NHS National Services Scotland

Water Safety Guidance

Scottish Health Technical Memorandum

Part E - Alternative materials and filtration

SHTM 04-01 part E

Draft 1.11 - March 2026.

Contents

Executive Summary

Scottish Health Technical Memorandum (SHTM) 04-01 “Water safety guidance” is published in seven parts:

- part A: Design, installation, and commissioning
- part B: Operational management
- part C: Microbiological testing
- part D: Disinfection of domestic water systems
- part E: Alternative materials and filtration
- part F: Chloramination of water supplies
- part G: Operational procedures and Exemplar Water Safety Plan

The documents give comprehensive advice and guidance on the legal requirements, design implications, maintenance, and operation of safe water systems in healthcare premises. The use of these premises is very intense, the occupancy level high and the patients may be particularly susceptible to waterborne infection risks. Their condition may also require close control of the clinical and built environment.

This 2026 SHTM suite draws together developments and updates from the previous guidance, including recommendations for the safe management of water systems, via the integration of the principle of Water Safety Groups (WSGs) and Water Safety Plans (WSPs) and how to manage and minimise the risks to health from various aspects, ranging from clinical risks, microbial and chemical contamination, changes to the water system, resilience of the water supply and so on. It also introduces a stronger emphasis on staff competencies and the implementation of water hygiene awareness training.

There has been increasing evidence that the interaction of water supply and above ground drainage can each give rise to problems where the design and/ or operation is poorly configured. Therefore, a brief section on above ground drainage design has been included in this version.

Information regarding the mechanisms for compliance with the Scottish Water Byelaws are also discussed.

This 2026 version of SHTM 04-01 supersedes all previous versions of SHTM 04-01 “Water Safety for Healthcare Premises”.

Guidance in this SHTM applies to all healthcare facilities containing domestic water and above ground drainage systems.

Language used in technical guidance

In SHTMs verbs such as “must”, “should” and “may” are used to convey notions of obligation, recommendation or permission. The choice of modal verb will reflect the level of obligation needed to be compliant.

The following describes the implications and use of these modal verbs in SHTMs (readers should note that these meanings may differ from those of industry standards and legal documents):

A. “Must” is used when indicating compliance with the law

B. “Should” is used to indicate a recommendation (not mandatory/ obligatory), for example among several possibilities or methods, one is recommended as being particularly suitable - without excluding other possibilities or methods

C. “May” is used for permission, for example to indicate a course of action permissible within the limits of the SHTM

D. “Shall”, in the obligatory sense of the word, is never used in current SHTMs

Typical usage examples

A. “All water fittings used in the construction of systems referred to in this SHTM must comply with the requirements of the Water Supply (Water Fittings) (Scotland) Byelaws 2014.” [obligation]

B. “Waterborne bacteria should be considered during the design, construction, installation, commissioning and maintenance of the hot and cold water systems and above ground drainage system in the healthcare-built environment,” [recommendation]

C. “There are also other waterborne bacteria acknowledged to be in the water systems that may require further supplementary management practices to control)” [permission]

Project derogations from the Technical Guidance

Healthcare facilities built for the NHS are expected to support the provision of high-quality healthcare and ensure the NHS Constitution right to a clean, safe and secure environment. It is therefore critical that they are designed and constructed in accordance with appropriate technical standards and guidance. This applies to all new and refurbishment projects, regardless of procurement model.

Note 1: The healthcare organisation, and their project teams, should ensure that they have a fully documented list of technical standards and guidance that are applicable to the specific project.

It is recommended that the starting point for all projects should be one of full adherence to the SHTM guidance or better if that can be demonstrated. While it is recognised that derogations may be required in some cases, these must all be risk-assessed and documented in order that they may be considered within a structured derogation review and approval process. In all instances derogations must not compromise the health and safety or operational resilience of the healthcare facility. Healthcare organisations should ensure that any derogations do not impact on their legal or statutory obligations.

Derogations must be properly authorised by the project's senior responsible officer and informed and supported by appropriate technical advice including that of the WSG, irrespective of a project's internal or external approval processes.

A schedule of derogations should be created for any project, including details of approvals, risk assessment and identified mitigations.

Note 2: This guidance does not alter the healthcare organisations legal or statutory obligations.

NHS Scotland Sustainable Development Policy Drivers

Responding to the global climate emergency is one of the Scottish Government's highest priorities. Sustainable development, the concept that the needs of the present must be met "without compromising the ability of future generations to meet their own needs" is integral to the Scottish Government's overall purpose. The Scottish Government's National Performance Framework (NPF) shares the same aims as the United Nations' Sustainable Development Goals. It highlights the need for a 'whole system approach' to successfully deliver the NPF's national outcomes for Health and recognises the important role that NHS Scotland has in helping to achieve this.

Over recent years the current and future impact of climate change has been well documented, with risks to human health and to health and social care delivery highlighted within Scotland's summary report of the UK Climate Risk Independent Assessment*. NHS Scotland is committed to the delivery of a high quality, environmentally and socially sustainable health service that is resilient to the locked-in impacts of climate change. Director Letter (DL) (2021) 38 'A Policy for NHS Scotland on the Climate Emergency and Sustainable Development' provides the framework for this aim to become a reality, and to maximise NHS Scotland's contribution to mitigating and limiting the effect of the global climate emergency.

* NHS Scotland Climate Change Risk Assessments and Adaptation Plans: A Summary Report on the National Services Scotland (NSS) website.

Who should read this guidance?

This document is aimed at specifiers, designers, suppliers, installers, commissioners, WSGs, estates and facilities managers and operations, and Infection Prevention and Control Teams (IPCTs). Elements of the document will also be relevant to managers concerned with the day-to-day management of healthcare facilities and senior healthcare management. Infection prevention specialists who are involved with monitoring water quality and managing infections and outbreaks potentially linked to water supplies will also find it helpful to be familiar with this guidance.

