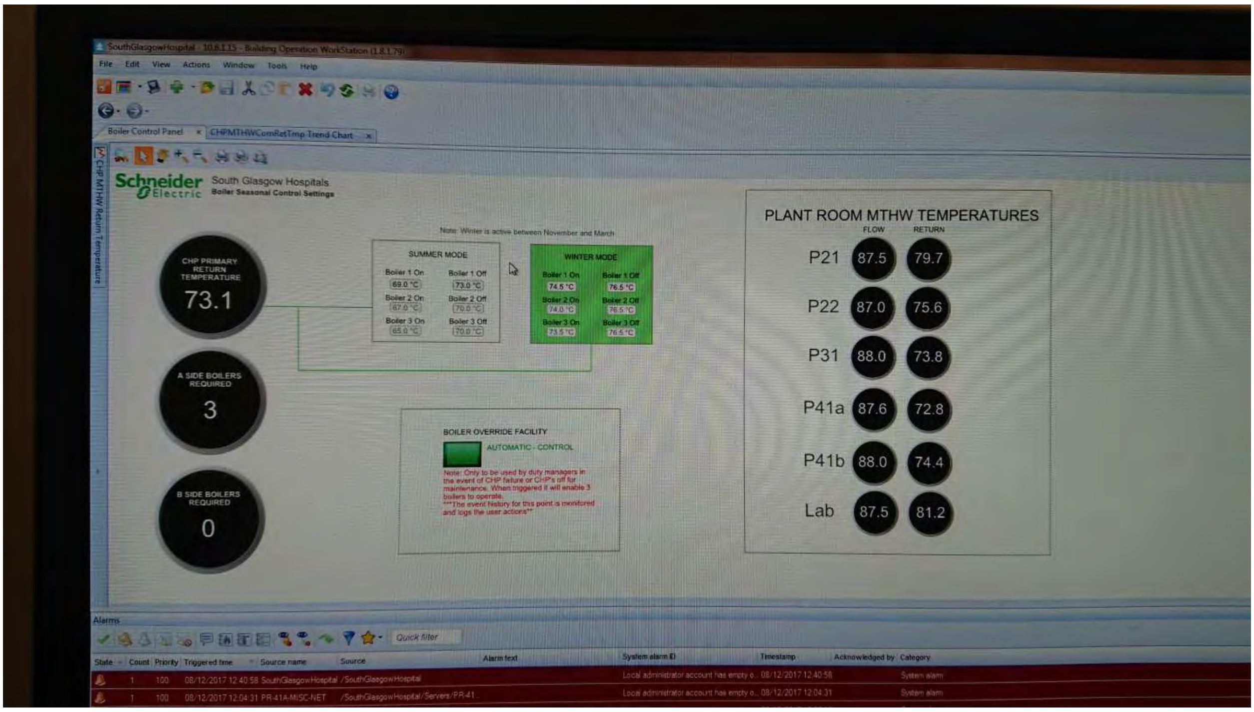
The next tab to select is Lab Block PHX, from here you can see the PHE Temperatures on the Primary and Secondary circuits. Screenshot below:-



The next tab to select is Boiler System, from here it allows you to visually see which side the system is operating, which Boilers are firing, Which pumps are running and all the PHE Secondary Flow and Return Temperatures. Screenshot below:-



From the Boiler tab, you select Boiler Seasonal Settings (Top Centre of Graphic), and this allows you to see the set points for each season. Summer has already been tried and tested with an average external air temperature of 16DEG to 18DEG and the system operated well. Winter is currently being tested and seems to be operating well over the last two days, with an average external air temperature of Zero Degrees Celsius. You can see the Winter set points are a lot higher than that of Summer, and this is to keep the system volume to maximum efficiency and does not allow the system volume to cool down. If for any reason, the settings require altering (Cold snap during Summer period), this is achieved by pressing the + or – buttons either side of the set points. Preferably I would leave these, as they are, as I have tested these and quite confident they work well. Screenshot below:-



Summer Settings

Operation – 1st April to 30th September

1 x Boiler is only enabled if the CHP Return Temperature falls to 69DEG, and then the Boiler operates until the CHP Return Temperature reaches 73DEG. If we lose a CHP, and suffer a cold spell in Winter, Boiler 2 is enabled when the CHP Return falls to 67DEG and goes off at 70DEG Return. Boiler 3 is enabled when the Return falls to 65DEG and goes off at 70DEG. If in the event of a cold snap (During Summer Period), or total CHP loss I am pretty confident that 1 x Boiler could deal with the QEUH but is still to be demonstrated (3 x CHP's load = 3.6MW and 1 x Boiler = 5MW).

Note:- During this period, the Absorption Chiller runs 24/7 assisting with Energy Performance on the PME. 1 x Boiler is only activated once a day for typically an hour, due to the external air temp being in our favour so you should notice a greater saving on Gas usage during this period.

Winter Settings

Operation – 1st October to March 31st

1 x Boiler is only enabled if the CHP Return Temperature falls to 74.5DEG, and then the Boiler operates until the CHP Return Temperature reaches 76.5DEG. If we lose a CHP, and suffer a cold spell in Winter, Boiler 2 is enabled when the CHP Return falls to 74DEG and goes off at 76.5DEG Return. Boiler 3 is enabled when the Return falls to 73.5DEG and goes off at 76.5DEG.

Note:- During this period, the 3 x Boilers are activated approximately 50% to 75% of the day.

A Side to B Side Changeover

I would like to see this changed over every 3 months, as I think every month would be time consuming and this still allows each side to have an equal share of the two seasonal periods.

Pump Settings

The PHE two ports now control the pump flow, If all 20 x PHE's are at 100% (2000% Total), then 4 x Pumps run at 50Hz. Once any 4 x PHE's close (1600% Total), then the 4 x pumps reduce to 40Hz and decrease in similar settings which are on BMS Graphic. We no longer run on differential as the DP's were quite problematic and caused to many errors on the system. Running with this same Philosophy, the Flow Meter has no longer an input on how the CHP operates, this is now only used as a visual element (This will still requires topping up of the Conductive Gel).

Bosch Service Intervals

For when Bosch are on site conducting Boiler Servicing, follow below steps:-

1. Turn all CHPs off, this is achived by the local key switch on each CHP Control panel.
2. As CHPs are isolated, the two ports within the Containers close and do not let any Primary MTHW FLow to go through the CHP PHE and protects the engine. This allows Bosch to put Boilers on Maximum load and achieve their desired Commissioning Figures.
3. Once Bosch are finished, turn the Boilers off via the BMS Screen and leave the system for one hour. Check the Common Flow and Return Temperatures of the Boiler House running and wait for the Flow Temperature to fall to approximately 75 Degrees Celsius.
4. As the Temperature has fallen below the CHP Return Maximum Parameter, the CHPs can be turned on locally at their key switch.
5. Wait 30 minutes and then place the Boilers back into Auto from the BMS Screen. This time period allows the CHPs to ramp to 100% efficiency.

Edina Service Intervals

If for any reason the CHP's are required to be switched off, Oil changes/General Maintenance, 32,000 or 64,000 hours service regimes etc, then no action is required. When the CHPs are isolated, the two port valve closes and stops water flowing so the Boilers kick in when they are required due to the set points trying to achieve the CHP Common Set Point which if all 3 x CHPs are isolated then this leg becomes isolated and cools down.

CHP Override

We do have a function to override the CHP, which basically is only to be used if the CHPs are isolated or have broken down. This button is a last resort function, which turns on 3 x Boilers and runs 24/7.

Problem Solving

Step 1 – Check Alarm History and see which element is low on Temperature, ie, Primary or secondary. If it is AHU's, check the AHU trends to see if this is a persistent problem or has only occurred recently, AHU's are more likely to be doors being left open or external air temps affecting FA inlet. DWS is only affected during peak times, so should be easy to pin point on trends.

Step 2 – Check the CHP Flow and Return Temperatures on the BMS Graphic. The ideal range should be 105DEG Flow to about 74DEG Return on the common sensors. There is a mixing valve after the Common Return sensor so the mixed return sensor does generally show 2DEG less. If the temperature on the Common F&R is low, it would mean that the CHP's have been limited to a lower percentage. If the Mixed Return sensor is above 74DEG, the 3 port will modulate allowing more cooler water flow to the engine but if this rises above 75DEG, when the Boilers are on Hand, the CHP's will most likely back off to 80%/60% as per their safety parameters.

Step 3 – Physically check the Front End screens on each of the CHP's, as these are independent from the BMS Front End. The BMS Front End is only from a MODBUS so does not cover all the functions of the CHP's. These will show alarms that the BMS cannot sense and as Edina can operates these via server, they can change set points whenever they see a potential fault occurring. If in doubt phone Edina as G59 faults are common.

Step 4 – Load up the Trends for all the Primary PHE's. This further proves if the PHE's are meeting temperatures, and at what time they are failing. All PHE's set points have been increased to 82DEG Flow, so they are within a better operating range to keep temperatures on the secondary side.

1 MTHW Primary Heating Overview

There are two medium temperature hot water (MTHW) heating circuits between the Energy Centre and the main adult's and children's hospitals. Circuit A emanates from A Side Plantroom and circuit B emanates from B Side Plantroom.

The MTHW heating in the A and B Side Plantrooms are provided in each by four 5000kW dual fuel boilers operating on the basis of 3 duty/1 standby, per plantroom. The Boiler plantrooms are on Level 2 of the A and B Side

Three CHP units are also being used to generate Medium Temperature Hot Water. The CHP units can provide 1200kW of MTHW each, therefore a total of 3600kW of heat. The CHP Units are located on Level 0 of the A Side Plantroom.

The boilers and CHP units shall feed the primary heating circuits which shall serve:

- plate heat exchanger units to provide secondary LTHW to the A&C
- plate heat exchanger units to provide secondary LTHW to the Laboratory/FM Building
- HWS Calorifiers to the A&C
- the absorption chiller
- future connections to serve the existing buildings on the hospital site

The primary side boilers and pumps of each plantroom are hydraulically linked to the primary pipework circuits of both A&B, so that the boilers/primary pumps of Plantroom A can serve both the A&B pipework circuits and also the boilers/primary pumps of Plantroom B can also serve both the A&B pipework circuits.

The strategy of the controls is as follows:

1 Where possible the heating capacity required by both pipework circuits A & B is to be provided by either Plantroom A or Plantroom B. There shall be times, however when the heating requirement is sufficiently high, that both the plantrooms shall need to operate independently and serve their own pipework circuits.

2 The CHP units are to be used as the lead boilers, whichever plantroom is considered as the lead, and are to provide the MTHW requirement for the heating whenever possible.

3 If it is between the 1st April and 30th September and there is a chilled water requirement then MTHW shall be provided to the absorption chiller, provided that there is 1200kW of spare heat available from the CHP units. The heating and hot water system shall take precedence over the absorption chiller for utilising the MTHW generated by the CHP.

4 Owing to both the complexity of the system, together with the size of the system, the CHP and boilers are to be enabled primarily by sensing the heat

5.2 Main MTHW Primary Pumps Pressure Control

Three Immersion differential pressure sensors measure the pressure across the pump system

- Plantroom 21 (136 mbar)
- Plantroom 22 (154 mbar)
- Plantroom 41 (93 mbar)

Each of the above plantrooms has a setpoint with PID (proportional, integral and derivative) control loop to maintain the differential pressure at setpoint. The maximum demand from the control loops will be used to drive the pumps inverters.
The duty pumps inverter drive is modulated via the control loop with the highest demand.
If the duty pumps control loop exceeds 90% for a period of five minutes the lag1 pump is enabled.
If both the duty and lag1 pump are running and the duty control loop exceeds 95% for a period of five minutes the lag2 pump is enabled.
The lag2 pump will be disabled when the control loops falls below a value of 50% for a period of five minutes.
The lag1 pump will be disabled when the control loops falls below a value of 50% for a period of ten minutes

The circuit is monitored for a mismatch between the set point and the actual differential pressure signal. Should the differential pressure deviate +/-20% of the set point then a mismatch alarm will be generated at the BMS.

The minimum running Speed of a pump is 15HHz (30%).

When both Plantrooms A and B sides are operational the A side pumps will control from Plantroom 22 differential pressure sensor. The B side pumps will control from Plantroom 21 and Plantroom 41 differential pressure sensors.

When three primary pumps are running at greater than 98% and a 30 minute time delay has expired then the standby plantroom is enabled and the load is shared by having two pumps running on the A and B side. The pressure control will return to the duty single plantroom when there is a maximum of three primary pumps running.

The A Side and B Side plantrooms are monitored for differential pressure within the Energy Centre primary flow and return pipework. The differential pressure can be manually selected to control the pumps in the same sequence as described above. This can be used during the system commissioning period.

6 Main MTHW Volume Control including CHP

The Main MTHW common discharge pipework on the A and B side is monitored for volume.
The volume flow rate in litres per second (l/s) is converted into Kilo Watts that will be used to Sequence the number of boilers required on the system. Each Main MTHW pump delivers a flow of 44 l/s. The system volumes will be converted as shown in the following table and the Boiler ON/OFF setpoints are shown.

MTHW/ LTHW Heating System Description

The main heating source for the site is a Medium Temperature Hot Water (MTHW) heating system, derived from 7 no. MTHW dual fuel shell & tube boilers and 3 no. Combined Heat & Power (CHP) units located in the Energy Centre Building. The system operates at 105°C flow and 82°C return temperatures.

The maximum heating load for the hospital site has been assessed at 28.0MW. For resilience purposes the boiler plant has been installed as two systems in Plantroom 'A' and Plantroom 'B' on Level 2 of the Energy Centre. There are 4 no. boilers installed in Plantroom 'A', and 3 no. boilers installed in Plantroom 'B'. There is space for a fourth boiler to be installed in Plantroom 'B' at a future date, if required. Pipework and associated valves & pump sets have been provided for this future boiler.

3 no. natural gas fired CHP units located on Energy Centre Level 0 Plantroom 'B' act as the main heat source on site and provide 'free' heat to reduce overall CO2 emissions. These units are sized at 1200MW each, giving a total heat output of 3600MW. Further details on the system operation of the CHPs is located in the CHP Section of the O&Ms.

Each boiler has an output of 5MW and they are manufactured by Bosch (type UT-M34) with a Riello fully modulating burner (RLS-800/EV MX) which operates on dual fuel light oil or natural gas. Natural gas is the main fuel which is fed from the gas rig located externally on the site next to Govan Road, via the gas governor room on the Energy Centre ground floor. Light fuel oil is fed from the main oil tank room located in the Energy Centre Level 0 Plantroom 'A' and is pumped up to Level 2 via pump skid no. 2 (serving Plantroom 'A'), and pump skid no. 3 (serving Plantroom 'B'). Both gas and oil supplies to the boilers have solenoid shut off valves linked to the fire detection system.

Maximum operation is on a 3 No. run and 1 No. stand-by basis. In the event of a catastrophic failure of either the 'A' or 'B' plantrooms, the remaining plant will be able to provide 66% of the total load which should allow the site to continue. Connections are provided to each main plant header to allow a temporary boiler plant to be connected to boost the available heating capacity to each boiler system in the event of a long term outage.

The boilers shall be arranged with reverse return flow and return headers and each boiler has its own primary circulating pump. A back end protection bypass has been incorporated into each boiler assembly. Each boiler has a matched in-line gas economiser fitted in the stainless steel twin wall insulated flue system to improve heat output efficiency. Attenuation hoods are used to minimise noise breakout from each burner, in line with the acoustic specifications.

Safety valves are installed on each boiler which are rated to the maximum design pressure (6 bar), and the maximum design temperature (120°C). These safety valves are piped directly into individual flash trap vessels which allow the hot water to flow to drain, and allow any blow off steam to vent to high level.

Primary heating circuits from the Energy Centre arranged as 'A' and 'B' circuits are fed from their respective boiler system. Each of the 'A' and 'B' pipework circuits is sized to provide the full hospital heating requirement.

The flow and return pipework is routed from the Energy Centre via pre-insulated buried pipework (Starpipe), and enters the A&C Building Basement where they connect to the

MTHW header which for resilience purposes, allows either 'A' or 'B' circuits to feed the hospital.

Valved connections have been provided at the Energy Centre Level 0 Plantroom 'B' service pit to serve the retained estate and other proposed developments at some point in the future.

Each primary MTHW heating system (A and B) includes the following elements:

- Pressurisation units (type Flamco FLUKSSSF) c/w associated expansion vessels to maintain the 4.2 bar pressure in the primary MTHW System (level 2 plantrooms 'A' & 'B')
- Multiple secondary circulation pumps to distribute the water across to the A&C Building (level 2 plantrooms 'A' & 'B')
- Combined air/ dirt separators on the main flow pipework for each plantroom (level 2 plantrooms 'A' & 'B').
- Primary twin head shunt pumps (level 2 plantrooms 'A' & 'B').
- Manual dosing pots located on level 2 plantrooms 'A' & 'B' so the system can get treated with corrosion inhibiting chemicals

Two port control valves are installed on all of the major load centres to allow the use of variable volume control of the primary heating circuit. The circulating pumps are controlled by the BMS in sequence as needed to match the varying load demand. This maintains the pressure differential between flow and return pipework within set limits with sensors located within the main sub-distribution pipework. The system incorporates a number of three port constant volume valves to act as bypasses so that the minimum flow shall not be less than 40% of a single pump in operation.

In times of a boiler requirement of less than 15MW, one of the two Energy Centre Boiler Rooms shall act as the lead boiler room and with the CHP system provide heat to both the 'A' & 'B' circuits. The switching of one boiler room, to the other, to act as lead, including the switching of the CHP units from feeding once circuit, to the other, is achieved by the opening and closing of various 2 port motorised valves. This is described in more detail within the BMS system description.

Plate heat exchange units (type Sondex S22) convert MTHW to Low Temperature Hot Water (LTHW) to serve the Labs Building. This is located on Energy Centre Level 0, Plantroom 'B'. The purpose of the plate heat exchanger installation is to positively separate the primary MTHW and secondary LTHW circuits to create smaller strategic load centres in a manner which improves system integrity and operational requirements. The units selected provide one unit as complete standby, in the event of planned maintenance or breakdown.
The sizing is on the basis of primary side flow and return temperatures of 105°C and 82°C respectively and secondary side temperatures of nominally 80°C flow and 60°C return

Comfort Cooling

Departments where space temperature control is required, such as the Emergency Centre, Diagnostic Imaging, etc. cooling is provided by treated air to clinical spaces and spaces with high equipment gains.

The department are arranged in a number of zones to suit the control requirements, varying heat gains and use of the spaces.

Active chilled beams and fan coil units are also provided for comfort cooling in areas where there is a need for separation or where high heat gains make these a more appropriate choice of systems.

The supply air ventilation plant heats or cools the air as required by the control system to provide the correct condition in the various rooms/zones.