Main changes since the 2014 suite

- This 2026 edition of SHTM 04-01 provides comprehensive guidance on measures to control waterborne pathogens.
- This edition has been updated to align with the Health and Safety Executive's (HSE's) revised Approved Code of Practice (ACOP) for Legionella (L8) and its associated Health and Safety Guidance (HSG) 274 guidance documents.
- A new chapter on above ground drainage has been added to SHTM 04-01 Part A.
- New guidance has been included in SHTM 04-01 Part A on the hygienic storing and installation of fittings and components and on the competency of installers/ plumbers working on healthcare water systems. The guidance also outlines that any person working on water distribution systems or cleaning water outlets needs to have completed a water hygiene awareness training course.
- Information is discussed in relation to compliance with the Scottish Water Byelaws in SHTM 04-01 Part A.
- SHTM 04-01 Part A and Part E now outlines requests for pipework manufacturers data sheets regarding the product limitations.
- Part B of the SHTM 04-01 now includes updated guidance on the remit and aims of the WSG.
- SHTM 04-01 Part B now includes information on Nontuberculous mycobacteria (NTM).
- Guidance on sampling techniques for, testing for, and the microbiological examination of *Pseudomonas aeruginosa* samples - originally in the Health Technical Memorandum (HTM) 04- 01 Addendum - is now included in SHTM Part C to complement the Total Viable Count (TVC) guidance.
- Whilst SHTM 04-01 Part G provides updated guidance on the WSP and in addition to the 2014 sample templates includes several more.

While some guidance on other water- service applications is included, it is not intended to cover them fully. For example:

- process waters used for laundries, see HTM 01-04 - ‘Decontamination of linen in health and social care’
- endoscopy units, see HTM 01-06 - ‘Decontamination of flexible endoscopes’
- primary care dental premises, see HTM 01-05 Decontamination in primary care dental facilities
- renal units, see Health Building Note (HBN) 07-01 and HBN 07-02, the Renal Association's guidelines and ISO 13959 and 11663
- sterile services departments (SSDs), see Scottish Health Planning Note (SHPN) 13 - Part 1 Decontamination Facilities: Central Decontamination Unit
- hydrotherapy pools, see the Pool Water Treatment Advisory Group’s (PWTAG's) ‘Swimming pool water: treatment and quality standards for pools and spas’
- spa pools, the control of legionella and other infectious agents in spa-pool systems HSG282
- birthing pools, see HBN 21 - ‘Maternity’ and PWTAG’s ‘Swimming pool water: treatment and quality standards for pools and spas’

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NHS Scotland Assure would like to thank the National Water Services Advisory Group (NWSAG), Scottish Engineering and Technology Advisory Group (SETAG) and colleagues from Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) Scotland for their contributions and efforts to the production of the SHTM suite revision.

NHS Scotland Assure would also like to thank those who took the time to comment and send feedback during the scoping and technical engagement phases of this document.

NHS Scotland Assure acknowledge contributions from those individuals and organisations involved in the development and publication of previous versions of the SHTM 04-01 suite.

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Background

The original Scottish Hospital Technical Note (SHTN) 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 Scottish Health Technical Memorandum (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 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 Scottish Health Technical Memorandum (SHTM) covers the policy, design, commissioning, operation, and maintenance requirements for the installation of domestic hot and cold water (DHCW) services systems throughout NHS Scotland premises.

Note 3: The water (hot and cold) in these systems is considered potable.

1.2. For NHS Scotland this SHTM supersedes the specification of DHCW systems outlined in the NHS Health Technical Specification CO1 - Common Services, Mechanical, except where specifically noted.

1.3. This SHTM 04-01 Part E addresses the selection of materials for distribution pipework and fittings, it also 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 potential 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 (PB)
- cross-linked polyethylene (PE-X)
- multi-layer

Guidance on the requirements for the specific use of these materials is given in this SHTM.

Policy and strategy

1.13. It is accepted that some areas in NHS Scotland 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.

Note 4: 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 NHS Scotland 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 5: 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 NHS Scotland and the Health and Safety Executive (HSE).

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 9 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 (for example those specified by the World Health Organization (WHO).

Note 6: 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 Water Research Centre (WRc) plc/ WaterRegsUK - which is designed only to satisfy the requirements of BS 6920-2.1: 2014.

1.19. Compliance with health standard requirements 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:

- British Standard (BS) 806 part 1 - 5 sections as applicable
- Deutsche Industrie-Norm (DIN) 16836
- BS 21003- 1
- BS 21003-2:2008 + A1:2011
- BS 21003-3
- BS 21003-5
- 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 (COSHH) 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 NHS Scotland 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 NHS Scotland 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 requirements set out in Scottish Health Technical Note (SHTN) 1; on delivery, all material and equipment fully complies with the prescribed specifications and contract requirements
- 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 domestic hot and cold water (DHCW) systems are outlined in this section. Specific requirements for materials are laid out in the following Chapters.

2.2. The onset of widespread corrosion in copper piping led to extensive investigations of DHCW services systems in NHS Scotland premises. These investigations highlighted many design and operational difficulties. For example, test results showed there were a number of areas where it was difficult to comply with the maintenance of 'safe' water temperatures, as stipulated in Scottish Health Technical Memorandum (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.

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 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, 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. Therefore, it is important that the options for each pipework material is reviewed and an agreement made by the Project Water Safety Group (PWSG) and Water Safety Group (WSG) on what should be used on each installation.

2.5. As noted in SHTM 04-01 Part A, where practicable cold-water pipework should not be installed adjacent to a known heat source, such as the implication of installing over/ within location of radiant heat panels. However, it is accepted that this is not always possible particularly during re-piping activities, whilst maintaining the existing system in operation. The designer and installer should consider the implication of installing over/ within location of radiant heat panels.

2.6. All pipework and fittings should therefore be insulated to a standard to minimise heat gains 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.

> Note 7: Care must be taken in the ventilation of water tank rooms to avoid condensation and mould growth. This requires particular attention in basement tank rooms where colder building surfaces can coincide with high specific air moisture content. Refer to SHTM 03-01 for guidance.

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, 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.

2.11. Where trace heating installations are in place these will require management, maintenance and monitoring to ensure that the installation is capable of maintaining the set temperatures and performance characteristics. There have been incidences where performance degradation has occurred with age leading to temperatures that would support/ assist micro-organisms such as Legionella. Water system design should negate the need for trace heating in healthcare premises unless it is essential for frost protection.

Materials

2.12. The alternative materials investigated and deemed acceptable to replace copper piping in DHCW services systems in NHS Scotland premises are as follows:

- 316 S16 austenitic stainless steel to the following specifications:
  - British Standard (BS) EN 10312:2002
  - Deutsche Industrie-Norm (DIN) 1988
  - DIN 2463
  - BS EN 10088-2

- unplasticised polyvinyl chloride (PVC-U) to the following specification:
  - BS EN 1452: 2009 (for cold water systems only).

Note 8: PVC-U has now generally been superseded in use by chlorinated polyvinyl chloride (PVC-C).

- chlorinated polyvinyl chloride (PVC-C to the following specifications:
  - BS 7291, Part 1: 2001 (for hot and cold-water systems)
  - DIN 8079 and DIN 8080
- Polybutylene (PB) to the following specification:
  - BS 7291, Parts 1 and 2: 2001;
- Cross-linked polyethylene (PE-X) to the following specification:
  - BS 7291, Parts 1 and 3: 2001, DIN 16892.
- Multi-Layer to the following specification
  - DIN 16836, BS 21003- 1
  - BS 21003-2:2008 + A1:2011
  - BS 21003- 3, BS 21003-5

Note 9: PVC-U, PVC-C, PB, PE-X or Multi-Layer should not be used for a fire hose-reel system. 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.

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

2.14. 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. Materials that are known to leach should only be used if risk assessed. A typical example is the use of copper alloy fittings 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.

Note 10: Consider the effect that disinfection products (oxidants) can have on glues/ solvents and joint materials. When working with joints that require gluing, ensure that the correct glue is selected. Any glue/ solvent should be compatible with shock treatment chemicals used. Particularly when working with Acrylonitrile butadiene styrene (ABS).

2.15. 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 11: The attention of designers and management of all NHS Scotland premises (and in particular augmented care, maternity and infant care units) is drawn to the need to carefully examine 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.

2.16. In the case of the polyvinyl-chloride (PVC) plastics, initial concerns regarding 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.

2.17. 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.

2.18. 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 United Kingdom Water Byelaws Scheme (UK WBS), managed by Water Research Centre (WRc) plc.

Leachate flushing

2.19. It has been determined that the use of stainless steel, PVC-U, PVC-C, PB, PE-X or Multi-Layer 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 DHCW services and it should be assumed that all pipework materials must undergo a flushing procedure prior to being brought into use.

2.20. Details of this regime are given in paragraph 2.70 and its timing within the construction and commissioning of a new or refurbishment project is shown in Figure 2.2.

Pipe fittings and valves

2.21. All pipe fittings (such as 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 12: 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.

2.22. All valves should be of the ¼-turn ball or butterfly type and have either compression coupling ends, screwed ends, flanged ends, press fit/ crimped 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.

2.23. Where practicable, only one manufacturer of fittings and only one manufacturer of valves should be used in any single NHS Scotland premises.

Pumps

2.24. All pumps should be made to British Standards 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. Corrosion may result from galvanic action where dissimilar metals are connected. Dissimilar metals should therefore be avoided as far as practicable or effective measures should be taken to avoid deterioration. Where copper pipework is used, it may be prudent to specify gunmetal pump casings due to their material compatibility. This avoids the need for additional precautions, such as the installation of dielectric unions or insulating couplers, which are generally required when combining copper with stainless steel to mitigate galvanic corrosion risks.

Note 13: In general, all pumps and their associated valves should comply with the relevant requirements of BS 6920: 2014 (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

2.25. All cold-water storage cisterns should meet the requirements of UK WBS Byelaw 30, SHTM 04-01 and BS 806 part 1 - 5 and be constructed of single piece or sectional glass-reinforced plastic. All internal components of the cisterns (for example nuts, bolts, washers, stays, spacers, bracings, and so on) should be of 316L stainless steel. All external components should be zinc plated.

2.26. 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 (no internal flanges) 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.

2.27. It is important to note that many manufacturer warranties require tanks to be filled within approximately three weeks to avoid deformation, material degradation, or voided guarantees. This needs to be agreed by the PWSG and included in the Project Water Safety Plan (PWSP) in respect to ensuring that suitable flushing programs are implemented once water has been introduced.

Pipework system

2.28. Stainless steel, PVC-C, PB, PE-X and Multi-Layer 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 14: Where PVC-C, PB, PE-X or Multi-Layer 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 SHTM Part D.

Excessive temperatures may also occur should there be a failure within the calorifier control system.

The installation of check 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.

If the design intent is to have a continuous disinfection system installed, the designer should also consider whether there are limitations to duration of dosing, temperature, concentration limits, etc that may affect system components warranty and longevity.

2.29. 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 (2014), BS 806 part 1 - 5; DIN 16836, BS EN 21003-1, BS EN 21003-2:2008 + A1:2011, BS EN 21003-3, and BS EN 21003-5
- 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 considered 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 NHS Scotland 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, bellows or flexible sections that contain ethylene propylene diene monomer (EPDM) lining materials should not be used. (See Safety Action Notice SAN (SC) 09/03 Nov 2009)

2.30. 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, although Multi-Layer Composite pipework, which has an aluminium layer is closer to the expansion coefficient of copper 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).