Heating

Heating for the building fabric, ventilation plant and hot water generation is derived from a Medium Temperature Hot Water (MTHW) heating system.

Primary heating circuits emanate from the Energy Centre arranged as A and B circuits fed from their respective boiler system. Each of the A and B pipework circuits is sized to provide the full hospital heating requirement.

From the hospital header, MTHW radial feeds run via the basement corridors and risers to the hospital's plant areas to serve plate heat exchanger stations and domestic hot water calorifiers.

Plate heat exchange units convert MTHW to Low Temperature Hot Water (LTHW) to serve ventilation plant and perimeter heating systems. The purpose of the plate heat exchanger installation is to positively separate the primary MTHW and secondary LTHW circuits to create smaller strategic load centres in a manner which improves system integrity and operational requirements.

The units selected provide one unit as complete standby, in the event of planned maintenance or breakdown (e.g. 2 @ 100% or 3 at 50%, etc).

From the plate heat exchangers installed within the plantroom areas, the secondary heating circuits systems emanate to serve specific zones of the hospital.

Heat emitters are generally ceiling located providing inherent safety in respect of patient care. Where heat emitters are within touch of patients or the public, the emitters shall be of the low surface temperatures type with a mean surface temperature below 43oC.

The majority of heating is achieved by either ceiling perimeter radiant panels, active chilled beams or four pipe fan coil units. Air curtains are also provided above entrance doors to alleviate drafts.

Client Details

The Queen Elizabeth University Hospital

Report By

D. Holloway BSc (Hons) MRSPH
Water Microbiology Manager
Intertek
The Old Mill
Oxford Road
Stoke On Trent
England
ST6 6QP
[redacted]

Date Work Commenced

22/06/2018

Date Of Report

11/07/2018 – continuing work will be reported separately at a later date

Signed By:

D. Holloway

D. Holloway BSc (Hons) MRSPH

Purpose of Work Undertaken

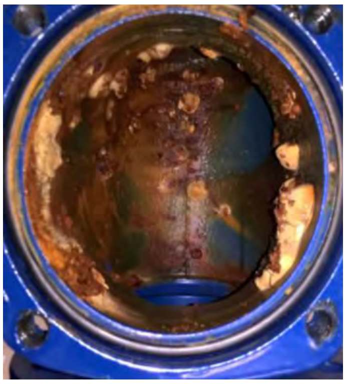
A mains water inlet valve with water meter was received into the laboratory form Queen Elizabeth Hospital Glasgow. The laboratory was asked to investigate the deposits visible on the internal surface of the pipework.

Asset Number 85079

Meter security seal intact (wired from meter housing to fixing bolt) seal broken by DH in the laboratory 03/12/2018.

The meter was removed from the pipe to gain access to all areas of the unit. When removing the meter further deposits were found on the internal surface of the pipe and on the casing of the meter fan.

The deposits were white in colour and solid to the touch.



2 samples of the deposits were taken for analysis

1. *Taken from the surface of the water meter fan casing*
2. *Taken form the internal surface of the pipe.*

Analysis performed

Microbiology

1 gram of sample was taken and put into sterile ¼ strength ringers salts and agitated to free off the organisms into solution.

*A serial dilution was then made up from the solution to 10*6*

Each sample was plated onto non selective agar to obtain a total viable organism count per gram.

Further confirmation of organism type performed

Physical/ chemical analysis

Total organic matter.

Sample was dried to remove all the moisture from the sample and the sample weighed.

The sample was then put into a microwave furnace for 3.5 hours at 550oC to burn off any

The sample was cooled in a desiccator and weighed and the total percentage organic calculated.

Total Iron

0.1 gram of sample was digested in acid and analysed using ICP to determine the Iron concentration.

The pipe and meter were cleaned so the full surface of the pipe could be inspected

When the debris was removed from the internal surfaces of the pipe evidence of pitting of the surface was visible in all locations debris was removed. In areas where no debris was present no pitting was visible and there was no damage to the paintwork.

Analysis Results

Microbiology

sample	TVC cfu/gram
1	50,000,000,000
2	100,000,000,000

Organism identification

Total organic matter

sample	Dry weight (g)	Ashed weight (g)	Total loss (g)	% organic
1	3.3140	2.8561	0.4579	14
2	1.2894	0.9253	0.3641	28

Possible causes for non-uniform corrosion.

Electro chemical- this is where the chemical composition of the water combined with the friction caused by flow create an electrical charge causing the surface to act as a cathode and the water to act as an anode to create a break in the surface of the pipe and allow corrosion to form.

Microbiological corrosion- this is where certain organisms attach to the surface of the pipe creating a localised biofilm and use the materials in the pipe as a nutrient source to sustain growth and initiate corrosion.

Item 487

Irrigation system

The irrigation system and external bib-taps are served from the Trades Water distribution system. This is separated from the Domestic Cold Water system by the Trade Water Tanks.

The external services were being flushed prior to being removed. FM First ticket references have been attached.

A job ticket was raised to carry out isolation of the outside taps on 30/12/16 and completed on 24/02/17.

C.Purdon

19/07/18

Water System Risk Assessment

NHS Greater Glasgow & Clyde

Queen Elizabeth University Hospital And Royal Hospital for Children

Report Issue Date: January 2019
Latest Recommended Review Date: Ongoing as current remedial works completed

LEGIONELLA RISK ASSESSMENT

Report carried out by	DMA Canyon Ltd
Address	14 Canyon Road Netherton Wishaw ML2 0EG
Telephone No.	01698 536790
Fax No.	01698 360211
e-mail	office@dmacanyon.co.uk
Website	www.dmacanyon.co.uk
DMA Contacts	Allan McRobbie Compliance Manager Mike Kinghorn Director David Watson Director [redacted]

Dates of Assessment (On Site)	Ongoing assessment during October - December 2018
Draft Submission for Review	January 2019 (Interim information submitted at time of assessment)
Final Submission	TBC
Risk Assessors	David Watson Assisted by; Allan McRobbie & Mike Kinghorn (Technical Assistance) Euan Renfrew & Craig Guyer (Plant Items) Fraser Murray & James Kyle (Hot and Cold Water Outlets) Jamie Clayforth (General site and system knowledge and guidance)

Risk Assessor assisted on site by (Site Representative)	Mel MacMillan
Knowledge of systems being surveyed	Good

Report Commissioned by:	Phyllis Urquhart (NHS Estates)
Report Issued to:	Phyllis Urquhart (NHS Estates)
Format of Report:	Electronic
	The findings included within the report have been communicated throughout the assessment process by Craig Guyer, Allan McRobbie and David Watson of DMA Canyon Ltd to NHS Estates staff both verbally and where appropriate electronically.

N.B. The findings and recommendations presented in this report have been based on information made available and inspection of areas made accessible by site staff during the survey. DMA are only able to assess areas/systems, which they have been given access to and using information supplied by site personnel. This survey was undertaken only on pipe work/areas that were accessible and visible, and it is possible that some sections remained hidden during the survey. Schematic drawings, where produced, and how services link up, have been assumed to run as indicated using basic engineering principles and our experience. However, no responsibility can be accepted for systems and/or areas, which DMA have not been provided access to, or as a result of incorrect, misleading information supplied or information not provided. No guarantees as to the completeness of the information within this report are provided.

WATER SYSTEM RISK ASSESSMENT

DMA Staff Training and Competency

All DMA staff attending site are fully trained and deemed competent by DMA management for the tasks they have been allocated to carryout.

DMA training records are held centrally by DMA Canyon Ltd.

Copies of the relevant personnel training certificates can be supplied upon request.

Training and competency records for site/client/other staff involved in Legionella control should also be held by client. Records for those carrying out the Risk Assessment will be submitted as an appendix to this document.

DMA will only offer Legionella control services for which we have LCA accreditation.

An up to date copy of our LCA certificate and accreditation details can be found at www.dmacanyon.co.uk

For information on the LCA code of conduct for service providers and other information on the LCA requirements please refer to http://www.legionellacontrol.org.uk/

Legionella Control Association

A Code of Conduct for Service Providers

Certificate of Registration

This is to certify that the following company has submitted a registration under the Conditions of Compliance as laid out in the LCA's Code of Conduct for Service Providers

Name of Company: **DMA Canyon Ltd**

Registration Number: **2012/2218** Certificate valid until: **31st August 2019**

Registration under the following services categories:

(1) Legionella Risk Assessment Services
- 1.1 Hot and Cold Water Services
- 1.2 Evaporative Cooling Systems
- 1.3 Process and Other Systems
- 1.4 Healthcare Risk Assessment

(2) Water Treatment Services
- 2.1 Chemicals
- 2.2 Dosing and/or Control Systems
- 2.3 On-site Analytical and Monitoring Services

(3) Hot and Cold Water Monitoring and Inspection Services
(4) Cleaning and Disinfection Services
(5) Independent Consultancy Services
(6) Training Services
(7) Legionella Analytical Services
- 7.1 Sampling
- 7.2 Laboratory Analysis
- 7.3 Interpretation of Analysis

(8) Plant and Equipment Services
- 8.1 Installation
- 8.2 Refurbishment
- 8.3 Servicing
- 8.4 Design and Supply

This Certificate is only valid if the Company named is listed on the LCA website www.legionellacontrol.org.uk/directory.php

Signed: [redacted] Chairman, Executive Committee

[redacted] Certificate Secretary

Legionella Control Association Limited. www.legionellacontrol.org.uk

Registered in England and Wales No. 8502723

WATER SYSTEM RISK ASSESSMENT

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WATER SYSTEM RISK ASSESSMENT

Section 1

Executive Summary

WATER SYSTEM RISK ASSESSMENT

Executive Summary

Building Overview
(System information below adapted from information provided by Brookfield in 2015 with Legionella Control comments by DMA)

This assessment covers the QEUH (Adult) Hospital and the adjoining Royal Hospital for Children. The Adult Hospital is 14 storeys, including the basement, with approximately 1100 beds and the Children's Hospital is 5 storeys, including the basement, with approximately 250 beds.

This facility has the largest Critical Care complex, one of the largest Emergency Departments in Scotland, offers acute specialist inpatient care, medical day care services and outpatient clinics servicing the local population.

The Children's Hospital provides specialist services to the West of Scotland and the wider population of Scotland in addition to the full range of secondary care services to people of Greater Glasgow and Clyde. Specialist services include cardiology and cardiac surgery, renal and bone marrow transplantation. For a number of these specialised services, the Children's Hospital is recognised as the sole provider in Scotland.

The construction phase ended in January 2015 with phased occupancy of patient areas beginning in April 2015 and full working occupancy achieved in July 2015. There have been departmental changes and small scale works in the intervening period (e.g. ward use changes and the required service alterations) though no significant water system alterations have been notified to DMA prior to this report being commissioned.

In early 2018 an issue with regards to Cupriavidus bacteria being detected in the system water was identified in Wards 2A & 2B of the Children's Hospital. Disinfection works were carried out in these wards by DMA at this time. An extensive sampling regime was also implemented across the hospital which identified this and other bacterial control issues on the water system generally.

A decision was taken at this time by Infection Control, Clinical Staff and Estates to fit anti-microbial (PALL) filters in "high risk" areas throughout the hospital. Initially filters were fitted by both Estates staff and DMA (supported by Morris & Spottiswood), in locations as instructed by Infection Control, with the management and exchange of the filters being allocated to DMA in the period afterwards. These filters remain in place at time of report, and are anticipated to remain in place until such times as all parties are satisfied the water system(s) are brought back into specification (microbiologically).

In late 2018 Wards 2A & 2B in the Children's Hospital was closed to allow for extensive alterations to be made to the local water system, running hot flow and return services as close as is practical to the outlets, changing taps and WHBs, trough sinks removed from anterooms within the isolation rooms in 2A and other rooms repurposed to suit ward operations. In December 2018 NHS GG&C released a statement highlighting that whilst these wards were closed the opportunity to upgrade the air conditioning system would be taken. It is anticipated that this will take approximately 12 months to complete and the wards will remain closed for this period.

In light of the issues identified NHS GG&C commissioned the Water Solutions Group (Tim Wafer) to write a specification for a chlorine dioxide (ClO_2) background dosing system for the domestic water system in the Adult and Children's Hospital. The installation of the dosing units was contracted to Scotmas Ltd with temporary units being installed to supply Wards 2A & 2B in November 2018.

Dosing units were specified for various critical points throughout the water system with the bulk water tank supply units being switched on in December 2018, with the other units scheduled to be commissioned throughout January 2019.

Extensive alteration works to the pipework in the various plantrooms throughout the hospital were required in order for the ClO_2 units to be installed.

Other remedial works have been implemented on the water system in light of the issues found, including surveys of the drainage system[1], cleaning and disinfection of WHB and shower drains and Optitherm flow regulator/diffuser replacement regime.

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[1] DMA have not been provided with a copy of the report on the drainage system. This is outwith the scope of DMA's work. DMA would be unable to comment on the accuracy, or technical elements contained within this report.

WATER SYSTEM RISK ASSESSMENT

***Please note** that the plantroom surveys were conducted prior to the installation of the chlorine dioxide (ClO_2) dosing units and the associated alteration works required to allow for the installation of these units. It is recommended that the plantrooms are resurveyed upon completion of these works (Anticipated to be completed in late January 2019).*

During the period from report being commissioned and being presented to NHS GG&C, plantroom and risers were surveyed and draft copies of these sections of this report were issued to Estates, with issues identified also being reported both verbally and electronically to Estates.

Town Mains

There are 2 separate incoming mains water supplies serving the cold water storage tanks within the basement plantroom of the Adults and Children's hospital building, and a separate dedicated fire main line supplying the fire tanks in the adjacent plantroom.

The incoming mains enter the building in the MTHW/Chilled Plantroom (Govan Road Mains) and basement tank room (Hardgate Road Mains) and run into the tank room to serve four off "Raw" water storage tanks and two Trades water tanks. These incoming mains both have double check valves and water meters fitted.

The water meters are linked to the BEMS system and allow the user to cross reference the quantity of water used against the quantity indicated on the external meter.

The Hardgate Road (small) mains supply feeds only the main fire sprinkler tanks in the basement fire tank plantroom.

The RHS 'Trades' Water tank has been drained and isolated, with the mains supply to this removed.

There are various short deadlegs on the domestic water mains which may be used as drain down points, injection points or emergency bypass connection points. Some of these connection points are being utilized by Scotmas for testing/sensor points for the chlorine dioxide (ClO_2) background dosing systems which are being installed. DMA would recommend any which are not utilised in this way are incorporated into the site flushing regime, where they are not already included.

DMA have described both the Govan Road and Hardgate Road supplies as medium risk due to the drain points etc. on the pipework for which there is no record of flushing. We have described the Hardgate Road (small) as a High Risk due to the low turnover to the Fire Suppression system.

CWSTs and Filtration System

QEUH Adult and Children's Hospital CWSTs

There are 10 domestic water storage tanks in the building which are all situated in the basement tank room.

Raw Water Tanks 1A/1B and 2A/2B are supplied by two town mains (Govan Road and Hardgate Road) to ensure continuity of supply in case of a town mains failure. The Raw Water tanks supply the Bulk Water tanks 1A/1B and 2A/2B via two 0.2 micron filtration sets (level of filtration advised by Estates).

All four tanks can be linked together (via outlets) to supply both filtration units. There is a short section of link pipework, which can be opened or closed depending on operational requirements, between the tanks R1A/1B and R2A/2B which can allow each set of tanks to supply separate filtration units, or all tanks to supply both filtration units. When the link pipework is closed tanks R1A/1B supply filtration unit 1 with R2A/2B supplying filtration unit 2.

The filtration units fill separate Bulk Water Tanks (filtration unit 1 supplying 1A & 1B and filtration unit 2 supplying 2A & 2B). There appears no way to reconfigure set-up to allow the filtration units to fill the other tanks under fault conditions, other than backfilling through the outlet distribution pipework from the post filter tanks. Filtration sets should be maintained in accordance with manufacturer's instructions and maintenance schedule.

DMA understand that there is an intention in 2019 to alter the filtration pipework and to install a third filtration unit to provide additional capacity, reliability and redundancy.

WATER SYSTEM RISK ASSESSMENT

Bulk Water Tanks 1A and 1B are linked, with 2A and 2B also linked. All four tanks can be linked together (via outlets) to supply domestic cold water including drinking water to the building with the exception of the trades system. There is a short section of link pipework, which can be opened or closed depending on operational requirements, between the tanks 1A/1B and 2A/2B which can allow each set of tanks supplying separate zones and plantrooms (calorifiers) within the hospital, or all tanks to supply all areas. When the link pipework is closed tanks 1A/1B supply plantrooms 21/22/41 and the corresponding outlets in these zones with 2A/2B supplying plantrooms 31/32/33 and the corresponding outlets in these zones.

The CWSTs were cleaned and disinfected in summer 2018 by DMA. Large amounts of debris were found in the water tanks, including large particles of rust coloured materials (particularly in the Govan Road supplied tanks), sponges in a Raw water tank (believed to have been left over from initial pre-handover cleaning and disinfections, bolts/washers in post filter tanks (again believed to have been left over from initial pre-handover cleaning and disinfection).

N.B. It should be noted that there is no separate dedicated supply to the Renal (or other medical) systems, with all being fed from the Bulk Water system. This means that system disinfections will require to be very carefully scheduled or carried out locally as the disinfection procedure/chemical may interfere with the renal/medical systems and impact on patient welfare. DMA understands that suitable filtration and testing regimes have been implemented on the renal system in light of the ClO_2 dosing systems being installed, and that supply pipework to the renal plants have been altered to bypass the local ClO_2 "top-up" units.

Emergency procedures should be considered and formulated to allow for system disinfection if required.

Alternatively, a separate independent supply should be considered for this system.

There are 2 No. water booster sets in the water tank room. Each booster set is set to a different set point pressure depending on which plantroom and area it serves. In the event of failure each booster can also be switched to the other set point pressure.

- BS01 – Feeding Plantroom 31, 32 & 33 - 7.7 Bar
- BS02 – Feeding Plantroom 21, 22 & 41 – 5 Bar

The expansion vessels attached to the CWST booster sets are not of a flow through design and they are not insulated.

From the 2 No. water booster sets there are 8 domestic water systems:

- Plantroom 21
    - Via a Pressure reducing valve (PRV) the BCWS feed 21CAL01/02/03
- Plantroom 22
    - Via a Pressure reducing valve (PRV) the BCWS feed 22CAL01/02/03
- Plantroom 31 – 122
    - BCWS feeds 31CAL01/02/03
- Plantroom 31 – 128
    - Via a Pressure reducing valve (PRV) the BCWS feeds 31CAL07/08/09
- Plantroom 31 – 129
    - BCWS feeds 31CAL04/05/06
- Plantroom 32
    - BCWS feeds 32CAL01/02/03
- Plantroom 33
    - BCWS feeds 33CAL01/02/03
- Plantroom 41
    - BCWS feeds 41CAL01/02/03

The water supply into each plantroom is metered by a CWS flow meter. This allows for monitoring of specific parts of the system for energy purposes.