Note 15: Expansion devices/ bellows will deteriorate over time and an inspection for degradation should be included as part of a Planned Preventive Maintenance (PPM) programme. This should include a replacement schedule in line with manufacturers recommendations.

2.31. Thermal expansion or contraction of a metal pipe can be calculated according to the formula:

$\Delta L = \Delta T \times \alpha \times L$

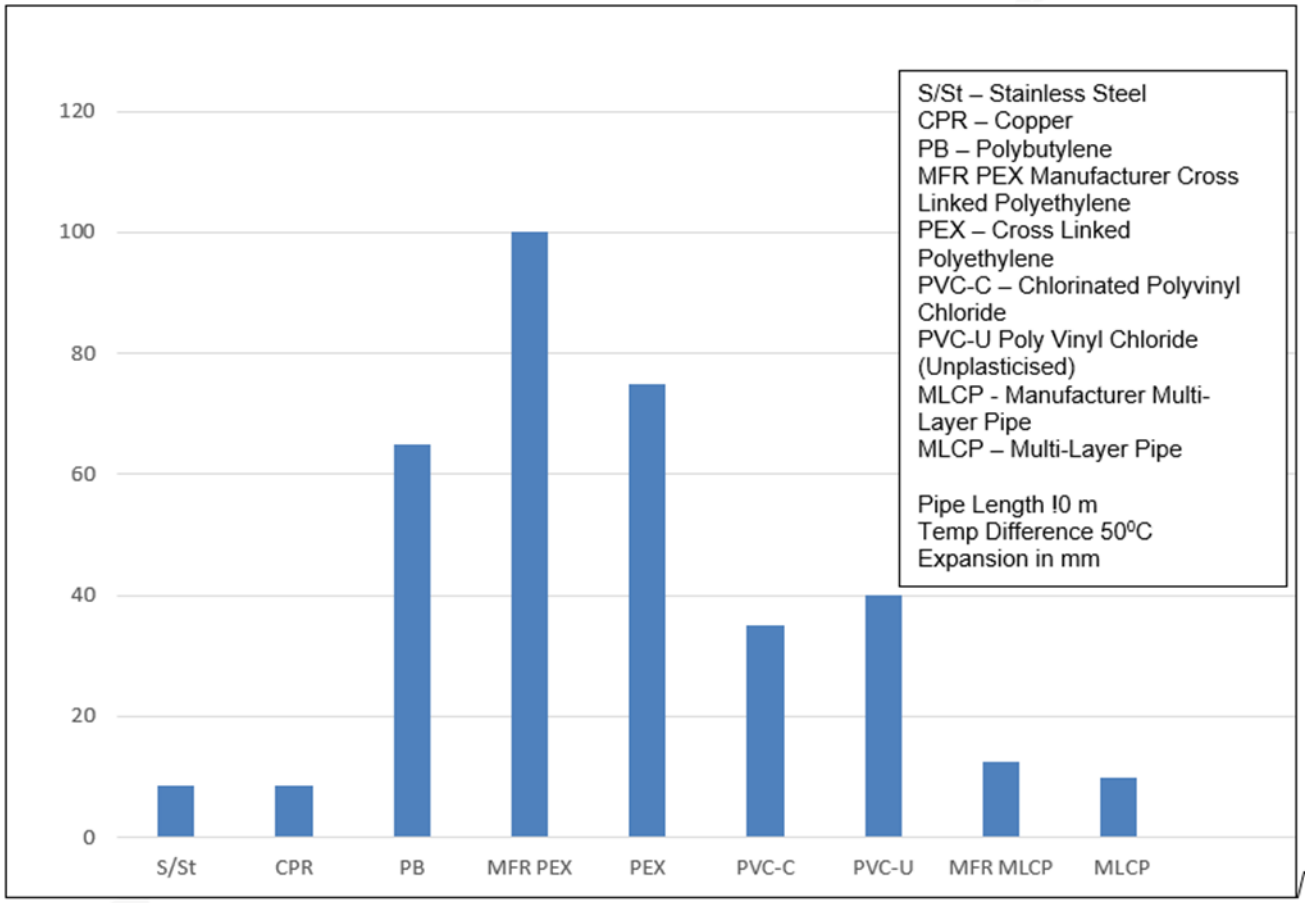
where

- ΔL is the thermal length variation, in mm
- ΔT is the temperature difference, in K
- L is the length of the pipe, in m
- α is the coefficient of thermal expansion in accordance with Table 1, in mm/ (m · K)

Table 2.1 - Thermal coefficients from BS 808-4 and thermal expansion calculation

Pipe material	BS 806-4 α mm/ (m · K)	Expansion based on T 50^{0C} and L = 10 m
Stainless Steel	0.017	8.5mm
Copper	0.017	8.5mm
PB	0.13	65mm
PE-X	0.15	75mm
PVC-C	0.07	35mm
PVC-U	0.08	40mm
Multi-Layer	0.02	10mm

Figure 2.1 - Expansion of pipework in mm, coefficients from BS 806 with additional manufacturer figures inserted



Note 16: Pipe Expansion (see Table 2.1) based on BS 806-04. Manufacturers thermal expansions may differ. For example manufacturers data predominately shows a coefficient of PE-X as 0.2 and Multi-Layer Composite Pipe (MLCP) as 0.025. The Manufacturer Technical Data Sheet should be consulted to calculate pipework expansion.

2.32. 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.

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

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

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

2.36. 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, and so on.

Note 17: Manufacturer's literature indicates that a fixed point may be achieved with a tightened pipe clip with oversized pipe shells either side.

2.37. Installation experience has shown that the dimension from the building fabric face to the centreline 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.

2.38. 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 18: Where PVC-C, PB, PE-X or Multi-Layer pipework 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. 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.

This should include ensuring that:

- 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. See also SHTM 04-01 Part A.
- Unless specified otherwise, servicing isolating valves should be provided on each water draw-off connection to a fitment.