There are numerous connection points on the domestic water system within plantrooms and risers (which DMA have assumed were installed for flushing purposes and bypasses) which are creating deadlegs on the system. It is advised that these be removed wherever practicable or a register of the locations created and points incorporated into the site flushing regime. These were noted during the plantroom surveys, though DMA have been advised that a programme of removing these wherever practical is under way by Estates. DMA shall

WATER SYSTEM RISK ASSESSMENT

review these connection points when plantrooms are next surveyed, anticipated after the completion of the ClO_2 dosing system installation programme.

The Trades Water System supplies "Non-domestic" outlets such as bib taps in plantrooms, irrigation connections points and the 12th floor heli-pad fire suppression system. One side of the Trades tank was valved off with the mains supply to this tank being removed. It would appear that this tank has been offline since the construction phase. DMA would advise should this tank ever be brought back online it is cleaned and disinfected prior to the tank being reinstated.

There are various connection points onto other "non-domestic" outlets from the domestic water system such as renal dialysis, endoscopy wash, pressurisation units, steam humidifier units (DMA advised all supply pipework to these are now removed) and MRI chiller cooling which are connected to the Bulk Water system. It is expected that as the lines to these systems will often have a very low turnover, a double check valve or similar should be fitted as close as practicable to the tee-off point to prevent potentially stagnant water from contaminating the domestic system, or preferably these are switched to the Trades Water system.

N.B. for information on Fire Suppression Tanks please see section 8.

Calorifiers (PHE's with Storage Vessels)

The calorifiers are situated in various plantrooms on the 2nd, 3rd and 4th floors of the building feeding designated zones within the hospital building. See supportive data following which identifies which calorifiers feed which areas.

Each set of calorifiers is a bank of 3-linked calorifiers fed from the boosted Bulk Water system, with heat source being via a plate heat exchanger on the outside of each calorifier fed from the MTHW system. A circulating pump on each calorifier/plate heat exchanger ensures the water is circulated throughout each vessel to maintain temperature.

The distribution temperatures were above 55°C at outlets (and on supply to TMVs) in the majority of areas tested with direct hot feeds above 55°C (see outlet section for supportive data and exceptions). **N.B.** This will require to be reviewed upon completion of Optitherm tap monitoring element in the "high-risk" areas of this assessment.

It should be noted however that whilst carrying out flushing works and ClO_2 testing in wards 2A & 2B during December 2018 there were multiple instances of hot temperatures dropping off and being recorded at <55°C. This was reported to Estates on each occasion, with DMA advised there were issues in the Energy Centre which were causing a reduction in the MTHW supply to the Adult & Children's Hospital, which had a knock on effect to the calorifiers. Generally when advised issues were rectified the temperatures recovered quickly to ≥60°C within the wards.

Distribution flow temperatures were consistently above 60°C, with return temperatures to calorifiers consistently above 55°C on all calorifiers (Plantroom 21 calorifiers just above 55°C), as recommended within L8/HSG 274 Part 2 and SHTM 04-01. All base temperature appeared satisfactory at time of survey also (26/09/18)

The expansion vessels attached to the calorifiers are not of a flow through design as recommended in HSG 274 Part 2 (info Box 2.1) and SHTM 04-01 Part A (Para 8.22) and they are not insulated as recommended in SHTM 04-01 Part A (Para 8.22). Estates advised that there is an intention to alter the pipework and vessels to accommodate flow through vessels in early 2019.

Generally water flushed from drain on calorifiers and expansion vessels ran clear either instantly or after only a very short period of time (typically <10 seconds). No internal inspection records for calorifiers were available.

WATER SYSTEM RISK ASSESSMENT

Hot and Cold Water Systems

The domestic cold water system within the hospital is fed from the Bulk Water tanks located in the basement tank room of the hospital. DMA have been informed there are no outlets fed directly from Town Mains within the building.

"Non-domestic" outlets such as bib taps in plantrooms, irrigation connections points (now removed) and the 12th floor heli-pad fire suppression system are fed from the Trades Water tanks. Please refer to the section 5 for information and supporting data relating to the CWSTs.

There are however some connection points onto other "non-domestic" outlets such as renal dialysis (both plant and individual 'emergency' points), endoscopy wash, pressurisation units, steam humidifier units and MRI chiller cooling which are connected to the Bulk Water system.

N.B. NHS Estates have fitted 'Emergency Dialysis' points on cold water system since the initial installation. NHS should confirm location of all Emergency Dialysis Points and ensure System Drawings and Asset Lists (not produced as part of this assessment) are updated to reflect this. Additional filtration and testing procedures should be incorporated into the use of these emergency points in light of the chlorine dioxide background dosing systems being installed on the domestic water system.

There are also numerous connection points and drain points on the domestic water system within plantrooms and risers (which DMA have assumed were installed for flushing purposes and bypasses) which are creating deadlegs on the system. It is advised that these be removed wherever practicable or a register of the locations created and points incorporated into the site flushing regime.

The domestic hot water systems are fed from a series of Calorifiers located on the 2nd and 3rd floors in the adult hospital and on the 4th floor of the children's hospital. These calorifiers feed different areas/zones within the Hospital. Please refer to section 6 for information and supporting data relating to the calorifiers.

Access to record temperatures within the hospital were restricted prior to December 2018 as DMA were advised no panels could be removed to access pipework in patient areas. This meant that in many areas only mixed hot temperatures could be recorded. In December 2018 an HAI Scribe was issued to Estates and subsequently to DMA which permitted panels to be removed in "low risk" patient areas. "Low-risk" areas were generally described as locations where PALL filters were not fitted. A separate HAI Scribe was provided to allow the Horne Optitherm tap to be bypassed to draw direct hot water through the tap using a flushing kit in "high-risk" areas, generally described as those areas with PALL filters fitted. This allowed for "low-risk" temperatures to be recorded for this survey in December 2018, with the "high-risk" areas scheduled to be recorded in January 2019.

Cold water temperatures recorded by DMA vary with some indicating heat gain on the cold water system. Investigations should be carried out as to the reasons for this with appropriate remedial actions taken e.g. additional insulation, installation of flushing valves, manual flushing of outlets, servicing of TMVs to reduce likelihood of back flow of hot into cold (or opposite). Sampling, disinfections and background dosing should be considered as part of the escalation process should any issues persist.

DMA were advised flushing valves are installed at a number of points on the domestic cold water system in the lower floors of the Adult and Children's Hospitals however Estates were unable to confirm the location of all valves. The operating conditions for the valves (e.g. temperature controlled/timed) should be reviewed to ensure these are suitable for the intended purpose. It may be prudent to consider additional dump valves at the end of main or sub-ordinate pipe work runs to improve cold water flow throughout site.

DMA understands that investigations into remote temperature monitoring systems, to record temperatures at critical points on the hot and cold system (e.g. sentinels, sub-ordinate flow and returns etc.) are being undertaken, though no decision on the system has been taken at the time of this report.

The hot water temperatures recorded at outlets were generally satisfactory with only a small number of local excursions. We would advise this is investigated and the flow and return commissioned as appropriate. At the time of initial assessment in 2015 DMA were advised that there are minimal localised "tertiary" loops, with the drops to outlets running from above the ceiling (approx. 2m). Alterations have been made to the hot flow and return system in Wards 2A & 2B to bring the flow and return loops down as close as practical to the actual outlets, though these Wards remain out of use at the time of this report (Though the water system is live with a flushing regime implemented)

WATER SYSTEM RISK ASSESSMENT

It was generally noted that hot temperatures rose quickly when DMA were recording temperatures throughout the building and the flow and return circuits appear to be circulating hot water in most areas (please refer to following pages for supporting data and exceptions). **N.B.** This will require to be reviewed upon completion of Optitherm tap monitoring element in the "high-risk" areas of this assessment.

Domestic water pipework runs above ceilings throughout the building. Access for ongoing monitoring of flow and return loops is problematic as ceiling tiles cannot be easily removed within the hospital environment and alternative methods of monitoring should be considered should current BEMS monitoring points not be sufficient for the hot flow and return system (e.g. additional BEMS monitoring points installed).

The recent provision of the HAI Scribes for temperature monitoring in the "low-risk" and "high-risk" areas should allow for more accurate temperature monitoring at outlets going forward.

As noted during previous assessment pipework within the Hospital is generally labelled and insulated where visible.

Issues were identified with WHB drains backing up, which in light of the issues identified with potential retrograde contamination from drains to taps, along with the potential reduction in use of outlets where WHBs not draining freely should be rectified.

The vast majority of Thermostatic mixing valves (TMVs) installed are TMV taps, (Horne Optitherm in clinical areas and Armitage Shanks in non-clinical areas) with the only exceptions noted being infrared outlets in non-patient area toilets with infrared taps which have a TMV mounted approximately 0.5m from the outlet. Thermostatic mixing valves (TMVs) should be regularly serviced as per the manufacturers instructions and in accordance with the Written Scheme for site which should include input from the relevant NHS departments (e.g. Estates, Clinical, Infection Control, Authorising Engineer, Compliance Team, Health & Safety, Water Safety Group etc. – please note DMA's attendance at Water Safety Group meetings has not been requested) for local infection control guidance for bacterial control taking into account the location, design, operation, servicing and requirements of infection control.

Horne Optitherm TMV taps are designed to be demounted for maintenance and servicing elsewhere. Specific service method statements and maintenance requirements for these items in these areas should form part of the written scheme.

Showers appear to be a standard design throughout the hospital with no adjustable heads noted during the survey. However, no cleaning and disinfection of shower heads and hoses or replacement regime is in place at present, though Colin Purdon and Andy Wilson were investigating options in relation to showers at the time of this report. As showers have not been part of a regular cleaning regime up to this point we would advise consideration is given to changing all heads and hoses with new WRAS approved components prior to the commencement of a new cleaning/replacement regime.

DMA were advised by Mercury Engineering and Estates in 2015 that all materials fitted during the construction were WRAS approved and therefore do not support bacterial growth. However, DMA have been advised that some sections of pipework may have been 304 Stainless Steel rather than 316 Stainless Steel and that not all pipework was WRAS approved. It is advised that should this be the case confirmation should be sought from the manufacturers and/or installers that the pipework is of a suitable standard and that this will not contribute to microbial growth, or in any other way impact on the safe operation of the water system(s). Alternatively, independent testing of the non-WRAS approved materials could be undertaken to confirm suitability or otherwise of the materials and components in question.

EPDM flexible hoses have been installed in a small number of non-clinical areas with the only patient areas DMA have noted as having flexible hoses being the connection to Arjo baths (both connections to the hot/cold system and internally within the actual bath). Wherever practicable DMA would recommend all flexi hoses are removed and connections hard piped. Where flexible hoses cannot be removed then replacing with alternative WRAS approved hoses with linings other than EPDM should be considered. In healthcare premises additional guidance on the replacement and use of flexible hoses is provided in the "safety action notice SAN(SC)09/03".

Flexible hoses have also been noted on the boosted bulk water system on pressure reducing valves. If possible, these should be hard piped (stainless steel) or WRAS approved hoses with linings other than EPDM should be considered. Should these not be available for these types of units/connections then a regular inspection and replacement schedule should be implemented for these.

WATER SYSTEM RISK ASSESSMENT

The bib taps, irrigation points (which DMA have been informed are no longer connected to the water system) and 12th floor heli-pad fire suppression system are fed from the Trades system with very long pipework runs through the building and plantrooms to the outlets. DMA would advise all points on the trades system should be included in the site flushing regime. Please also refer to section 8 for information on other risk systems.

No outlets on the Trades system have been designated as "sentinel outlets". Due to the type of system and the extended pipe runs to the outlets it may be prudent to designate all outlets from this system as sentinel and include in monthly monitoring and site flushing regime. DMA understands that a programme or removing all non-essential bib taps and outlets on the Trades water system is under way by Estates.

It should be noted that the information and recommendations included within these pages relates to the outlets surveyed only though many of the conditions highlighted are likely to be replicated throughout the hospital. Issues and information included should not be taken as a complete data set and should be treated as a representative sample of the system conditions found within the hospital. (NHS records should also be consulted for additional information e.g. temperature excursions)

Other Risk Systems

There are various 'Other Risk Systems' on site which may create a risk from Legionellosis and or other waterborne bacteria. Please refer to Section 8 of this assessment for details of other systems.

Water Systems Governance and Documentation

DMA completed a Gap Analysis and a review of the Written Scheme and Governance procedures as part of this assessment, which identified gaps in the PPM programme and areas where the Written Scheme are Governance procedures could be amended and expanded upon were identified. Records for tasks advised as completed by NHS Estates were not always available for assessment at the time of issue.

Pleaser refer to Section 9 of this document for further information on Governance and Documentation and Section 10 for guidance on the tasks which are recommended for inclusion within the Written Scheme and PPM regime.

WATER SYSTEM RISK ASSESSMENT

Risk Assessment Summary

Site Name	Queen Elizabeth University Hospital (Adults) Royal Hospital for Children	
No of Storeys	14 in Adult Hospital and 5 in Children's Hospital (including basement).	
Date of construction	Completed and handed over to NHS in January 2015 for phased occupation. Full occupancy achieved in July 2015.	
Date water services last upgraded	Original system with minor modifications	
Is building used by potentially "at Risk" groups?	Yes – persons with acute medical conditions	As the building is used by persons with acute underlying medical conditions which increases susceptibly to contracting legionellosis then the requirements for L8, HSG 274 and HTM/SHTM 04-01 compliance is of paramount importance.
Risk Rating	Due to the ongoing microbiological control issues identified within the water system(s) on site and the gaps identified in the Governance and PPM control regime, the increased susceptibility of some system users the water systems would be categorised as: • Potential for system to pose a hazard – Possible *(Mitigated by the control measures implemented during 2018)* • Condition of system being assessed (deficiencies/non-compliances found) - Major Therefore the water systems and the control regime would be classified as **High Risk**	

Total Quality. Assured.

Examination of Corroded Valve Body

For the attention of:
Dominic Holloway
Intertek Food Services
The Old Mill
Oxford Rd
Stoke-on-Trent
ST6 6QP

Intertek P&IA Ref. PR14273
Rev 0
January 2019




LIST OF REVISIONS

REV.	DATE	REVISION DETAILS	AUTHOR	ISSUED BY
0	January 2019	DRAFT	Dr Paul Roffey Senior Forensic Engineer [redacted]	Mr Andrew Piercy Principal Engineer [redacted]

Issuing Office: Manchester Technology Centre, UK

DISCLAIMER

LOCATIONS

UAE	ABERDEEN	MANCHESTER	OXFORD	MALAYSIA
ITS Testing Services U.K. Ltd. Plot NO26/M Street 3, Fourth Industrial Road Industrial Area 13 P.O. Box 4660, Sharjah	Exploration Drive Aberdeen Science and Energy Park Bridge of Don Aberdeen AB23 8HZ	Manchester Technology Centre, Units 12 – 15, Longwood Road, Manchester M17 1PZ,	Unit 6 Long Hanborough Business Park Long Hanborough Witney OX29 8LH	Exploration & Production ITS Testing Services Malaysia Sdn. Bhd. No. 7 Jalan Teknologi 3/5A Pusat Teknologi Sinar Damansara PJU 5, Kota Damansara 47810 Petaling Jaya Selangor Darul Ehsan Kuala Lumpur
T +971 (6) 5387036 F +97 (6) 5086111	T +44 1224 708500	T +44 161 875 7600 F +44 161 872 7670	T +44 1993 882445 F +44 1993 882559	T +603-6156-2200

CONTENTS

1 INTRODUCTION

Intertek Food Services instructed Intertek P&IA to carry out a metallurgical examination of an internally corroded water meter valve body removed from the Queen Elizabeth Hospital in Glasgow.

The purpose of the examination was to determine the elemental composition of the corrosion products and determine the mechanism and depth of corrosive attack on the valve body.

2 LABORATORY RESULTS

2.1 VISUAL AND MACROSCOPIC ASSESSMENT

An overview of the valve body and water meter is shown in Figure 1. No corrosion was observed on the external surface of the valve body.

The meter following removal is shown in Figure 2. Transferred red/brown corrosion products were noted on the plastic and brass components, Figure 3. The sealing O-ring appeared to be in good condition and when the lightly adhered transferred product was removed from the brass surface no evidence of attack was observed.

To allow the internal surface to be examined more closely the valve was longitudinally sectioned, see Figure 4. Red/brown corrosion products were noted on the internal surface, particularly around the points of geometry change at the flanges and neck.

Tubercules of corrosion product were seen at high magnification with evidence of damage to the paint layer, Figure 5.

It was also noted that the majority of the internal surface had an ‘orange peel’ surface finish to the paint layer.

2.2 ENERGY DISPERSIVE X-RAY ANALYSIS

The internal corrosion products were semi-quantitatively analysed using Energy Dispersive X-ray Analysis (EDX), the results are provided in Figure 6.

The products were primarily iron and oxygen with phosphorus, sulphur, calcium and aluminium detected at low levels. Chlorine, most likely in the form of chloride, was also detected at low levels.

2.3 OPTICAL MICROSCOPY

A section was taken through the corroded region shown previously in Figure 5, mounted in Bakelite and metallurgically prepared for optical microscopy by grinding and polishing to a one-micron finish. The microstructure of the material was revealed using a nitric acid solution etch.

The micrograph shown in Figure 7 shows a section through one of the geometry changes close to a flange with areas of corrosive attack up to depths of 1mm. The microstructure of the material confirmed it to be a flake graphite cast iron.

The mechanism of corrosion observed was graphitic corrosion, a mechanism which selectively leaches out specific alloying elements resulting in a weak skeletal structure, Figure 8. As the corrosion continues it propagates through the material, in some cases can show limited external indications, Figure 9. It should be noted that the remaining pant layer in the area of corrosion appeared to be only 40µm thick in some locations.

A section of the valve away from the corrosion where the orange peel texture was noted is shown in Figure 10. The textured finished was most likely the result of a coarse surface finish to the cast valve body. The paint layer whilst coarse appeared intact and approximately 500 µm in thickness.

2.4 CHEMICAL COMPOSITION

The composition of the valve body was assessed using Spark Optical Emission Spectroscopy (OES), the results are provided in Table 1.

3 DISCUSSION

The water meter (valve) body showed no evidence of external corrosion. Internally corrosion and paint blistering were seen around the section changes close to the flanges and around the neck.

Although some of the corrosion products had been removed in a previous investigation by Intertek Food Services, small tubercules remained which were red/brown in colour.

EDX analysis of the products showed them to be primarily iron and oxygen (iron oxide) with low levels of phosphorous, sulphur, calcium and aluminium. Chlorine was also detected, which would most likely have been in the form of chloride(s), a corrosive species.