2.39. All other valves should be fitted as and where necessary to:

- balance the DHWS system
- allow isolation of individual circuits

- 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

Note 19: Consideration should be given to the vibration and motion caused by electrical pump motors and start/stop actions. This is particularly important when considering PVC components which may be connected to stainless steel fittings. Anti-vibration dampening should be considered, and the appropriate amount of support and rigidity must be designed in at all stages of pipework installation.

- 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
- designers and installers should consider the risks associated with the potential for dead legs within water systems. A dead leg is defined as a section of pipework connecting to an outlet that in normal operation may be little used. All pipework installations should be arranged to eliminate or minimise dead legs. Pipe runs should not be excessively long and kept to an absolute minimum to avoid stagnant flow conditions

Note 20: This is particularly applicable to hot water systems, for which compliance with SHTM 04-01 Part A is necessary.

- where there is risk of potential dead legs within a design or installation consideration should be given to re-routing pipework to ensure that final connections are made to a frequently used outlet that will deliver an adequate turnover of water to avoid stagnation
- where a reduction of bore is accomplished at a pipe joint using a reducer, these should be eccentric when installed in horizontal pipework and concentric when vertical

- thermal insulation should comply with BS 5970: 2012 and should preferably not be applied to any pipework until after the pipework has been pressure tested. 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

2.40. Tubular pipe sleeves should be fitted to all pipes which pass through external walls and internal divisions in the building fabric (such as walls, floors, ceilings, and so on). These sleeves should have internal diameters of sufficient size as to permit the free passage of the pipes through the building fabric and ensure that the pipes do not touch either the sleeve or the building fabric.

Note 21: Pipes should not be insulated over the length within the sleeves.

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

- 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, and so on
  - 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 22 For requirements specific to wet floors see NHS Health Technical Specification C01, Element 02, Item 09.

- 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
- 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 23: Filler rings should be fitted to facilitate 2 and 3. The sleeve infill should extend along the full length of the sleeve.

Fire sleeves

2.42. 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.

2.43. 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

2.44. They should comply, as appropriate, with the requirements given in Sections 3, 4, 5, 6 ,7 and 8 for stainless steel, PVC-U, PVC-C, PB, PE-X and Multi-Layer pipework systems, respectively.

Installing the pipework

2.45. Site supervision should be such as to ensure that a high standard of cleanliness is attained and maintained throughout all stages of installation. Cleanliness is to include tools/ handling equipment/ wrappings/ storage. Tools used, need to be regularly cleaned. Tools and handling equipment should also be inspected as part of a PPM system, damaged tools and Handling equipment should be condemned, removed, and replaced. When taps are installed, they should be protected from the environment for example Sterile cling film.

2.46. As part of good hygiene practices there should be segregation of tools, coveralls and equipment when working on water systems/ clean areas and when working on soiled/ contaminated areas, such as sewers/ drains/ toilets/ macerators and so on.

2.47. 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 hard capped.

Note 24: Any item which, on delivery, does not meet the specification and contract requirements should be rejected and replaced.

2.48. 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.

2.49. 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.

2.50. 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 25: 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.

2.51. 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 26: The use of hacksaws is not permitted due to their generating burrs and allowing swarf to enter the pipe bore.

2.52. 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.

2.53. 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.

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

Note 27: This is of particular importance for compression couplings. Over-tightening can impair the integrity of the joint and, 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.

2.55. Samples of pipework will be removed from the installation during construction for examination and analysis to ensure appropriate levels of workmanship are being maintained. Refer to SHTM 04-01 Part A for guidance.

2.56. 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.

2.57. 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

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

2.59. 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

2.60. The testing procedure should be in compliance with BS 806 part 1 - 5, BS 21003-1, BS 21003-2:2008 + A1:2011, BS 21003- 3, BS 21003-5 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.

2.61. 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

2.62. If, contrary to paragraph 2.28, 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.

2.63. 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 refer to SHTM 04-01 Part A for further details.

2.64. 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.

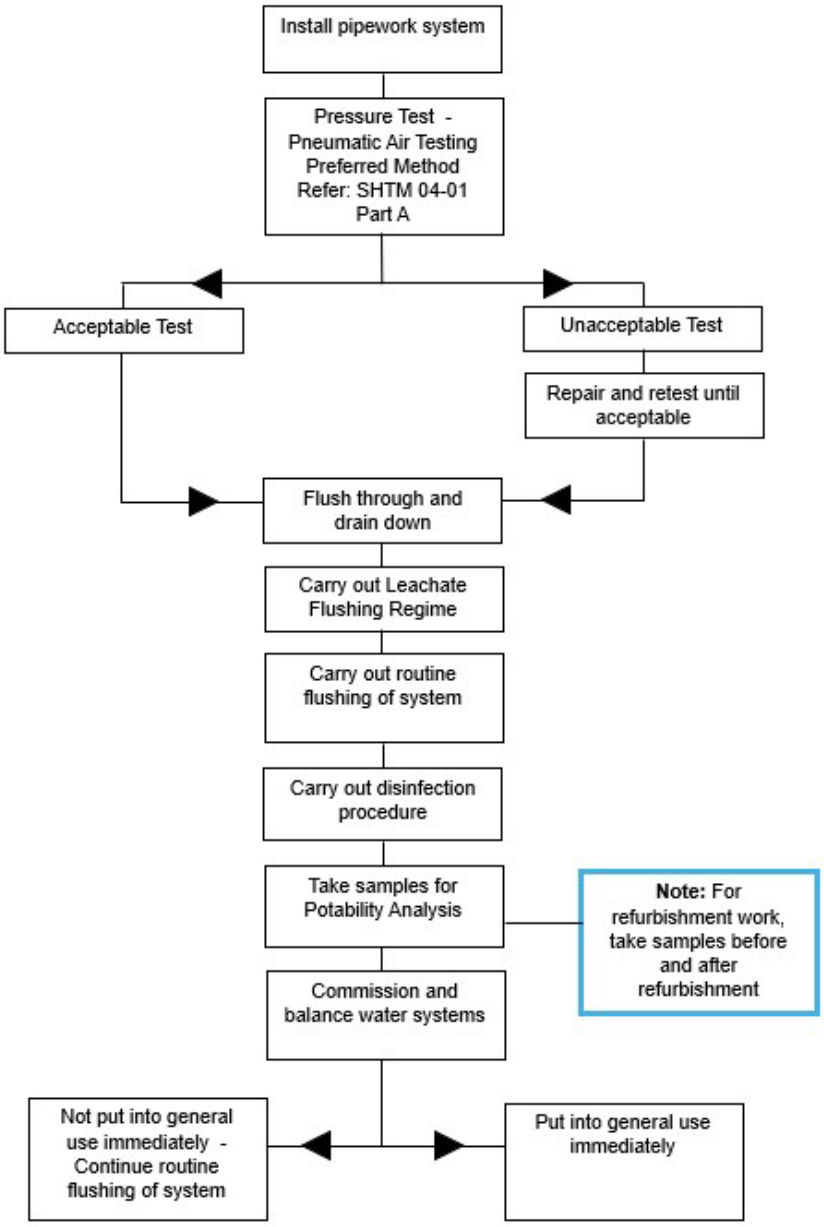
Note 28: The test pressure applied should not exceed the nominal pressure rating of the lowest rated item in the pipeline system by more than 50%. (For PB, PE-X and multilayer pipework and fittings the system should be pressure tested in accordance with BS EN 806 test procedures for elastomeric pipes at a pressure indicated by BS EN 806 or by the manufacturer).

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

2.66. 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.

2.67. 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 in order to avoid the installation sitting with a large, wetted surface area. Figure 2.2 algorithm illustrates a simple application, but the comments set out here and in paragraph 2.51 must be considered.

Figure 2.2 - Sequence of events



Note 29: 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.

2.68. Both the installer and the client's supervising officer should sign pressure test certification.

2.69. 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 2.86).

Flushing

2.70. 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

2.71. 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 using 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 intervals to be agreed with the WSG

Disinfection

2.72. Where stainless steel or other non-copper pipework materials are used, the application of sodium hypochlorite at elevated concentrations is not suitable due to the risk of material degradation or corrosion. Sodium hypochlorite is generally acceptable for copper pipework and glass-reinforced plastic (GRP) cold water storage tanks, though manufacturer guidelines should always be verified. It is recommended that specialist firms are engaged for the disinfecting and water sampling process.

2.73. 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 30: A closed isolating valve is not acceptable as a physical break. All outlets shall be clearly marked with **Disinfection in Progress. Do Not Use**.

2.74. The disinfection procedure should generally be in compliance with: BS EN 806, considering 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
- membrane filters manufactured from polypropylene

2.75. Part D of this SHTM provides guidance on the various options for disinfection, their applications, advantages, and disadvantages.

Note 31: The contractor's attention should be drawn to the necessity to comply with the requirements of the Control of Substances Hazardous to Health Regulations (COSHH) 2002 and that these requirements must be fully adhered to when handling disinfectants.

2.76. 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, and so on) 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 50 parts per million (ppm) (that is, fifty parts peracetic acid to one million parts of water) should be considered.

2.77. 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. The project team should request a letter of assurance from the system materials manufacturers that the proposed disinfection will not cause a detrimental effect on the materials.

2.78. 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 SHTM Part D.

Note 32: PVC-U piping should not be subjected to temperatures exceeding 60°C.

Commissioning and using the system

2.79. When all disinfection work has been completed the whole system should be drained down, thoroughly flushed out and fully recharged with water of a known quality and tested to demonstrate that it is microbiologically "fit for purpose" in preparation for commissioning and 'balancing' the hot water system.

Note 33: Disinfection and this subsequent flushing should be carried out preferably as continuous and consecutive operations without any intermediate delays.

2.80. The WSG should discuss and agree a sampling regime and appropriate parameters (physical, chemical, and microbiological) depending on the intended use of the system and vulnerability of the patients.

2.81. Water testing should be caried out to demonstrate the water in the system is of Wholesome quality. A suitable number of samples should be taken when the system is fully recharged at locations agreed by the WSG. Microbiological analysis of the water samples should be carried out by the Public analyst, or an approved independent body to determine if it is of Wholesome quality. The contractor should supply a full set of analysis results to the site supervisor for approval before the system can be taken unto use.

2.82. Sampling for Legionella should be to BS 7592:2022 Sampling for Legionella bacteria in water systems - Code of practice. A sampling location plan with appropriate microbiological parameters should be agreed by the WSG.

2.83. For Pseudomonas testing a sampling location plan with appropriate microbiological parameters should be agreed by the WSG.

Following sampling, analysis results should be supplied to the WSG for review, and action taken if required, in accordance with Health and Safety Guidance (HSG) 274 - Table 2.3. Actions to be taken following legionella sampling in hot and cold-water systems in healthcare premises with susceptible patients. Also refer to guidance in SHTM 04-01 Part C.

2.84. Water samples should be obtained from appropriate points in the system after each recharging. Potability analysis of these samples 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. Sampling to BS 7592: 2022 Sampling for Legionella bacteria in water systems - Code of practice. Independent analysis of water samples should be carried out by a United Kingdom Accreditation Service (UKAS) accredited laboratory.

2.85. In the event of the system not being in typical use for periods of 24 hours or more during the first month after commissioning, a routine flushing programme should be implemented to generate appropriate throughput of the newly installed system to match volumes of typical operational use. The flushing methodology should be risk assessed and agreed by the WSG and documented within the Operation and Maintenance (O&M) manuals. The weekly flushing records should be provided to the WSG for review. Further, once the system is wetted, it should be considered as “live”, the system components requiring PPMs and system checks should start at this time. Once the water system is wetted, the building air temperature should be maintained to that expected at handed over and occupied, any changes to the air temperature setpoints prior to handover should be risk assessed and agreed by the WSG.