Optical microscopy of a section taken through a corroded region confirmed a mechanism of graphitic corrosion, also known as selective leaching. This type of corrosive attack selectively corrodes specific alloying elements of the microstructure the resulting in a weak skeletal structure. It is often observed in relatively mild environments such as soft waters, water with slightly acidic pH, brackish water or other high conductivity waters. Once initiated it can propagate through a structure with only limited external evidence.

The maximum depth of attack observed in the section examined was around 1mm, this would have increased with continued service. It should be noted that the paint layer was measured a minimum of only 40µm in the corroded region at the geometry change, compared with 500µm away from the corrosion. The paint specification is not known to the author but typically a layer greater than 40µm would be expected. Typically, external corners exhibit reduced paint thicknesses, this is not normally seen on an internal corner however.

The orange peel effect noted on the internal surface was shown to be due to poor surface finish of the cast body prior to painting, whilst this may not be a direct cause for corrosion initiation, any holidays or asperities in the finished coating may lead to corrosion issues.

4 CONCLUSIONS

- The water meter valve body showed evidence of internal graphitic corrosion up to a maximum depth of ~1mm. Graphitic corrosion is often observed in flake graphite cast irons exposed to soft water conditions.
- A paint layer thickness of only 40µm was observed in the area of corrosion, whilst up to 500µm was observed in a remote region.
- An orange peel finish to the paint layer on the internal surface was due to poor surface finish on the as-cast valve surface.

5 RECOMMENDATIONS

Review the specification for the paint layer system to determine the specified minimum paint layer thickness required for optimum performance of the valve body. This may also specify a required surface finish and preparation before coating.

Graphitic corrosion can be potentially dangerous in pressure-containing cast iron equipment. If such items are installed these should be subjected to a visual inspection.

6 APPENDIX

6.1 TABLES

Element	Mass %
C	3.76
Si	2.62
Mn	0.51
P	0.054
S	0.086
Cr	0.13
Mo	0.01
Ni	0.04
Cu	0.11
Mg	<0.01
Fe	Balance

Table 1: Chemical composition of valve body.

6.2 IMAGES

Figure 1: Overview of valve body and water meter provided for examination.

Figure 2: Water meter removed showing transferred red/brown corrosion products on the brass body.

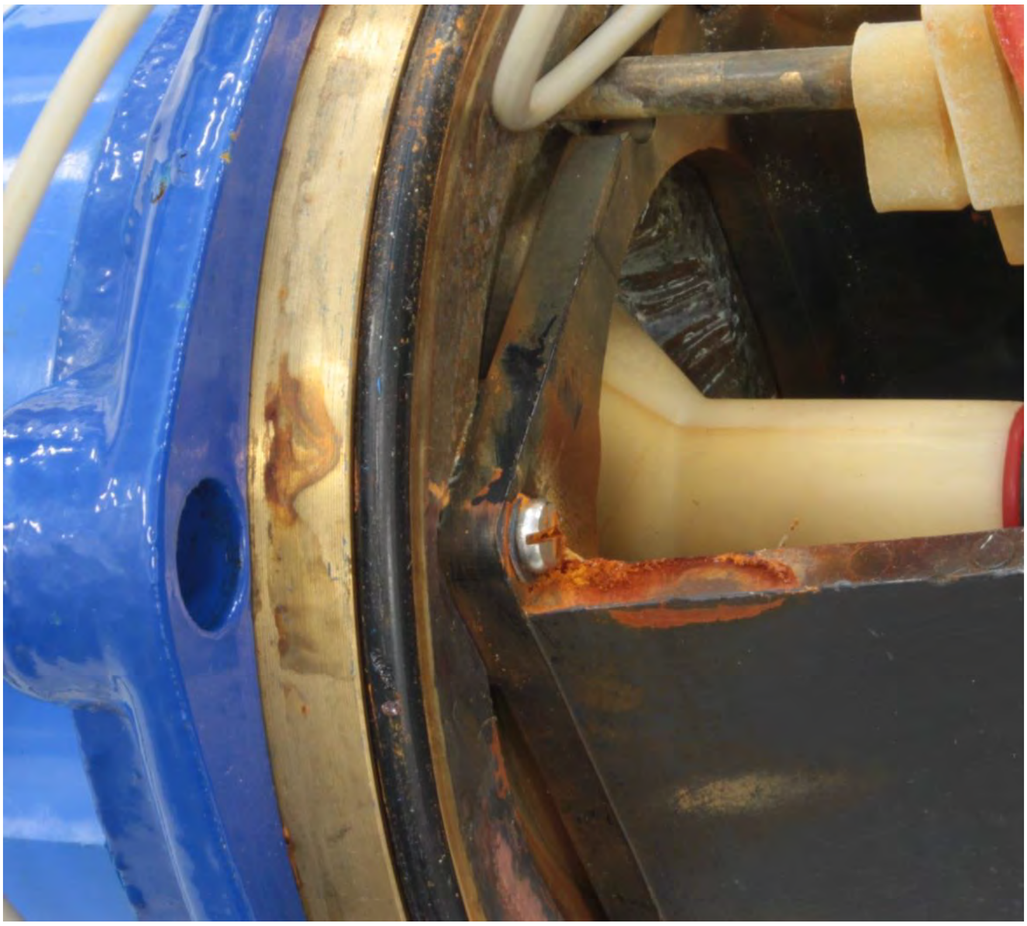

Figure 3: Transferred red/brown corrosion products with no evidence of corrosion on brass component.

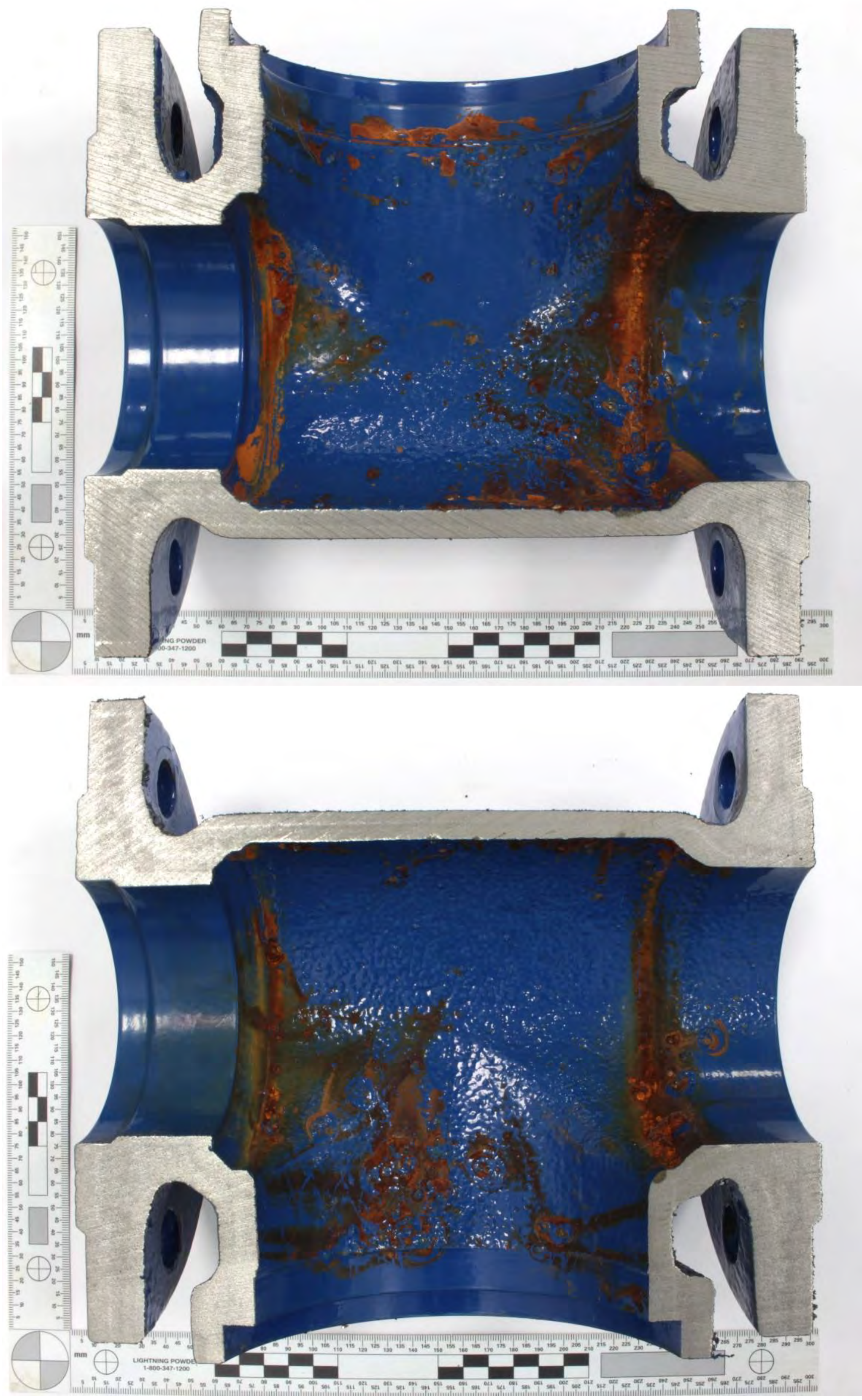

Figure 4: Overview of sectioned valve body showing corrosion products and paint blistering on internal surfaces. Note orange peel texture to paint layer.

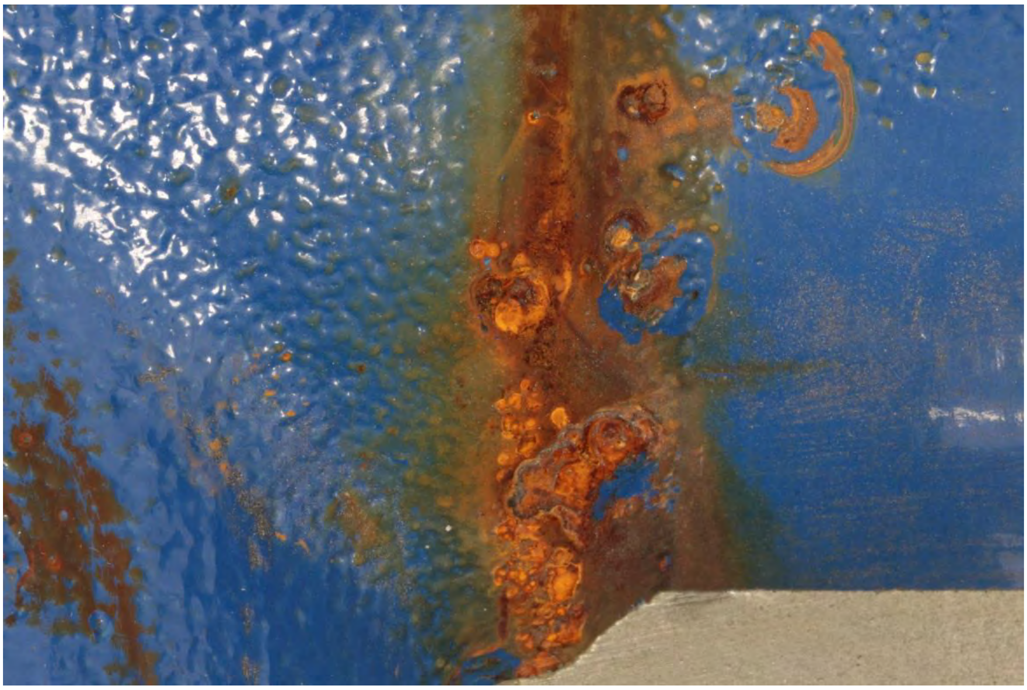

Figure 5: Corrosion at geometry change with red/brown corrosion product and orange peel finish.

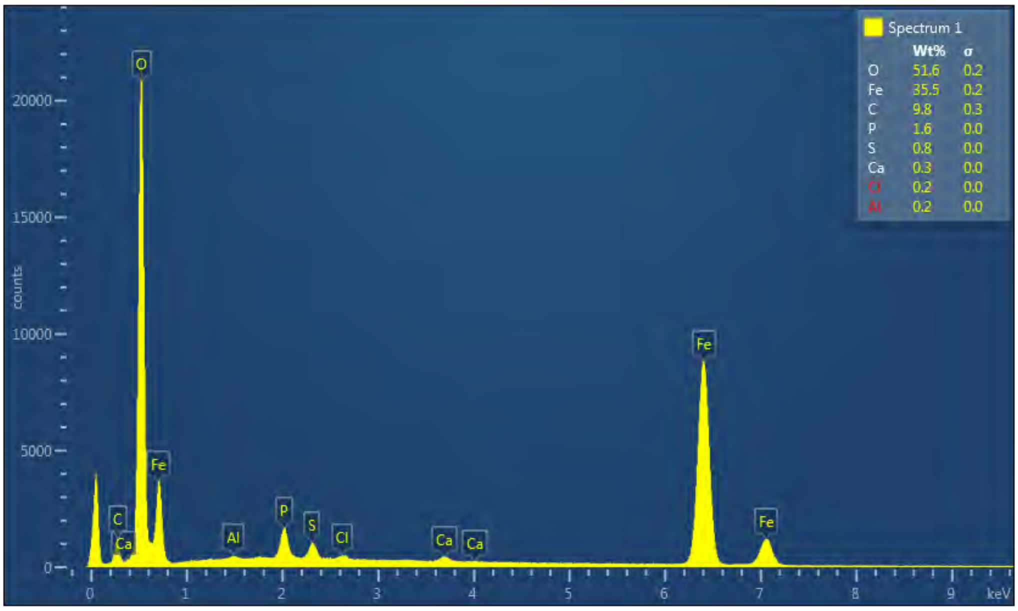

Figure 6: EDX Spectrum obtained from internal corrosion product.

Figure 7: Optical micrograph showing section through geometry change near flange with corrosive attack typical of graphitic corrosion.

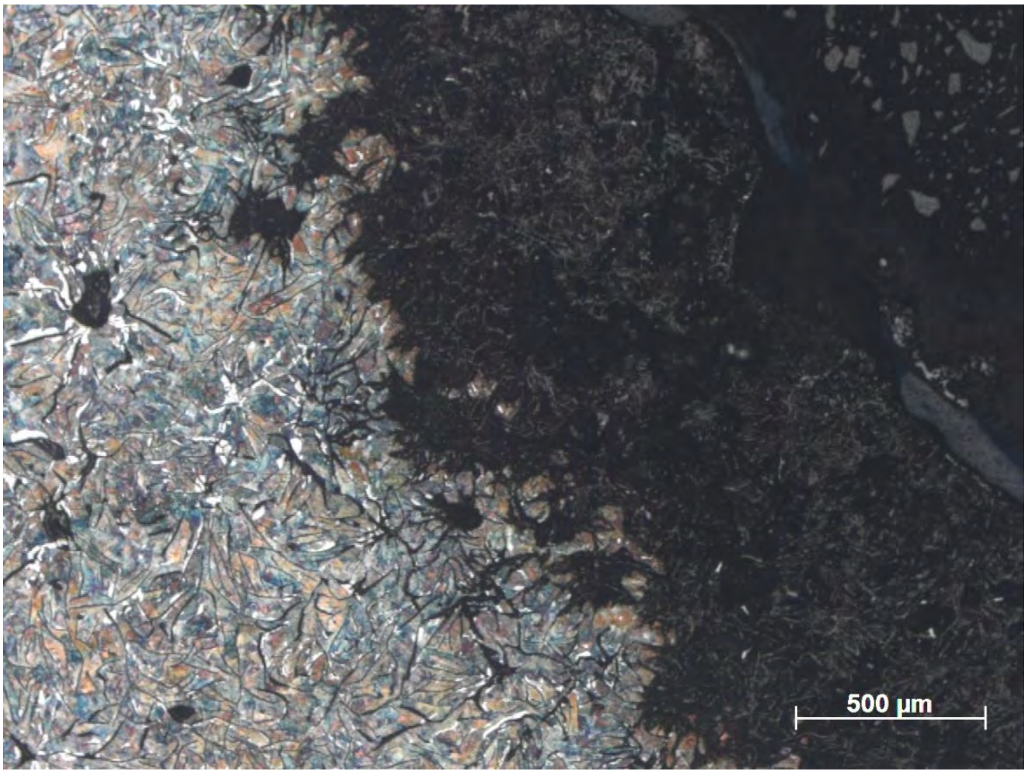

Figure 8: Detail of graphitic corrosion beneath paint layer.

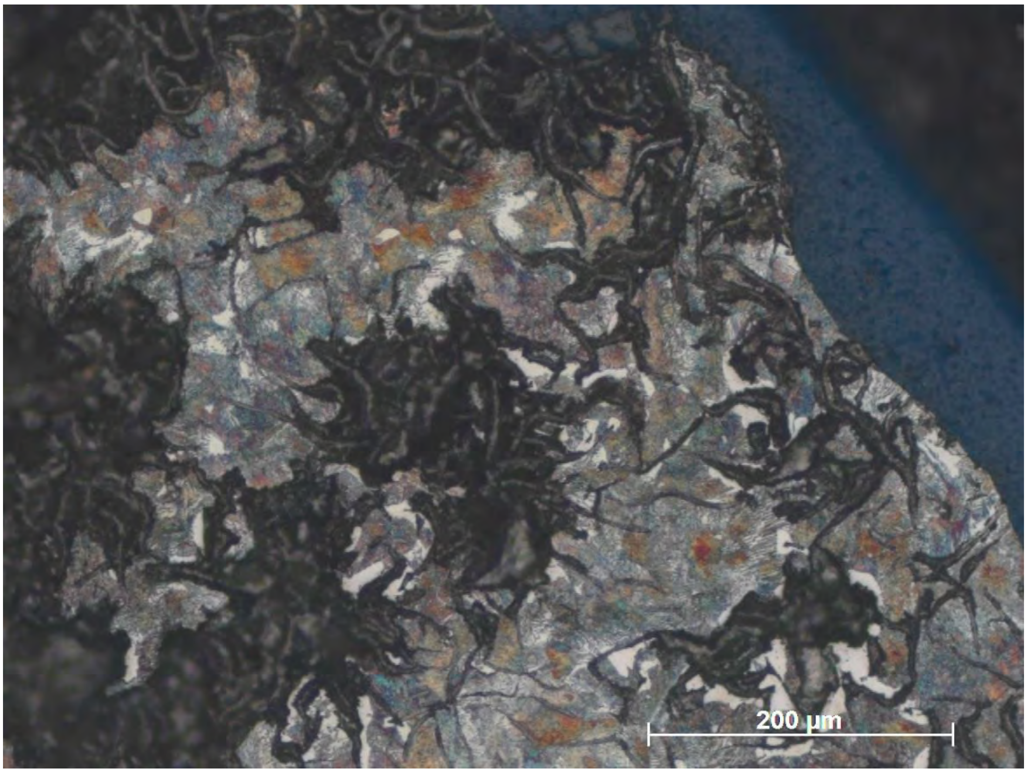

Figure 9: Corrosive attack around graphite flakes beneath paint layer. Note relatively thin paint layer.

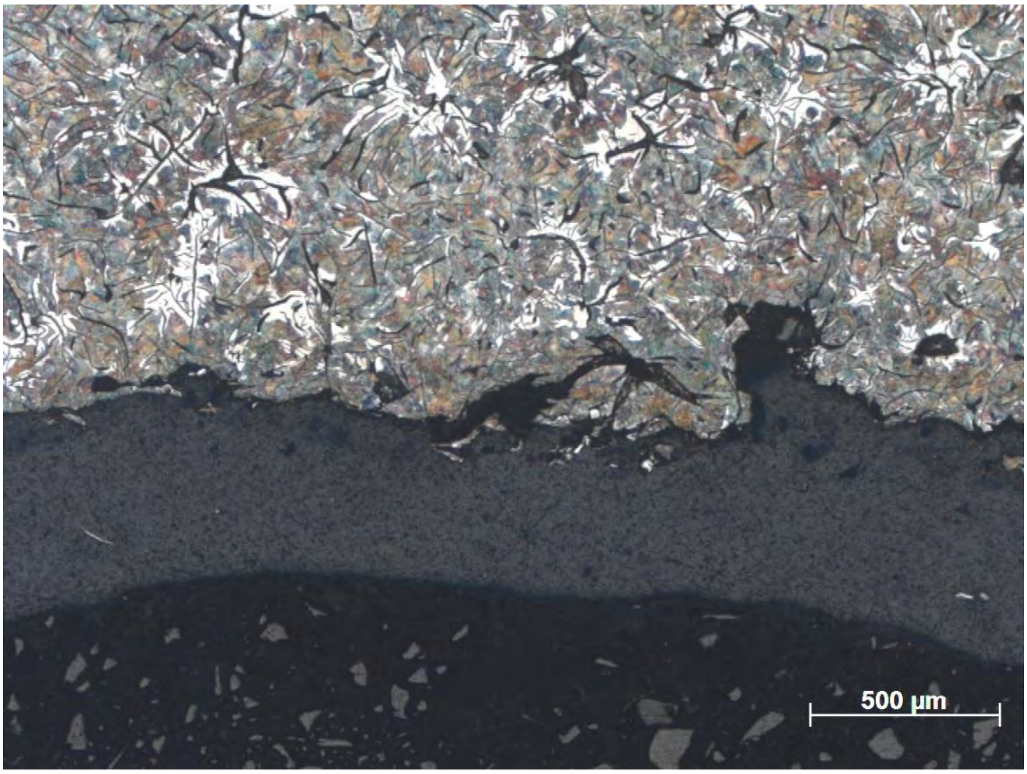

Figure 10: Painted external surface showing relatively coarse surface finish.

Scottish Water Byelaws Inspection Report

SPID: 200003690101

Byelaws Compliance Officer: Colin Semple

Premise: Queen Elizabeth University Hospital
1345 Govan Road,
Glasgow,
G51 4TF

Contraventions

Maternity Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Maternity Boiler Room	Boiler Room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Provide Fluid Category 4 protection for quick fill filling loop for heating system.
Fire Hose Reel	Maternity Building	Full Building	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install a double check valve	Install a double check valve back at source or on supply pipe to each fire reel. Also put in place a flushing program for fire reels.
Main Inlet	Maternity Boiler Room	Plant Room	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	install stop valve, double check valve and drain valve on incoming supply	
Main Inlet	Maternity Building	Unknown	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	install stop valve, double check valve and drain valve on incoming supply	Locate incoming supply pipe and install stop valve (**BS1010**) ,double check valve and drain valve.
Shower	Maternity Building	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all shower heads.

Energy Centre

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Energy Centre Building	Next to heating pressure unit	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Quick fill filling loop to top up heating system requires category 4 protection.
Main Inlet	Energy Centre Building	Mains Incoming Water Supply	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	install stop valve, double check valve and drain valve on incoming supply	

Adult and Children Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Hose Union Taps	Adult and Children Building	Basement Hydro Pool Plant Room	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Install a backflow prevention device to provide Fluid Category 5 protection.	This union hose tap must be fed from a storage cistern which incorporates a category 5 air gap or replace with bib tap and install double check valve on supply pipe.
Pipework	Adult and Children Building	Water Tank Room	03/08/2020	5	Dead Leg of Pipe Work - High Risk	Disconnect at relevant point so that no stop end at pipe work remains. Failure to remove may increase the risk of Legionella bacterial growth	Put flushing program in place at trade tank 1 & 2 on drain off outlets to lower the risk of Legionella bacterial growth.
Reduced Pressure Zone Valve (RPZ)	Adult And Children Building	Plant Room 31 3rd Floor	03/08/2020	4	RPZ Valve has not been commissioned/tested	RPZ Valve must be commissioned / tested by qualified tester annually.	Please provide test certificate from qualified tester.
Reduced Pressure Zone Valve (RPZ)	Adult And Children Building	Children Building Plant Room	03/08/2020	4	RPZ Valve has not been commissioned/tested	RPZ Valve must be commissioned / tested by qualified tester annually.	RPZ valve feeding hydrotherapy pool needs commissioned /tested by qualified tester also re-installed away from electrical appliances.
Shower	Adult And Children Building	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all shower heads on site.
Stop Valve	Adult And Children Building	Basement Fire Fighting Tank	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install **BS1010** stop valve	Install **BS1010** stop valves on the main inlet supply pipe to both firefighting tank.
Warning Pipe	Adult and Children Building	Water Tank Room	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install warning pipe	Reconfigure all early warning pipes in water tank area to correct air gap.

Teaching and Learning

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Teaching and Learning	4th Floor Boiler Room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Install category 4 protection on supply pipe to the quick fill filling loop for heating system.
Reduced Pressure Zone Valve (RPZ)	Teaching And Learning	4th Floor Boiler Room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	RPZ Valve must be commissioned / tested by qualified tester annually.	RPZ Valve supplying heating system must be commissioned / tested by qualified tester annually.
Shower	Teaching And Learning	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all shower heads.

Westmarc Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Westmarc Building	Boiler room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Quick fill filling loop for heating system must have fluid category 4 protection installed.
Main Inlet	Westmarc Building	Boiler Room	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install a Double Check Valve and a Drain Valve	Install a double check valve and drain valve on the mains water incoming supply pipe.

Neonatal Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Neonatal Building	Plant Room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Quick fill filling loop for heating system must have Fluid Category 4 protection.
Main Inlet	Neonatal Building	unknown	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	install stop valve, double check valve and drain valve on incoming supply	Locate and install - Possible location ground floor fire exit door in pipe chase.
Pumps	Neonatal Building	Secondary Filter Water Tank	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	This equipment must be fed from a storage cistern that incorporates a AA, AB or AD air gap	Pump booster Set must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Shower	Neonatal Building	Full Site	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all shower heads on site.

Neurology Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Pumps	Neurology Building	Level 6 Plant Room Water tank	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	This equipment must be fed from a storage cistern that incorporates a AA, AB or AD air gap	All booster sets fed from storage cistern must incorporate a AA,AB or AD air gap
Reduced Pressure Zone Valve (RPZ)	Neurology Building	Neurology Boiler House	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	RPZ Valve must be commissioned / tested by qualified tester annually.	This RPZ valve also needs re-installed sighted wrongly too high.
Shower	Neurology Building	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all Shower heads.

Landlangs Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Filling Loop	Landlangs Building	Boiler room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Quick fill filling loop for heating system requires fluid category 4 protection.
Filling Loop	Landlangs Building	Boiler room	03/08/2020	4	Insufficient Backflow Prevention for Category 4 Contamination Risk	Install suitable backflow prevention to provide Fluid Category 4 protection.	Quick fill filling loop for heating system requires fluid category 4 protection.
Pumps	Langlands Building	2nd floor plant room b	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	This equipment must be fed from a storage cistern that incorporates a AA, AB or AD air gap	Booster pump sets must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Shower	Langlands Building	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all shower heads.

PDRU And Vascular Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Main Inlet	PDRU And Vascular Building	Unknown	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	install stop valve, double check valve and drain valve on incoming supply	Locate incoming supply pipe and install stop valve **(BS1010**) ,double check valve and drain valve.
Pumps	PDRU And Vascular Building	Loft Area	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	This equipment must be fed from a storage cistern that incorporates an AA, AB or AD air gap	The booster pump set in loft area must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Shower	PDRU And Vascular Building	Full Building	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Restrain shower head	Restrain all Shower Heads.

Laboratory and Medicine Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Pipework	Laboratory and Medicine Building	Laboratory Level 4	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Install a backflow prevention device to provide Fluid Category 5 protection.	Laboratory taps must be fed from a designated category 5 tank supply which feeds labs only. Please confirm if level 4 laboratory taps are fed from domestic tank on level 4 or laboratory tank in basement.
Pumps	Laboratory and Medicine Building	Mortuary Tank 2 In Basement	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	Install a backflow prevention device to provide Fluid Category 5 protection.	Booster pump set fed from mortuary tank 2 requires category 5 protection.

CMB Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Fire Hydrant	CMB Building	At hydrant on grass verge left hand side of main entrance door	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Remove	Remove temporary water supply from fire hydrant to CMB building and install a permanent supply which meets the water bylaws regulations.
Main Inlet	CMB Building	Unknown	03/08/2020	5	Dead Leg of Pipe Work - High Risk	Disconnect at relevant point so that no stop end at pipe work remains. Failure to remove may increase the risk of Legionella bacterial growth	The old water mains incoming supply pipe needs disconnected back at source. Please confirm if this has been done.

AMB Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Pipework	AMB Building	Unknown	03/08/2020	5	Dead Leg of Pipe Work - High Risk	Disconnect at relevant point so that no stop end at pipe work remains. Failure to remove may increase the risk of Legionella bacterial growth	This building is vacant please confirm if pipework has been capped off back at source.

Max Fax Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Pipework	Max Fax Building	Lab Area - Grinder Machine	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install a double check valve	Install double check valve on supply pipe to dental grinder.

Podiatry Building

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Main Inlet	Podiatry Building	Plant Room	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install a Double Check Valve and a Drain Valve	Install Double check valve and drain valve on incoming supply pipe.

Whole Site

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Bath	All Buildings	Arjo Baths	03/08/2020	5	Insufficient Backflow Prevention for Category 5 Contamination Risk	This equipment must be fed from a storage cistern that incorporates a AA, AB or AD air gap	Arjo Baths must be fed from a designated storage cistern that incorporates a AA, AB or AD air gap. Rhapsody/Primo P200+ Location- NSGH-02-DMW-013 NSGH-02-DMW-011 NSGH-01-STW-079 NSGH-06-GENW1-001 NCH-04-DCFP-038 NCH-03-GW3-059 NCH-03-GW1-068 NCH-02-SCH-079 NCH-02-ARU-006 NCH-01-CCW-051 NCH-01-CAR-048
Main Inlet	Full Site	All boundary incoming supply	03/08/2020	3	Insufficient Backflow Prevention for Category 3 Contamination Risk	Install a double check valve to give whole site protection	Install a double check valve to all main inlet boundary's supply points. location- Meter -11W712602 150MM X-253618/Y-665875 06M440901/03H000872 80/20 COMBI X-253329 Y-665758 3K220000653954 150MM X-253443 Y-665842 09H701812/09M102281 80/20 COMBI X-253547 Y-665541 11W727521/19W711190 100MM X-253815 Y-665585 11H762937/11M686368 80/20 COMBI X-253790 Y-666042

Recommendations

Premise Fitting	Area	Location	Recommendation
Fire Hydrant	Full Site	Full Site	All fire hydrants on site to have flushing program in place to remove any risk of legionella bacterial growth.

Comment/Issues

Premise Fitting	Area	Location	Comment/Issue
Pipework	Neuro-Surgical Plant Room 9	Plant Room 9	This area is under renovation and has double check valve in place. This area will require a revisit in one years' time once work has been completed.

element

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REF No	E 105723	: Issue 1
Page	1 of 1	
Ord No	PO-6343/DW	
Date Tested	14/10/21	
Date Reported	14/10/21	

Attn: David Watson

Item - 10mm DIAMETER SCREWED ROD : CWST 2A

Specification - Client Requirement

Chemical Analysis - ICP-OES,Combustion (C+S) (* Sub-Contracted To: Element Teesside(UKAS 0038))

	C [%]*	Si [%]*	Mn [%]*	P [%]*	S [%]*	Cr [%]*	Mo [%]*	Ni [%]*	Al [%]*	Co [%]*	Cu [%]*	Comments
001:	0.04	0.50	1.45	0.042	0.007	18.4	0.31	8.23	<0.01	0.16	0.90	Nil
	Nb [%]*	Ta [%]*	Ti [%]*	V [%]*	W [%]*							Comments
001:	0.02	<0.01	<0.01	0.07	0.04							Nil

Certificate Comments

---------------------------End Of Text-----------------------------

Tested by **Element Teesside, UKAS 0038**

[redacted]

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REF No E 105725 : Issue 1
Page 1 of 1
Ord No PO-6343/DW
Date Tested 14/10/21
Date Reported 14/10/21

Attn: David Watson

Item - 12mm DIAMETER BOLT : CWST 2A

Specification - Client Requirement

Chemical Analysis - ICP-OES,Combustion (C+S) (* Sub-Contracted To: Element Teesside(UKAS 0038))

	C [%]*	Si [%]*	Mn [%]*	P [%]*	S [%]*	Cr [%]*	Mo [%]*	Ni [%]*	Al [%]*	Co [%]*	Cu [%]*	Comments
001:	0.04	0.52	1.19	0.033	0.004	18.6	0.04	7.96	<0.01	0.18	0.85	Nil
	Nb [%]*	Ta [%]*	Ti [%]*	V [%]*	W [%]*							Comments
001:	<0.01	<0.01	<0.01	0.06	<0.01							Nil

Certificate Comments

---------------------------End Of Text-----------------------------

Tested by **Element Teesside, UKAS 0038**

[redacted]

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REF No E 105724 : Issue 1
Page 1 of 1
Ord No PO-6343/DW
Date Tested 14/10/21
Date Reported 14/10/21

Attn: David Watson

Item - 12mm DIAMETER BOLT : CWST 1B

Specification - Client Requirement

Chemical Analysis - ICP-OES,Combustion (C+S) (* Sub-Contracted To: Element Teesside(UKAS 0038))

	C [%]*	Si [%]*	Mn [%]*	P [%]*	S [%]*	Cr [%]*	Mo [%]*	Ni [%]*	Al [%]*	Co [%]*	Cu [%]*	Comments
001:	0.024	0.52	1.19	0.033	<0.003	18.5	0.04	7.95	<0.01	0.18	0.85	Nil
	Nb [%]*	Ta [%]*	Ti [%]*	V [%]*	W [%]*							Comments
001:	<0.01	<0.01	<0.01	0.06	<0.01							Nil

Certificate Comments

----------------------------End Of Text-----------------------------

Tested by **Element Teesside, UKAS 0038**

[redacted]
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**For and on authority of
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REF No E 105722 : Issue 1
Page 1 of 1
Ord No PO-6343/DW
Date Tested 14/10/21
Date Reported 14/10/21

Attn: David Watson

Item - 10mm DIAMETER SCREWED ROD : CWST 1B

Specification - Client Requirement

Chemical Analysis - ICP-OES,Combustion (C+S) (* Sub-Contracted To: Element Teesside(UKAS 0038))

	C [%]*	Si [%]*	Mn [%]*	P [%]*	S [%]*	Cr [%]*	Mo [%]*	Ni [%]*	Al [%]*	Co [%]*	Cu [%]*	Comments
001:	0.04	0.48	1.68	0.038	0.015	18.2	0.47	8.33	<0.01	0.15	0.26	Nil
	Nb [%]*	Ta [%]*	Ti [%]*	V [%]*	W [%]*							Comments
001:	0.04	<0.01	0.01	0.06	0.03							Nil

Certificate Comments

---------------------------End Of Text-----------------------------

Tested by **Element Teesside, UKAS 0038**

[redacted]

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For and on authority of
Element Materials Technology

QEUH and RHC Hospitals					
NHS GGC Annual Water Systems AE Audit					
Site Address: Queen Elizabeth University Hospital and the Royal Hospital for Children Hospital, 1345 Govan Rd, Glasgow G51 4TF					
Building	QEUH and RHC Hospitals	**Date**	28th February and 1st March 2022	**Auditor**	Dennis H. Kelly
Staff Interviewed	Mel MacMillan and Kerr Clarkson of the NHS GGC Estates Department at the QEUH.				

Description of Levels of Risk:

Very High	Urgent Remedial Action – Lp growth and aerosol opportunity with susceptible people present on site
High	Remedial Action is needed but not immediately – Lp growth opportunity is present
Medium	Acceptable risk but some concerns– Lp likely to be controlled but improvements should be sought
Low	Risk controlled and acceptable

Levels of Risk found during the Audit:

The levels of risk detailed below reflect the highest level of risk identified during the audit in that particular category.

The audit process reviews the following five areas:

Audited Topic	Level of Risk
B1 Risk Assessment	
B2 Schematic Drawings	
B3 Written Scheme Monitoring and Records	
B4 On Going Water Treatment	
B5 Task Completion	

Comments

There is a high level of completion of the required tasks at both hospitals and an improvement on the performance of the management and control systems compared to the audits that were completed in February 2020 and also in February 2021. The direction of travel in terms of managing the water systems continues to be positive.
The close working relationship between the NHS GGC Estates Department and the contractors, DMA Canyon Ltd and Scotmas, appears to be important in delivering the required risk reduction processes and procedures.
The on-site involved Estates staff at the two hospitals have a high level of technical understanding and this is crucial in maintaining lower levels of risk associated with the water systems.

There are thirteen recommendations made in this section of the audit and fthat is an increase of three over the audit completed in 2021.

Summary of Actions				
Actions		Risk Level	Completed Date	Signature
1.	It is recommended that a new QEUH/RHC risk assessment is commissioned as soon as possible.			
2.	It is recommended that NHS GGC formalise their approach to when risk assessments should be completed and reviewed.			
3.	It is recommended that a check is made to ensure that the Hydrotherapy pool has been risk assessed.			
4.	It is recommended that the current and other recent pipework modifications that are being completed in Wards 2A/2B are reflected in updated drawings and that these updated drawings are added to the drawings file.			
5.	It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.			
6.	It is recommended that the chlorine dioxide current monitoring programme is amended to fall into compliance with the HSG 274 guidance document.			
7.	It is recommended that the failing isolation valves are replaced in order to allow the internal inspections of the unopened calorifiers to be undertaken as soon as possible.			
8.	It is recommended that non TMV'd hot and cold outlets are identified in areas requiring HAI Scribes for panel removal, in order that a picture can be built up of the hot and cold-water temperatures in that particular area, without the need to remove panels.			