2.86. If the system is not immediately put into use after commissioning, partial re-plumbing or maintenance work, a flushing programme should be implemented until it is taken into use.

2.87. 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.

Note 34: The system should be disinfected and flushed before being put back into use.

2.88. Local disinfection should be carried out on those parts of a system affected by partial re-plumbing and maintenance work.

Water consumption

2.89. 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.

2.90. Water consumption design estimates were 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 Department of Health and Social Security (DHSS) in 1973. In Data Sheet DY1.1. Today with the use of pulse meters and modern technology NHS Boards have more accurate water consumption figures which can be used.

2.91. Within NHS Scotland, NHS boards use an energy monitoring, data collecting and analysing tool. This tool gathers energy and water data for NHS sites and produces consumptions based on automated meter readings on an hourly, twenty-four hourly, weekly and an annual basis. This information is available at NHS board/ Site level and can be accessed by contacting the relevant Energy/ Estates Officer for the information required.

2.92. There is guidance to assist designers in Appendix 1 of SHTM 04-01 Part A. Impact of water consumption on care pathways. In many situations, however, the best estimates of water consumption will be provided by the user or from NHS board records.

Water storage

2.93. 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, Health and Safety Executive (HSE) Approved Code of Practice (ACOP) L8 and the hospital. Further guidance is contained in SHTM 04-01 Part A.

Water filtration

2.94. As stated earlier, SHTM 04-01 Part A 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, high standards of filtration of water, air vents and water overflows.

2.95. Infection Prevention and Control/ Scribe procedures should be followed when working in patient areas or areas that may impact on the patient.

2.96. 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, and so on are special cases). In cases where it is identified that there are high-risk patient groups then it may be appropriate to specify point of entry filtration down to as low 0.2 micron. Any decision should be based upon a documented risk assessment agreed by the WSG.

2.97. To help achieve the above and minimise the formation of biofilms 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 0.5 microns should be specified
- for stainless steel pipework covered by this SHTM a maximum cut off of 0.5 micron should be specified
- 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

Further guidance is given in Section 9 of this SHTM.

2.98. 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. This can be achieved through modified work practices and the implementation of high standards for water filtration, air vents, and overflow protection. Overflows and warning pipes must be fitted with borosilicate glass traps and filled with a mixture of water and a disinfectant compatible with the supplied water quality. Air vents must incorporate filters matching the water filtration grade - for example, a system with 0.5 µm filtration must have a corresponding 0.5 µm air filter. There should be no direct openings to atmosphere that are not protected by either a sealed glass trap or a suitably rated air filter to ensure the integrity of the filtered water within the storage tank.

Spares

2.99. 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. The spares to be, sealed/ capped, catalogued, and stored securely within the Estates Department spares storage area or as agreed.

Record documentation

2.100. 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 Post Commissioning Documentation, as stated in Scottish Health Technical Note (SHTN) 1.

2.101. 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
- (in accordance with BS 8580-1) a risk assessment for the control of Legionella and where applicable Pseudomonas aeruginosa and other waterborne pathogens in accordance with BS 8580-2
- full records and certificates of pressure tests for all sections of pipework
- results of any tests undertaken on any stainless-steel welding, and pipework joint testing
- detailed confirmation of disinfection procedures to BS EN 806 series (parts 1–5) and BS 8558 and results of post- disinfection microbiological analysis
- 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 where applicable
- 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 appropriate test and commissioning certificates
- and manufacturer's test certificates and engineers' test certificates where applicable
- as-fitted drawings, including schematics, showing clearly the location of balancing valves, flows and settings, isolation valves, drain valves. All Principal, Subordinate, and Tertiary loops must be annotated accordingly, on floor plans with flow directions and colour coding in line with the conventions set out in HSG274 Part 2, Appendices 2.4 and 2.5

Note 35: These drawings must fully detail:

- balancing valves positions, indicating flow and setting
- isolation valves positions
- drain valves positions; all clearly and precisely detailed

- schematic drawings for installation in plantrooms showing all valves and plant items
- full details of water treatment parameters and operating modes and settings
- full details of maintenance requirements based on the assets installed and the recommended frequency of the maintenance/ monitoring/ inspection of each
- full records confirming that all materials and fittings are compliant with the Water Byelaws, via Water Regulations Advisory Scheme (WRAS) or equally approved other certifications
- expected operational conditions of the water system (that is, expected pressures, expected temperatures, expected flow rate throughout the system as pressure drops will occur)
- full details of plant and equipment that require to be maintained until handover, and records of all planned maintenance or service contract reports
- full records of any routine flushing of the water systems until handover
- results of any microbiological sampling carried out until handover, and records of any remedial actions carried out

2.102. 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, six monthly, and annual maintenance requirements.

Statutory requirements

2.103. 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
- The Water Supply (Water Fittings) (Scotland) Byelaws 2014
- The Building (Scotland) Regulations 2004
- The Building (Scotland) Regulations: Technical handbooks and guidance, 2019
- Water Fittings and Materials Directory, WRAS/ WaterRegs UK 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.

Note 36: It has been identified that in some new builds there has been a mixture of materials from different manufacturers and countries with varying grades and dimensions. This has led to issues when pipework was subsequently modified.

To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework grade and external and internal pipe dimension.

3.2. Stainless steel pipework and fittings intended for the conveyance of potable cold water and hot water service for uses within NHS Scotland Premises should comply with the requirements of the following:

- British Standard (BS) EN 10088-2: 2014
- BS EN 1254 1 & 2: 1998
- Deutsche Industrie-Norm (DIN) 2463
- BS EN 10312:2002
- DIN 1988

Note 37: 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 Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance 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.