9.	It is recommended that a search is made to attempt to find the missing temperature records for 2020, and if found, that these records are added to the logbook.			
10.	It is recommended that a review of the outlets that are used to record temperatures is made to ensure that the appropriate secondary loop outlets are covered as required in the guidance.			
11.	It is recommended that a process is created for the taking and recording of tertiary loop water temperatures throughout the QEUH/RHC hospitals.			
12.	It is recommended that valves are fitted to enable the expansion vessels to be flushed and that a flushing programme is initiated as soon as possible.			
13.	It is recommended that the TMV/TMT servicing process is reviewed to ensure it covers the requirements as outlined in the HSG 274 document – this process should contain a clean of the strainer filters at least once per year.			

Section B1 Risk Assessment		Y/N U/K, N/A or Partial	Comments	Risk Level
B1.1	Is there a written risk assessment in place for the building water systems?	Y	The risk assessment was undertaken by DMA Canyon Ltd.	
B1.2	Was the risk assessment completed and delivered to site within the past two years?	N	Risk assessment was completed in January 2019 with the on-site work having been completed between October and December 2018. The risk assessment is therefore outside the 2-year recommended review period detailed in the SHTM 04-01 guidance. It is noted that the HSE guidance document has removed the need for the two-yearly review of the risk assessment. There have been significant changes to various parts of the QEUH and RHC water systems and consequently, this would trigger the need for a new risk assessment to be completed. There have been significant works completed on the water systems in wards 2A and 2B. It is known that a ward specific water risk assessment has been commissioned and this is being undertaken at the time of completing this audit. The Smartsheet system hold the response to the recommendations for the February 2021 AE audit and this states that this is a work in progress although there is no date against this entry. It is recommended that a new QEUH/RHC risk assessment is commissioned as soon as possible. It is recommended that NHS GGC formalise their approach to when risk assessments should be completed and reviewed.	

B1.3	Does the site/organisation have plans with regard to reviewing or redoing the risk assessment?	U/K	At the time of this audit it was stated by DMA Canyon Ltd that discussions are ongoing with regard to completing a new updated risk assessment. HAI Scribes have been completed by Estates and submitted to ICT for the purposes of completing a risk assessment. Feedback is now awaited from NHS GGC on this issue. The recommendation made in B1.2 covers this issue.	
B1.4	Does the risk assessment address all the water systems in the building?	Partial	Section 8 of the current risk assessment details 15 other water systems in the two hospitals and includes a brief description of each system as well as an initial high-level assessment of risk. It further advises that specialists in each field are consulted to confirm the risk assessment detail is reflective of the function of each water system. The entry in the Smartsheet system states that the compliance manager is arranging for all the risk assessments for the other water systems to be completed The recommendation associated with this question is covered in Part A of this audit.	
B1.5	Are there any systems that are defined as being excluded from the assessment in the RA scope?	Partial	Although the Hydrotherapy pool was mentioned in the list of additional water systems, the risk assessment document did state that the pool was not assessed in the risk assessment process. However, it did state on page 4 of section 3 of the report that the hydrotherapy pool was "covered under a separate assessment". It is recommended that a check is made to ensure that the Hydrotherapy pool has been risk assessed.	

Actions on Risk Assessment

1. It is recommended that a new QEUH/RHC risk assessment is commissioned as soon as possible.

2. It is recommended that NHS GGC formalise their approach to when risk assessments should be completed and reviewed.
3. It is recommended that a check is made to ensure that the Hydrotherapy pool has been risk assessed.

Section B2 Schematic Drawings		**Y/N U/K, N/A or Partial**	**Comments**	**Risk Level**
B2.1	Are schematic drawings available in the written scheme, or in some other place in the property?	Y	There is a note in the Smart Sheet electronic data management system detailing the locations of the soft copies of the drawings as being available on ZUTEC (electronic data storage system).	
B2.2	Do the schematic drawings show all the components of the water systems?	Y	The drawings are as fitted and detail the entire system configuration including all component parts.	
B2.3	Are the water system return legs shown on the schematic drawings?	Y		
B2.4	Are secondary and tertiary loops shown on the schematic drawings?	Y		
B2.5	Have any amendments been made to the schematic drawings?	N	As an example, Scotmas, who provided the chlorine dioxide dosing systems, are also contracted to supply drawings of the tank room pipework which was altered to allow for the installation of the dosage equipment. It was stated at the time of the audit that these drawings had not yet been created and delivered. The entry in the Smartsheet system states that all the Scotmas related drawings have been added to the SCART ClO2 folder.	

			It is recommended that a check is made that the relevant ClO_2 drawings have indeed been added to the folder. There are currently works being completed on the water systems in wards 2A and 2B and any pipework modifications must have the appropriate updated drawings added to the drawings file. It is recommended that the current and other recent pipework modifications that are being completed in Wards 2A/2B are reflected in updated drawings and that these updated drawings are added to the drawings file.	
B2.6	If amendments have been made are they signed and dated?	N/A	See comment B2.4 above.	
B2.7	Is there any indication that drawings are regularly inspected and updated if required?	Partial	It was stated that drawings will be checked during the working year as and when required. There is no formal process in place. Drawings will be inspected when required to trace valves for pipework isolation for example. It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.	

Actions on Schematic Drawings

4. It is recommended that the current and other recent pipework modifications that are being completed in Wards 2A/2B are reflected in updated drawings and that these updated drawings are added to the drawings file.
5. It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.

Section B3 Written Scheme, Monitoring and Records		Y/N U/K, N/A or Partial	Comments	Risk Level
B3.1	Is there a written scheme in place?	Y	The written scheme is entitled 'QEUH Campus Water Systems - Written Scheme – Controlling the risks to Legionella and other harmful bacteria in Water Systems – 2021 Rev C'.	
B3.2	Is a copy of the written scheme available on site and does this include this building?	Y		
B3.3	Is there a statement in the written scheme of the expected "correct and safe operation" processes detailing targets for temperatures and other control measures?	Y	The statement of correct and safe operations for the water systems can be found in section 4.1 of the written scheme document. Section 4.51 on page 55 details the target temperatures.	
B3.4	Is there any seasonal difference in the use profile of the water systems within this building?	N		
B3.5	Are any pieces of duty standby equipment in this building that require to be switched on a weekly basis, and do the records show that they are being switched?	N	Pump sets automatically change the lead pump on a daily basis and there is a record of checks on the pump sets in the log book.	
Actions on Written Scheme Monitoring and Records				

None				
Section B4 On Going Water Treatment		**Y/N U/K or Partial**	**Comments**	**Risk Level**
B4.1	Is there any form of water treatment in use in the building?	Y	Incoming mains water is treated via a membrane filtration system and is filtered down to 0.2 micron. The filtered mains water is secondary disinfected using chlorine dioxide dosing.	
B4.2	Is there any form of secondary disinfection in place for this building?	Y	There are a number of chlorine dioxide units installed throughout the QEUH and the RHC. These chlorine dioxide units automatically dose ClO2 to the hot and cold-water systems as required. Dosing control is maintained via ClO2 probes installed throughout the building water systems.	
B4.3	Are the required checks for secondary disinfection levels being completed and recorded?	Partial	Discussions were held with the contractor, DMA Canyon Ltd, who complete the analytical testing of the water systems for chlorine dioxide levels. Tests are completed on the hot and cold water systems at 78 locations throughout the hospital. This does not cover all of the sentinel points in the hospital water systems, as recommended in the HSG 275 guidance document, but was deemed by NHS GGC to be representative of the levels of chlorine dioxide that would be found throughout the hospital water systems. Tests are completed on a weekly basis and a full set of records were available from DMA Canyon Ltd. It was stated at the time of the audit that additional sample points are currently in discussion. The BMS system monitors the chlorite levels as well as the chlorine dioxide levels constantly at the tank. Alarms are built in if certain chlorite levels are measured.	

			Scotmas, the suppliers of the chlorine dioxide dosing equipment, complete a monthly service check on the chlorine dioxide systems. While there is a comprehensive chlorine dioxide monitoring system in place, it does not fully comply with the requirements as laid out on the HD+SG 274 document. It is recommended that the chlorine dioxide current monitoring programme is amended to fall into compliance with the HSG 274 guidance document.	
B4.4	Are the required levels of disinfection being achieved in the building water systems?	Y	Cold water and mixed water chlorine dioxide residuals are generally within accepted limits. The hot water chlorine dioxide levels are reduced as would be expected in a hot water system as chlorine dioxide is a gas in solution.	
B4.5	Is there a record of biocide stock levels in the written scheme?	Y	Biocide stock levels are checked as part of the Scotmas monthly contract. These checks should be made on a weekly basis but there are automatic measurements made of chemical stocks in the dosage tanks and these would alarm if the amounts of chemical dropped to an unacceptable level.	
B4.6	Is any of the building water base exchange softened?	N/A		
B4.7	Are service records for the base exchange softeners available in the written scheme?	N/A		
B4.8	Is filtration in use in any of the building water systems?	Y	Mains water is treated via a membrane filtration system. There are three membrane filtration sets in the hospital to allow for servicing of any unit if required.	

B4.9	Are service records for the filtration equipment available in the written scheme?	Y	Veolia, the equipment supplier, has a service contract for the filtration equipment. The Veolia service records are held online and can be accessed when required. The records were accessed and demonstrated to the auditor during this audit.	

Actions on Ongoing Water Treatment

6. It is recommended that the chlorine dioxide current monitoring programme is amended to fall into compliance with the HSG 274 guidance document.

Section B5 Task Completion		Expected Task Levels	Actual Records	Comments	Risk Level
B5.1	Tank Inspections	2 with temperature taken twice per year	11	Tank inspections are undertaken by DMA Canyon Ltd. Inspection certificates were provided by DMA Canyon Ltd at the time of the audit.	
B5.2	Hot Water Storage Vessel blowdowns	4	12	Details are held on the monthly calorifier record sheets in the CMB Building.	
B5.3	Hot Water Storage Vessel Internal Inspections	1	1 Partial	Records were provided for inspections that were completed on calorifiers that are able to be opened. These records run from early December 2021 through to the end of February 2022. There are several calorifiers on site that cannot be isolated due to failing isolation valves. Consequently, there are some	

				calorifiers that are not being internally inspected on an annual basis. It is recommended that the failing isolation valves are replaced in order to allow the internal inspections of the unopened calorifiers to be undertaken as soon as possible.	
B5.4	Shower/Spray Heads	4	4	Showers are replaced on a quarterly basis. This is the case on any parts of the building where POU shower filters are not used. Where POU filters are used they are replaced as required and the shower hose is replaced at the same time or at least quarterly. This task is completed by DMA Canyon Ltd. Records of shower replacements were supplied on a memory stick and are also available in the Estates' office.	
B5.5	Hot Water Storage Vessel F and R Temps	12	12	The calorifier flow and return temperatures generally appear to be acceptable. They are monitored on the monthly sheets and also on the Scheider BMS.	
B5.6	PH Ex F and R Temps	12	N/A		
B5.7	Hot Sentinel Temps	12	6	Sentinel temperatures are taken by NHS GGC staff and recorded on paper. The record for the temperatures at the hot outlets appear to be missing for the months of April – only two sheets of records for that month, June, September, October, November and December 2020. Although the temperature records were not available for all months, it was stated that an inspection of the facilities management system, showed that the checks had been undertaken, except for November 2021. The bulk of the hot temperatures that are recorded in the records are from the TMV outlet as it is not allowed to remove	

				IPS panels in many areas without an HAI Scribe. This does not therefore inform us as to what is going on in the hot water flow and return systems with the required level of detail. The BMS does however have end of line sensors within the Adults and Children hospitals and many of these will be on secondary loops. The BMS alarms if the temperatures are getting out of specification at these sensors. It is recommended that non TMV'd hot and cold outlets are identified in areas requiring HAI Scribes for panel removal, in order that a picture can be built up of the hot and cold water temperatures in that particular area, without the need to remove panels. Please note that this recommendation was also made in February 2020. It is recommended that a search is made to attempt to find the missing temperature records for 2020, and if found, that these records are added to the logbook.	
B5.8	Hot Sec Loop Temps	12	6	Incumbent water hygiene supplier DMA advised secondary loop temperatures are taken whenever possible as part of the routine temperature monitoring programme. This is confirmed by the records in the logbook. It is recommended that a review of the outlets that are used to record temperatures is made to ensure that the appropriate secondary loop outlets are covered as required in the guidance.	
B5.9	Tertiary Loop Hot Temperatures	4	U/K	These temperatures cannot be easily taken as the required areas cannot be accessed without an HAI Scribe. In the two weeks prior to the completion of this audit 12 remote sensors were installed on tertiary loops on wards 2A/2B.	

				It is recommended that a process is created for the taking and recording of tertiary loop water temperatures throughout the QEUH/RHC hospitals.	
B5.10	Hot Rep Temps	1	1	Incumbent water hygiene supplier DMA advised that secondary loop, and other temperatures, are taken whenever possible as part of the routine temperature monitoring programme. This will include non-sentinel outlets, or representative, temperatures. This is confirmed by the records in the logbook. Temperatures are also taken at many outlets during the process of monitoring the chlorine dioxide levels across the hospital.	
B5.11	Cold Sentinel Temps	12	6	There are missing records for the past twelve months as detailed for the hot water outlets in section B5.7 of this report. The BMS does however have end of line sensors on the Adults and Children hospitals. The BMS alarms if the temperatures are getting out of specification at these sensors. The recommendation for this is covered in the recommendation for section B5.7	
B5.12	Cold Sub Loop Temps	12	N/A		
B5.13	Cold Rep Temps	1	6	Incumbent water hygiene supplier DMA advised that representative temperatures are taken whenever possible as part of the routine temperature monitoring programme. This will include non-sentinel outlets, or representative, temperatures. This is confirmed by the records in the logbook. Temperatures are also taken at many outlets during the process of monitoring the chlorine dioxide levels across the hospital.	
B5.14	POU Heater Temps	12	N/A		

B5.15	Expansion Vessels	2 – 12 Monthly to six-monthly	0 Not applicable for many expansion vessels	Nearly all expansion vessels installed in the hospital are of the flow through type. There are two expansion vessels in the cold-water storage tank room which are not flow through in design. These are not being flushed as there are no flushing valves fitted to the units. It is recommended that valves are fitted to enable the expansion vessels to be flushed and that a flushing programme is initiated as soon as possible.	
B5.16	TMV's/TMT's	1	U/K	On a once-a-year basis a fail-safe check has been completed on all adult and Children TMV's by DMA Canyon Ltd. This check has involved doing a fail-safe check and also the temperatures, with a temperature reset if required. It is recommended that the TMV/TMT servicing process is reviewed to ensure it covers the requirements as outlined in the HSG 274 document – this process should contain a clean of the strainer filters at least once per year.	
B5.17	Little used outlet flushing	Past three months	>24	Flushing appears to be happening on a daily basis. This task is completed by DMA Canyon Ltd. A full set of records were presented at the audit.	
B5.18	ClO2 testing	52	52	Chlorine dioxide tests are being completed weekly on 78 outlets by DMA Canyon Ltd. Discussions are taking place on expanding the number of outlets that are being checked going forward. There are chlorite probes at the tanks. It was noted that the chlorite tests have not been completed for the past year. A recommendation covering this issue can be found in section 4.3.	
B5.19	Check on the cold water	1	1	In the written scheme it is confirmed that this should be completed on an annual basis. This is addressed while	

	distribution pipework thermal insulation			completing other tasks such as the monthly plant room checks, checks of cold water storage tanks and checks on calorifiers and TMV's. The fact that the insulation has been checked can be found on the calorifier monthly check sheets.	
B5.20	Tank Clean and Disinfection	1	1	The records show that the cold-water storage tanks were cleaned and disinfected in October 2021 and January 2022.	
B5.21	Legionella sampling	4	4	Legionella sampling has been undertaken on a monthly basis across the hospital and includes testing on the cold water storage tanks. There have not been any positive legionella tests completed in the past year.The samples are taken by DMA Canyon Ltd and are submitted to the GRI labs. The results are then sent to Estates and they are stored in Section 22 the Campus Scart folder. Any out of specification results would be listed on a separate spreadsheet. This spreadsheet will contain any remedial actions that would be completed in response to the out of specification result and the outcome in terms of retesting. Once an issue has been remediated and cleared the details would be recorded on a further spreadsheet and this records the three clear results. This system has been in place since 2018.	

It is recorded at this point that there are a significant number of risk reduction processes which are being completed and are in excess of the requirements of the HSE's HSG 274 and NGS SHTM 04-01 guidance documents. These actions include tap diffusers are being changed quarterly on the Optitherm taps and POU filter swap out records across the hospital where the filters are used.

Actions on Task Completion

7. It is recommended that the failing isolation valves are replaced in order to allow the internal inspections of the unopened calorifiers to be undertaken as soon as possible.

8. It is recommended that non TMV'd hot and cold outlets are identified in areas requiring HAI Scribes for panel removal, in order that a picture can be built up of the hot and cold water temperatures in that particular area, without the need to remove panels.
9. It is recommended that a search is made to attempt to find the missing temperature records for 2020, and if found, that these records are added to the logbook.
10. It is recommended that a review of the outlets that are used to record temperatures is made to ensure that the appropriate secondary loop outlets are covered as required in the guidance.
11. It is recommended that a process is created for the taking and recording of tertiary loop water temperatures throughout the QEUH/RHC hospitals.
12. It is recommended that valves are fitted to enable the expansion vessels to be flushed and that a flushing programme is initiated as soon as possible.
13. It is recommended that the TMV/TMT servicing process is reviewed to ensure it covers the requirements as outlined in the HSG 274 document – this process should contain a clean of the strainer filters at least once per year.

Site Address:

Queen Elizabeth University Hospital and the Royal Hospital for Children Hospital,
1345 Govan Rd,
Glasgow
G51 4TF

Date of Audit:	Auditor:	Staff Interviewed:
11th January 2023	Dennis H Kelly Snr – Authorising Engineer (Water)	Kerr Clarkson – Operational Estates Manager

Date of Previous Audit:

March 1st 2022

Site General Description:

This audit was completed on the NHS GGC QEUH and RHC properties only.
The QEUH adult Hospital building comprises of 12 stories, with the basement housing mainly FM areas. Connected to the main building is the RHC Hospital comprising of 4 storeys. Both buildings are served by the same water system.
There are two mains water supplies coming into the buildings and these are switched on a regular basis to limit the opportunity for stagnation in the mains water supply pipework.
Raw mains water is held in raw water tanks before being passed through a 0.02 micron membrane filtration process, The water is then stored in treated water storage tanks prior to being distributed around the building.
Cold water is then distributed through the hospitals via booster pump sets located in the tank room. Hot water is provided by a number of calorifier heating stations installed throughout the hospitals.
The hospital water systems are secondary disinfected with chlorine dioxide via multiple retrofitted dosing systems located throughout the hospitals.

Given the size of the two hospitals the water systems are large and complex. There are around 1400 en suite bedrooms and in excess of 6000 TMV/TMT's in the buildings.

Executive Summary:

The previous audit was completed in March 2022. That March 2022 audit was a review of the previous audit. It was decided for this current audit, as we had completed two audit review processes in the previous two years, to undertake a completely new full audit of the management of the water system risk reduction processes.

This current audit yielded nine recommendations. This can be favourably compared to last year's audit review which had twenty-three recommendations. Two of this year's "high risk" recommendations are for the provision of a new, in date, risk assessment.

The recommendations in last year's audit have been virtually addressed and it was pleasing to note that the recommendations from the extant risk assessment had been completed.

A summary of the current situation with regard to the water systems at the QEUH/RHC hospital is that the delivery of the required risk reduction processes and procedures is in safe hands and is virtually complete. There are some recommendations in this regard to improve this further.

The level of knowledge and understanding of the onsite Estates' staff is extremely high and a diligent approach is taken to ensuring that the water systems are operated in a manner required to deliver high quality risk reduction processes and procedures.

Thanks are due to Kerr Clarkson, Matt Feeney and Mel McMillan on NHS GGC for their help and support in completing this audit.

Description of Levels of Risk:

Very High	Urgent Remedial Action – Lp growth and aerosol opportunity with susceptible people present on site
High	Remedial Action is needed but not immediately – Lp growth opportunity is present
Medium	Acceptable risk but some concerns– Lp likely to be controlled but improvements should be sought
Low	Risk controlled and acceptable

Levels of Risk found during the Audit:

The levels of risk detailed below reflects the highest level of risk identified during the audit of that particular topic.

The audit process reviews the following 9 areas.:-

Audited Topic	Level of Risk
Risk Assessment	
Schematic Drawings	
Management and Competency	
Written Scheme Monitoring and Records	
Task Completion	
On Going Water Treatment	
Cleaning and Disinfection Procedures	
New Build and Refurb Capital Projects	
Water Safety Group	

Summary of Actions				
Actions		Risk Level	Completion Date	Signature
1.	It is recommended that NHS GGC ensure that an updated risk assessment for the QEUH and RHC buildings is completed as soon as possible.			
2.	It is recommended that a check is made to confirm when the other water systems are going to be risk assessed by a competent supplier for these particular types of water systems.			
3.	It is recommended that a process that ensures that any changes made which require updated drawings can be passed to the CAD manager for inclusion in the drawings file.			
4.	It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.			
5.	It is recommended that the requirement for CP training for the QEUH staff is evaluated and that appropriate training, if required, is delivered to the appropriate staff members.			
6.	It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual hot water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of hot water pipes going to the TMT's/TMV's.			
7.	It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual cold water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of cold water pipes going to the TMT's/TMV's.			
8.	It is recommended that until the expansion vessels are converted to flow through, that a flushing programme is initiated as soon as possible.			

9.	It is recommended that the practicability of twice yearly servicing of the TMVs/TMTs is reviewed and that a confirmed, risk assessed and agreed way forward for TMV/TMT servicing is created.			
10.				

Question Set and Associated Comments from the Audit				
Section 1 Risk Assessment		**Y/N U/K, N/A or Partial**	**Comments**	**Risk Level**
1.1	Is there a written risk assessment in place for the building water systems?	Y		
1.2	Was the risk assessment completed and delivered to site within the past two years?	N	The risk assessment was completed in January 2019 with the on-site work having been completed between October and December 2018. The risk assessment is therefore outside the 2-year recommended review period detailed in the SHTM 04-01 guidance. It is noted that the HSE guidance document has removed the need for the two-yearly review of the risk assessment, although the current SHTM 04-01 document retains the need for a risk assessment to be completed every two years. There have also been changes to various parts of the QEUH and RHC water systems and consequently, this would trigger the need for a new risk assessment to be completed. There have been significant works completed on the water systems in wards 2A and 2B. It is known that a ward specific water risk assessment has been commissioned to address these changes and this is being undertaken at the time of completing this audit. At the time of completing this audit, the QEUH campus other building risk assessments are being completed and the order has been placed for the new risk assessment of the QEUH and RHC buildings.	

			It is recognised that as any alterations have been made to the existing QEUH and RHC building water systems, then the appropriate changes have been made to the applied risk reduction processes. It is recommended that NHS GGC ensure that an updated risk assessment for the QEUH and RHC buildings is completed as soon as possible.	
1.3	Does the site/organisation have plans about reviewing or redoing the risk assessment?	Y	These plans are detailed in section 1.2.	
1.4	Does the risk assessment address all the water systems in the building?	N	Section 8 of the current risk assessment details 15 other water systems in the two hospitals and includes a brief description of each system as well as an initial high-level assessment of risk. It further advises that specialists in each field are consulted to confirm the risk assessment detail is reflective of the function of each water system. The entry in the Smartsheet system states that the compliance manager is arranging for all the risk assessments for the other water systems to be completed. It was then stated at the time of the audit that discussions have taken place on addressing the audits of the other water systems although it was stated that these were still to be completed. It is recommended that a check is made to confirm when the other water systems are going to be risk assessed by a competent supplier for these particular types of water systems.	
1.5	Are there any systems that are defined as being excluded from the assessment in the RA scope?	Y	Although the Hydrotherapy pool was mentioned in the list of additional water systems, the risk assessment document did state that the pool was not assessed in the risk assessment process. However, it did state on page 4 of section 3 of the report that the hydrotherapy pool was “covered under a separate assessment”. The Hydrotherapy pool was risk assessed by the BRI in Feb 2018.	

1.6	Does the risk assessment review the current risk reduction processes and procedures that are currently in use at the site?	Y	The current risk reduction processes are reviewed in Section 9 of the document.	
1.7	Does the risk assessment contain details of the people/organisations who are involved in the risk reduction processes and procedures? This should include comments on the dutyholder, the responsible person, any deputy responsible persons and also service providers and contractors.	Y	Section 9 of the risk assessment document is entitled “Governance and Documentation Review”. This section contains a comprehensive description of the roles and responsibilities for water within the NHS GGC organisation and the named individuals that hold these roles. Since the risk assessment has been completed many of the named persons have changed role. A new risk assessment will amend and update the details when the assessment process is completed. Information on DMA Canyon Ltd, who are the main service provider, can be found at the start of the risk assessment document.	
1.8	Is there an assessment of the competency of all involved parties in the risk assessment?	Y	Section 9 of the risk assessment details that there were no training records available. It is now known that the training records of the involved NHS GGC staff can be accessed on the Smartsheet system. The risk assessment document states that the DMA Canyon Ltd competency details are filed centrally in their local office and can be accessed by request from DMA Canyon Ltd. NHS GGC have a copy of the DMA training records on a memory stick and this was variable at the time of the audit.	
1.9	Does the risk assessment specifically address and comment on evidence of the current defect/remedial action processes and procedures?	Y	Section 9 of the risk assessment includes a gap analysis which comments on the evidence of the current remedial processes and procedures.	
1.10	Is there an assessment of the susceptibility of persons who may be affected by the building water systems?	Y	This is covered in Section 1 of the risk assessment document.	

1.11	Is there a schematic diagram provided with the risk assessment?	N	There are no schematics in the risk assessment document but as fitted drawings for both hospitals are available elsewhere in the Zutec system and are stored electronically. It may be the case that the supply of schematic diagrams was not part of the scope of supply covering the new risk assessment.	
1.12	Is there a new written scheme provided as part of the risk assessment?	Partial	This may not have been part of the scope of supply agreed with the risk assessment supplier. There is guidance provided in section 10 of the risk assessment document as to what should be included in a written scheme. Site has created a comprehensive written scheme since the current RA has been completed. This written scheme document has also been updated on a number of occasions.	
1.13	Does the assessment contain details of all the component parts of the water systems? This could include tanks, calorifiers, pipework and pipework layout, outlets, TMV's, expansion vessels etc etc etc.	Y		
1.14	Is consideration given to system design, flow, temperature and the opportunity for bacteria to grow and develop in the water systems?	Y		
1.15	Does the risk assessment identify any areas of spray and aerosol creation?	Y	This information is detailed and is available in section 7 of the DMA Canyon Ltd risk assessment documents.	
1.16	Are areas of low use and low flow identified in the risk assessment?	Y	This information is detailed and is available in section 7 of the DMA Canyon Ltd risk assessment documents.	
1.17	Are deadlegs specifically detailed in the risk assessment?	Y	This information is detailed and is available in section 7 of the DMA Canyon Ltd risk assessment documents.	

1.18	Is there a set of remedial actions clearly identified in the risk assessment?	Y	The remedial actions are detailed in section 2 in the RA document in the section titled Recommendations.	
1.19	Is there a clearly explained risk scoring system in the risk assessment?	Y	The risk scoring system is explained in section 10 of the RA document.	
1.20	Are there any areas of augmented care in the hospital?	Y	There are areas of augmented care in the hospital as per the criteria detailed in HPS guidelines.	

Actions on the Risk Assessment

1. It is recommended that NHS GGC confirm that the new risk assessment for the QEUH and RHC buildings is planned for the near future.
2. It is recommended that a check is made to confirm when the other water systems are going to be risk assessed by a competent supplier for these particular types of water systems.

Section 2 Schematic Drawings		Y/N U/K, N/A or Partial	Comments	Risk Level
2.1	Are schematic drawings available in the written scheme, or in some other place in the property?	Y	There is a note in the Smart Sheet electronic data management system detailing the locations of the soft copies of the drawings as being available on ZUTEC (electronic data storage system).	
2.2	Do the schematic drawings show all the components of the water systems?	Y	The drawings are as fitted and detail the entire system configuration including all component parts.	
2.3	Are the water system return legs shown on the schematic drawings?	Y		

2.4	Are secondary and tertiary loops shown on the schematic drawings?	Y		
2.5	Have any amendments been made to the schematic drawings?	Y	As an example, Scotmas, who provided the chlorine dioxide dosing systems, are also contracted to supply drawings of the tank room pipework which was altered to allow for the installation of the dosage equipment. It was stated at the time of the audit that these drawings had not yet been created and delivered. The entry in the Smartsheet system states that all the Scotmas related drawings have been added to the SCART ClO2 folder. The recently completed on the water systems in wards 2A and 2B had pipework modifications and drawings have been provided and are held in the SCART folder projects file. It was stated during the audit that any changes made to pipework are reflected in new drawings being provided at the time. Discussions were held with the Estates Technical Officer on the CAD drawings. It is recommended that a process that ensures that any changes made which require updated drawings can be passed to the CAD manager for inclusion in the drawings file.	
2.6	If amendments have been made are they signed and dated?	N/A		
2.7	Is there any indication that drawings are regularly inspected and updated if required?	Partial	It was stated that drawings will be checked during the working year as and when required. There is no formal process in place. It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.	

Actions on Schematic Drawings

3. It is recommended that a process that ensures that any changes made which require updated drawings can be passed to the CAD manager for inclusion in the drawings file.

4. It is recommended that schematic drawings are reviewed at least annually and amended and updated to reflect any water system changes.

Section 3 Management and Competency		Y/N U/K, N/A or Partial	Comments	Risk Level
3.1	Is there a nominated duty holder?	Y	There is a copy of an NHS GGC Policy Document dated April 2020 available electronically on site in the Smartsheet system. In appendix 1 of the policy document, it states that the Duty Holder is the Chief Executive. A more detailed hierarchy table was also available, naming people who are responsible for the various positions with regard to water. The policy is due for review in January 2023 and it was stated at the time of the audit this this is currently underway.	
3.2	Is there a responsible person nominated in writing?	Y	In NHS GGC, the sector estates manager is regarded as the responsible person and this is recorded, and is up to date, in the on-site WSP.	
3.3	Is there a clearly defined management structure which includes the relevant on-site personnel and all service providers and contractors?	Y	The management structure is defined in appendix 1 of the NHS GGC water policy. It is further defined in Section 3.2 of the Written Scheme document.	
3.4	Is there a clearly defined line of communication in the written scheme?	Y	The management structure is defined in appendix 1 of the NHS GGC water policy. It is further defined in Section 3.2 of the Written Scheme document.	
3.5	Are the responsibilities of all involved parties clearly defined in the written scheme?	Y	Roles and responsibilities are defined in table 3.1 of the written scheme.	

3.6	Does the organisation have an up to date and current policy document?	Y	NHS GGC has a policy document dated as approved in January 2020 and reviewed in January 2021. The document is due to be reviewed in January 2023. It was stated at the time of the audit that this process is underway	
3.7	Does the organisation have an up to date and current procedures document?	Y	NHS GGC has a Written Scheme document for the QEUH Campus. It is dated August 2022 and is revision E.	
3.8	Do all staff have relevant up to date training in place?	Partial	The details of the training records are available in the WSP in section 3. The board wide water skills register is available on Smart Sheet. Access to Smartsheet was not available at the time of the audit as there was a problem with the Smartsheet software and this was outside of the control of NHS GGC. The written scheme details completed AP training for the QEUH and full details, including dates of the training will be found in the Smartsheet system. It was stated at the time of the audit that the CP training may require updating. It is recommended that the requirement for CP training for the QEUH staff is evaluated and that appropriate training, if required, is delivered to the appropriate staff members.	
3.9	Are copies of the site personnel training records available in the written scheme?	Y	There was a note beneath table 3.1 of the QEUH written scheme advising that relevant training records and appointment letters are electronically filed on the QEUH shared drive within folder “Water Quality Training and Appointments”. Training records were produced for the auditor during this audit process.	
3.10	Is there evidence available in the written scheme of the competency of service provider and contractor staff?	Y	This issue is normally addressed at the procurement stage. The water hygiene contractor, DMA Canyon Ltd, is a member of the LCA and training records for the DMA Canyon Ltd staff are available. It is known that the framework plumbing contractor, Livingston Mechanical, have also had their plumbing staff undertake Legionella	

			Awareness training and that this training appears to be updated on a regular basis. A record of plumbing contractors is also now kept by the AP Lead for Water. All contractors are formally interviewed to assess their level of competence and understanding prior to them being allowed to work on the Campus water systems. The AP Lead for water is to be commended for this excellent process. Copies of contractor training certificates are kept in the AP Lead for Water's office. Letters of appointment are issued to contractors after the interview process and copies of these letters were also available on site.	
3.11	Are service providers and contractors LCA registered?	Y	DMA Canyon Ltd is LCA registered. Evidence of the registration is available on the LCA website. The main plumbing contractor is not LCA registered but it should be noted that not many plumbing contractors are registered in the LCA system.	
3.12	If the suppliers are not LCA registered, do they have other means of proving competence?	Y	Staff training certificates have been supplied by Livingston Mechanical who are the framework plumbing contractor for NHS GGC. It should be noted that very few plumbing organisations are registered with the LCA organisation. The auditor is aware of the fact that Livingston Mechanical have recently completed, and are planning on, further refresher training.	
3.13	Is there a formal contractor management process in place or any evidence available in the written scheme of review meetings with service providers and contractors?	Y	Section 3.12 of the written scheme details that regular review meetings should be held with contractors. Monthly meetings are held with the main contractor, DMA Canyon Ltd, and minutes if these meetings and required actions are kept.	
3.14	Is there any evidence in the written scheme of management reviews of the data and results produced by the monitoring and control processes and procedures?	Y	Minuted meetings are held monthly with DMA Canyon Ltd. DMA Canyon Ltd who also submit monthly updates as to the various actions that are being undertaken on the water systems. There is close cooperation between NHS GGC Estates and DMA Canyon Ltd.	

			An out of spec summary document is produced and this is reviewed at the quarterly WSG meetings. The consultant microbiologist holds informal monthly meetings with Estates on out of spec microbiological results. Minuted meetings are also held with Scotmas, this supplier of the chlorine dioxide dosing equipment.	
3.15	Is there evidence that authorised person competency checks have been completed?	Y	AP competency checks are carried out by the AE Water as and when requested by site. The Compliance Manager at the QEUH maintains a record of AP competency checks and these are currently up to date.	
Actions on Management and Competency				
5. It is recommended that the requirement for CP training for the QEUH staff is evaluated and that appropriate training, if required, is delivered to the appropriate staff members.				
Section 4 Written Scheme, Monitoring and Records		**Y/N U/K, N/A or Partial**	**Comments**	**Risk Level**
4.1	Is there a written scheme in place?	Y	Th The written scheme is entitled 'QEUH Campus Water Systems - Written Scheme – Controlling the risks to Legionella and other harmful bacteria in Water Systems – 2022 Rev E'.	
4.2	Is a copy of the written scheme available on site?	Y	A copy of the written scheme was provided electronically.	
4.3	Is there a statement in the written scheme of the expected "correct and safe operation" processes detailing targets for temperatures and other control measures?	Y	There is a statement of correct and safe operation in the WSP document and can be found in section 4.1 of the WSP.	

4.4	Is there evidence in the written scheme that any deadlegs have been removed?	Y		
4.5	Is temperature the primary means of control within the water systems?	Partial	While temperature is the primary means of control it is supported by the use of chlorine dioxide as a secondary disinfectant.	
4.6	Is there any form of water treatment being applied to the water systems?	Y	The hot and cold water systems in the hospitals are dosed with chlorine dioxide on an continual basis.	
4.7	Is there any seasonal difference in the use profile of the water system?	N		
4.8	Are any pieces of duty standby equipment that require to be switched on a weekly basis, and do the records show that they are being switched?	N	Pump sets automatically change the lead pump on a daily basis and there is a record of checks on the pump sets in the log book.	
4.9	Is there a logbook, either paper or electronic, defining all the required tasks for the risk reduction processes and procedures?	Y	Most of the data is held online although the checks completed by the Estates staff were available and are held on paper records.	
4.10	Are all tasks in the records signed and dated?	Y		
4.11	Are little used outlets (LUO's) listed and are they then flushed?	Y	Some of the required LUO flushing is completed by DMA Canyon Ltd. Specifically, DMA Canyon Ltd flush the following:- • Three times per week flushing of supply pipes to unused or removed water coolers • Flushing of temporary dosage connections in the plant rooms twice per week DMA Canyon Ltd will also flush anything that they regard may be little used. Records for this were found in the Teams folder for the DMA flushing.	

			Some of the flushing is completed by clinical staff and they make returns to the Estates department on a quarterly basis. These records are held in Estates. The level of returns is said to be improving. Domestic staff flush every wash hand basin every day and records of this were presented at the time of the audit. Areas that are closed at weekends do not receive 7 daily flushes, and instead receive 5 flushes.	
4.12	Is the flushing of little used outlets recorded in the records system?	Y	Records were available for the DMA Canyon Ltd completed flushing procedures as well as the clinical and domestic staff flushing.	
4.13	Are the remedials actions from the risk assessment being completed and are they signed and dated?	Y	The DMA risk assessment actions are filed in Smart Sheet and the records show that all recommended action from the risk assessment have been completed.	
4.14	Does the written scheme contain any incident plans?	Y	This is covered in section 5 of the written scheme document.	
4.15	Are non-conformances addressed in a timely manner?	Y	There is an incident report procedure which ensures that any out of spec situations are handled quickly	
4.16	Does the written scheme contain an “audit trail” for out of specification situations that allows for remedial actions to be tracked through to completion?	Y	A job would be raised on FM First which automatically produces an audit trail. There is also an incident reporting process which ensures that there is an audit trail for all of spec situations	
4.17	Is there a specific escalation procedure for positive Legionella results?	Y	There is a response to a positive legionella result in section 5.4 (page 94) of the QEUH written scheme.	
4.18	Are Legionella samples being taken and who is taking the samples?	Y	Legionella samples are taken by DMA Canyon Ltd on an NHS GGC agreed basis throughout the year.	
4.19	Are Legionella samples being taken in accordance with BS7592:2022?	Y		

4.20	Are Pseudomonas samples taken as part of the written scheme?	Y	Pseudomonas samples are taken by DMA Canyon Ltd on an NHS GGC designated area basis throughout the year. The sweep of samples is taken every month.	
4.21	Are the Pseudomonas samples taken in line with the guidance given in the relevant HPS documents?	Y		
4.22	Are there copies of method statements for any procedures that are completed in house?	Y	Site monitoring tasks method statements are available in the written scheme document in Section 4. The error that was noted in hot water target temperatures in a previous audit has now been corrected.	
4.23	Are there copies of method statements for any procedures that are completed by external providers?	Y	Copies of DMA Canyon Ltd method statements are held electronically.	

Actions on Written Scheme, Monitoring and Records

None

Section 5 Task Completion		Expected Task Levels	Actual Records Completed or Planned	Comments	Risk Level
5.1	Tank Inspections	2	3		
5.2	Hot Water Storage Vessel blowdowns	4	12	These checks are completed by Estates staff.	
5.3	Hot Water Storage Vessel Internal Inspections	1	1	These checks are completed by Estates staff.	

5.4	Shower/Spray Heads	4	4	Shower heads and hoses are renewed every three months by DMA Canyon Ltd and the records can be found in the Teams system.	
5.5	Hot Water Storage Vessel F and R Temps	12	12	These tasks are completed by NHS GGC Estates staff.	
5.6	PH Ex F and R Temps	12	N/A		
5.7	Hot Sentinel Temps	12	12	These tasks are currently completed by Estates staff. A review of the records show that the recorded hot temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to know what the actual hot water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the hot and cold feeds to the TMVs/TMTs. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual hot water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of hot water pipes going to the TMT's/TMV's.	
5.8	Hot Secondary Loop Temps	4	Continual	There are BMS sensors are fitted on secondary loops on all levels of the adults and children's hospitals.	
5.9	Hot Tertiary Loop Temperatures			When the TMV's are being serviced, any lack of time in getting hot water to the outlet would be taken as an inference that the tertiary loops may not be operating correctly.	
5.10	Hot Representative Temperatures	1	Multiple	These are completed when microbiological sampling is undertaken as well as when the TMV's are being serviced.	
5.11	Cold Sentinel Temperatures	12	12	These tasks are currently completed by Estates staff. A review of the records show that the recorded temperatures are all hot temperatures from TMT or TMV blended outlets. It is important to	

				know what the actual cold water system temperatures are. It is also conceded that there are situations where it will not be possible to remove lift off panels to get to the individual cold-water pipes. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual cold water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of cold water pipes going to the TMT's/TMV's.	
5.12	Cold Sub Loop Temps	12	N/A		
5.13	Cold Rep Temps			These are completed when microbiological sampling is undertaken as well as when the TMV's are being serviced.	
5.14	POU Heater Temps	1 – 6 times per year	N/A		
5.15	Expansion Vessel Flushing	2 – 12 Monthly to six-monthly	N	All hot expansion vessels are flow through. Cold water vessels are not getting flushed. A request has been made for drain valves to be fitted to the single entry expansion vessels. Annual maintenance is currently completed on the expansion vessels. It is recommended that until the expansion vessels are converted to flow through, that a flushing programme is initiated as soon as possible.	
5.16	TMV's/TMT's	2	1	The servicing is completed by DMA Canyon Ltd. At the time of this audit it was stated that the site was managing only one service per year. It may be the case that the logistics of this process might dictate that it is only possible to do one service per year. However, it is noted that the servicing requirement of some TMVs/TMTs can be somewhat imprecise. It is recommended that the practicability of twice yearly servicing of the TMVs/TMTs is reviewed and that a confirmed, risk assessed and agreed way forward for TMV/TMT servicing is created.	

5.17	Little used outlet flushing	104	Multiple	As evidenced earlier in this report the LUO's are being flushed where required.	
5.18	Check on the cold-water distribution pipework thermal insulation	1	1	This is a recommendation in the HSG 274 document which can also be found in the SHTM 04-01 document. Any defects with the insulation would be reported on the contractor monthly report sheet and this would result in an entry into the water system defect report and the appropriate tasks would be completed as required. The insulation is viewed at least in part on a regular basis as staff visit plant rooms or look behind lift off panels.	
5.19	Tank Clean and Disinfection	1	1	This work is completed by a contractor.	
5.20	Legionella sampling	Multiple samples		Samples are taken by DMA Canyon Ltd.	
5.21	Pseudomonas Sampling	Multiple samples		Samples are taken by DMA Canyon Ltd.	
5.22	TVC Samples	Multiple samples	0	Samples are taken by DMA Canyon Ltd.	
5.23	Looking over the past twelve months have the required risk reduction tasks been completed on the site?		Partial	The records, as detailed above, shows that some tasks have been missed, principally the flushing of single point of entry expansion vessels. In addition there is a need to complete more temperature monitoring of non TMV/TMT outlets, or at least record the temperatures of the water going into the TMV/TMTs. However, it was stated at the time of the audit that these issues are being addressed. Individual recommendations are made where appropriate earlier on in this section.	

Actions on Task Completion
6. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual hot water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of hot water pipes going to the TMT's/TMV's. 7. It is recommended that non TMT'd or TMV'd outlets are used to record the temperatures of the actual cold water temperatures going to the TMT or TMV, or that temperatures are recorded from the surface of cold water pipes going to the TMT's/TMV's. 8. It is recommended that until the expansion vessels are converted to flow through, that a flushing programme is initiated as soon as possible. 9. It is recommended that the practicability of twice yearly servicing of the TMVs/TMTs is reviewed and that a confirmed, risk assessed and agreed way forward for TMV/TMT servicing is created.

Section 6 On Going Water Treatment		**Y/N U/K or Partial**	**Comments**	**Risk Level**
6.1	Is there any form of water treatment in use on site?	Y	Incoming mains water is treated via a membrane filtration system and is filtered down to 0.02 micron. The filtered mains water is then secondary disinfected using chlorine dioxide dosing.	
6.2	Is there any form of secondary disinfection in place on site?	Y	In the past, chlorine dioxide tests have been completed on the hot and cold water systems at 78 locations throughout the hospital. Previously it was stated that this this did not cover all of the sentinel points in the hospital water systems, as recommended in the HSG 274 guidance document, but it was deemed by NHS GGC at that time to be representative of the levels of chlorine dioxide that would be found throughout the hospital water systems. It was stated at the time of this audit that a new monitoring contract had recently been awarded to Scotmas, and that all sentinel points are now included in the monitoring process. The BMS system monitors the chlorite levels as well as the chlorine dioxide levels constantly at the tank. Alarms are built in if certain	

			chlorite levels are measured. The new Scotmas contract also has chlorite measurements included as a requirement.	
6.3	Are the required checks for secondary disinfection levels being completed and recorded on site?	Y		
6.4	Are the required levels of disinfection being achieved in the water systems?	Y	Cold water and mixed water chlorine dioxide residuals are generally within accepted limits. The hot water chlorine dioxide levels are reduced as would be expected in a hot water system as chlorine dioxide is a gas in solution.	
6.5	Is there a record of stock levels of biocide in the written scheme?	Y	Biocide stock levels are checked as part of the Scotmas monthly contract. These checks should be made on a weekly basis but there are automatic measurements made of chemical stocks in the dosage tanks and these would alarm if the amounts of chemical dropped to an unacceptable level.	
6.6	Is any of the water base exchange softened?	N/A		
6.7	Are service records for the base exchange softeners available in the written scheme?	N/A		
6.8	Is filtration in use in any of the water systems?	Y	Mains water is treated via a membrane filtration system. There are three membrane filtration sets in the hospital to allow for servicing of any unit if required.	
6.9	Are service records for the filtration equipment available in the written scheme?	Y	Veolia, the equipment supplier, has a service contract for the filtration equipment. The Veolia service records are held online and can be accessed when required. The records were accessed and demonstrated to the auditor during this audit.	

Actions on Ongoing Water Treatment
None

Section 7 Cleaning and Disinfection Procedures		Y/N U/K or Partial	Comments	Risk Level
7.1	Are system cleaning and disinfection procedures in use on site?	Y	Cold water storage tanks are cleaned and disinfected on an annual basis.	
7.2	Are the cleaning and disinfection procedures completed by in house staff?	N		
7.3	Are the in house staff trained and competent to complete cleans and disinfections?	N/A		
7.4	Are the contractor's staff trained and competent to complete cleans and disinfections?	Y		
7.5	Are cleaning and disinfection procedures completed as a matter of procedure?	Y	Cold water storage tanks are normally cleaned on an annual basis.	
7.6	Are these cleaning and disinfection procedures completed in response to sampling/inspection results?	N	Any cleans and disinfections that would be required because of the ongoing risk reduction processes and procedures would be undertaken as required.	
7.7	Are there suitable method statements available in the written scheme covering the cleaning and disinfection procedures?	Y	The method statements are held electronically. All RAMS are going to be placed on the Teams folder.	
7.8	If chlorine is used, is the impact of pH considered in the disinfection process.	N/A	Silver Hydrogen peroxide is used as the disinfectant of choice for the disinfections on site on a spray basis.	
7.9	Are there completion certificates in the written scheme covering any	Y	This can be found on the Teams system	

	disinfection procedures that have been undertaken?			
7.10	Are localised outlet disinfections in use on site?	N	Localised outlet disinfections would be completed if it was deemed that they were required.	
7.11	Is there a suitable method statement available in the written scheme covering the localised cleaning and disinfection procedures?	Y	DMA Canyon Ltd have method statements for localised cleans and disinfections.	
Actions on Cleaning and Disinfection Procedures				
None				
Section 8 New Build and Refurb Capital Projects		**Y/N U/K or Partial**	**Comments**	**Risk Level**
8.1	Have any new build or refurbishment projects, which impacted on the water systems, been completed in the past 12 months	Y	Wards 2A and 2B have had upgrades completed on the ventilation system, and also some work completed on the water systems.	
8.2	Were the implications of this work risk assessed?	Y	2a and 2B were separately risk assessed after the completion of the work.	
8.3	Was the assessment added to the logbook and water system records?	Y		
8.4	Was the written scheme amended to account for the implications of the new build/amended water systems?	Y	Appropriate tasks were implemented for wards 2A and 2B.	
8.5	Were the details of the new systems discussed with the Estates	Y	It was stated at the time of the audit that the Estates department were fully engaged in the refurbishment process.	

	Department and any other involved personnel?			
8.6	Are minutes of discussions regarding the new water systems recorded and entered into the logbook?	Y		
8.7	Were systems, if required, cleaned and disinfected?	Y		
8.8	Are records of all cleans and disinfections available in the record systems?	Y		
Actions on New Build and Refurb Capital Projects				
None				
Section 9 Water Safety Group		**Y/N U/K or Partial**	**Comments**	**Risk Level**
9.1	Is there a Water Safety Group in place?	Y	NHS GGC holds WSG meetings on a quarterly basis	
9.2	Does the WSG have all the required groups represented?	U/K	It is recommended that a check is made to ensure that all the required groups are attending the water safety group meetings.	
9.3	Are WSG meetings held on a quarterly basis?	Y		
9.4	Are minutes and actions produced and followed through with the WSG?	Y		
Actions on the Water Safety Group				
None				

Scottish Water Byelaws Inspection Report

SPID: 200003690101

Byelaws Compliance Officer: Colin Semple

Premise:

Queen Elizabeth University Hospital
1345 Govan Road,
Glasgow,
G51 4TF

Contraventions

Premise Fitting	Area	Location	Due By	Risk	Contravention	Rectification	Comments
Bath	Full site	'Arjo' baths	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Arjo Baths - this equipment must be fed from a designated storage cistern that incorporates an AA, AB or AD air gap. Rhapsody/Primo P200+ Location-NSGH-02-DMW-013 NSGH-02-DMW-011 NSGH-01-STW-079 NSGH-06-GENW1-001 NCH-04-DCFP-038 NCH-03-GW3-059 NCH-03-GW1-068 NCH-02-SCH-079 NCH-02-ARU-006 NCH-01-CCW-051 NCH-01-CAR-048
Filling Loop	Energy Centre Building	Next to heating pressure (unit	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.
Filling Loop	Teaching and Learning	4th floor boiler room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.
Filling Loop	Westmarc Building	Boiler room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.

Filling Loop	Neonatal Building	Plant room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.
Filling Loop	Maternity boiler room	Boiler room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.
Filling Loop	Landlangs Building	Boiler room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	Quick fill filling loop to top up heating system requires fluid category 4 protection.
Hose Union Taps	Adult and Children Building	Basement hydro pool plant room	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	This union hose tap must be fed from a storage cistern which incorporates a fluid category 5 air gap or replace with bib tap and install double check valve on supply pipe.
Main Inlet	Energy Centre Building	Mains incoming water supply	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Install stop valve (BS1010), double check valve and drain valve on incoming supply.
Main Inlet	PDRU And Vascular	Unknown	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Locate incoming supply pipe and install stop valve (BS1010), double check valve and drain valve.
Main Inlet	Full site	All boundary incoming supply	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Whole site protection - install a double check valves to all main inlet boundary supply points. Meters and locations: 11W712602 150MM X-253618/Y-665875 06M440901/03H000872 80/20 COMBI X-253329 Y-665758 3K220000653954 150MM X-253443 Y-665842 09H701812/09M102281 80/20 COMBI X-253547 Y-665541 11W727521/19W711190 100MM X-253815 Y-665585 11H762937/11M686368 80/20 COMBI X-253790 Y-666042
Main Inlet	Westmarc Building	Boiler room	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Install a double check valve and drain valve on the mains water incoming supply pipe.
Main Inlet	Neonatal Building	Unknown	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Locate and install stop valve (BS1010), double check valve and drain valve on incoming supply. Possible location ground floor fire exit door in pipe chase.
Main Inlet	Podiatry Building	Plant room	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination	Install suitable backflow prevention to provide fluid	Install double check valve and drain valve on incoming supply

					risk.	category 3 protection.	pipe.
Main Inlet	Maternity boiler room	Plant room	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Install stop valve (BS1010), double check valve and drain valve on incoming supply.
Main Inlet	Maternity Building	Unknown	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Locate incoming supply pipe and install stop valve (BS1010), double check valve and drain valve.
Pipework	Adult and Children Building	Water tank room	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Dead leg of pipework - disconnect at relevant point so that no stop end at pipe work remains. Put flushing program in place at trade tank 1 & 2 on drain off outlets.
Pipework	Max Fax Building	Lab area - grinder machine	21/03/2022	3	Insufficient backflow prevention for fluid category 3 contamination risk.	Install suitable backflow prevention to provide fluid category 3 protection.	Install double check valve on supply pipe to dental grinder.
Pipework	Laboratory and Medicine	Laboratory level 4	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Laboratory taps must be fed from a designated fluid category 5 tank supply which feeds laboratories only. Please confirm if level 4 laboratory taps are fed from domestic tank on level 4 or laboratory tank in basement.
Pumps	PDRU And Vascular	Loft area	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Booster pump set - this equipment in loft area must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Pumps	Neurology Building	Level 6 plant room water tank	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Booster pump sets - this equipment must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Pumps	Neonatal Building	Secondary filter water tank	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Booster pump set - this equipment must be fed from a storage cistern that incorporates an AA, AB or AD air gap.
Pumps	Laboratory and Medicine	Mortuary tank 2 in basement	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Booster pump set - this equipment must be fed from a storage cistern that incorporates ab AA, AB or AD air gap.
Pumps	Langlands Building	2nd floor plant room B	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Booster pump sets - this equipment must be fed from a storage cistern that incorporates an AA,AB or AD air gap.
Reduced Pressure Zone (RPZ) Valve	Adult And Children Building	Plant room 31 3rd floor	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	RPZ valve must be commissioned/tested by a qualified tester annually. For guidance, please refer to the RPZ AIM document.
Reduced Pressure Zone (RPZ) Valve	Adult And Children Building	Children Building plant room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	RPZ valve feeding hydrotherapy pool must be commissioned/tested by a qualified tester annually. Also

							must be re-installed away from electrical appliances. For guidance, please refer to the RPZ AIM document.
Reduced Pressure Zone (RPZ) Valve	Neurology Building	Neurology boiler house	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	RPZ valve must be commissioned/tested by a qualified tester annually. This RPZ valve is currently too high. For guidance, please refer to the RPZ AIM document.
Reduced Pressure Zone (RPZ) Valve	Teaching And Learning	4th floor boiler room	21/03/2022	4	Insufficient backflow prevention for fluid category 4 contamination risk.	Install suitable backflow prevention to provide fluid category 4 protection.	RPZ valve supplying heating system must be commissioned/tested by a qualified tester annually. For guidance, please refer to the RPZ AIM document.
Shower	Adult And Children Building	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	Neurology Building	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	PDRU And Vascular	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	Teaching And Learning	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	Neonatal Building	Full site	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	Maternity Building	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.
Shower	Langlands Building	Full building	21/03/2022	5	Insufficient backflow prevention for fluid category 5 contamination risk.	Install suitable backflow prevention to provide fluid category 5 protection.	Restrain all shower heads.

Recommendations

Premise Fitting	**Area**	**Location**	**Recommendation**
Fire Hydrant	Full site		All fire hydrants on site to have flushing program in place to remove possible risk of bacterial growth.

Comment/Issues

A47392376

Premise Fitting	Area	Location	Comment/Issue
Double Check Valve	All areas		All double check valves to be maintained and if required replaced every 10 years.
Pipework	Neuro-Surgical plant room 9	Plant room 9	This area is under renovation and has double check valve in place. This area will require a revisit in one years' time once work has been completed.

SCOTTISH HOSPITALS INQUIRY

Bundle of documents for Oral hearings commencing from 19 August 2024 in relation to the Queen Elizabeth University Hospital and the Royal Hospital for Children, Glasgow

Bundle 15 - Water PPP