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

Pressure ratings - Pipe, fittings and values 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

Note 38: 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.

3.5. Normal operating temperatures will be in the range of 10°C - 65°C, in some exceptions there may be occasions that this may increase to 70°C for a short duration.

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

- BS 806: Part 1 - 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A, B and D
- the relevant manufacturer's instructions

3.7. 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.

3.8. 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.

3.9. 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%.

3.10. A protective aluminium foil should be applied to the pipework system surface first under all circumstances prior to insulation, with not less than a 50mm overlap at the joints. Unless letters of assurance are received from the insulation and pipework manufacturers stating their product will not be adversely effected by the other.

Pipes

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

- BS EN 10216-5: 2013;
- BS EN 10217-7: 2014;
- BS EN 10312:2002 LWHT 316S16;
- DIN 1988 Part 2 LWHT 316S16;
- DIN 2463;
- BS EN 10088-2: 2014.

Pipe fittings and valves

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

Note 39: Pipework normally selected for use within NHS Scotland Premises is generally 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.

Note 40: There have been issues identified with the use of shiny new carbon steel fitting such as bends, and T's being wrongly used in a stainless system. There should be procedures in place to ensure that there is segregation between stainless steel fittings and carbon steel fittings delivered to site. Ensure in-house staff and contractors are aware of this issue and put systems in place to differentiate between the different types of fittings on site.

3.13. 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 41: 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.

3.14. Stainless steel compression fittings to BS 4368-1: 1998 and DIN 2353 are available but are generally not considered for widespread use.

Note 42: 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 EN 1092-3: 2003.

Sealing rings and gaskets used in flanged joints should comply with BS 7874: 1998.

3.15. 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 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 non-dezincifiable 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

3.16. 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

3.17. 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 American Society or Testing Materials (ASTM): B280-86 Clause 12.

Workmanship, finish and appearance

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

Packaging and transportation

3.19. 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 43: Any pipes delivered unprotected or with open ends should be rejected.

3.20. 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

Note 44: Anyone involved in pipework installations should be competent, have sufficient training and hands on experience in the methods of pipework jointing, particularly the installation of crimped joints.

These crimped joints **MUST** be correctly cut and assembled in line with manufacturers detailed installation instructions. Upon completion, a percentage of crimped joints should be removed for detailed inspection and metallurgical examination.

3.21. 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.

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

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

3.24. Where expansion bellows are used, they should be of stainless-steel construction 316S16:

- of a design incorporating internal sleeving (to minimise the accumulation of debris in crevices)
- be finished with compressing coupling or flanged ends which meet the materials requirements stated in Note 40 and are appropriate to the size of pipe to which they are to be fitted.

Note 45: All parts of the expansion bellows in contact with water must be of stainless steel 316S16 construction.

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

3.26. 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.

Table 3.2 - Support bracket spacing; 60°C

Pipe outside diameter (mm)	Maximum interval Horizontal (metres)	Maximum interval 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

3.27. 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.

3.28. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (for example pumps and so on). This is especially important where different materials are being introduced into the system. A good example is Chlorine dioxide (ClO_2), where the pipework pertaining to the ClO_2 generation is plastic and inserted into the stainless pipework. Therefore, in order to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

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

Fire sleeves

3.30. Fire sleeves for stainless steel pipework should comply with the requirements of paragraph 2.32 and should be made of stainless steel and be sealed with a Class 'O' fire resistant infill which is chloride free.

Installing the pipework

3.31. 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: 2018. When this method of jointing is employed, it is important 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.

3.32. 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.

3.33. While the thermal expansion/ contraction of stainless steel is less than thermoplastic pipework nevertheless it must be considered 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 46: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

4. Copper pipework and copper/ copper alloy fittings specification

General

4.1. Requirements specific to the design and installation of copper pipework systems are contained within this Section. These are in addition to the general requirements outlined within Section 2. See Scottish Health Technical Memorandum (SHTM) 04-01 Part A, for further information about copper.

Note 47: It has been identified that in some new builds there has been a mixture of materials from different manufacturers and countries with varying grades and dimensions. This has led to issues when pipework was subsequently modified.

To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework grade and external and internal pipe dimension.

4.2. Copper pipework and copper/ copper alloy fittings intended for the conveyance of potable cold water and hot water service for uses within NHS healthcare premises should comply with the requirements of the following:

- British Standard (BS) EN 1057:2006+A1. Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications. British Standards Institution, 2010
- BS EN 1254 -1,2,3,4,5,6,7,8,20
- BS EN 805. Water supply. Requirements for systems and components outside buildings. British Standards Institution, 2000. BS EN 806 [All Parts]. Specifications for installations inside buildings conveying water for human consumption. British Standards Institution, 2005.

Note 48: All materials in contact with copper pipework must not have a chloride content exceeding 0.05%. (This applies in particular to insulation).

4.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

Pressures and temperatures

4.4. The working pressures and operating temperatures of press fittings, copper pipework, expansion joints and fittings are listed for guidance in Table 4.1, below.

Table 4.1 - Copper pipework – working pressures/ operating temperatures – Pipe, fittings and valves and expansion joints

Product	Size	Pressure rating
Fittings	15mm – 100mm	16 Bar at 80°C
Valves	15mm – 100mm	16 Bar at 80°C
Pipe	15mm – 100mm	See Chartered Institution of Building Services Engineers (CIBSE) Guide G 13.9-11
Expansion Joints	15mm – 100mm	6 Bar at 90°C

Note 49: 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.

4.5. Normal operating temperatures will be in the range of 10°C - 65°C.

Note 50: Maximum operating temperature must not exceed 110°C continuous or 130°C for a period of not exceeding one hour.

4.6. The whole of the copper pipework installation shall be installed, tested, disinfected, and commissioned in accordance with the requirements of the following:

- BS 806: Part 1 - 5
- BS 8558: (2015)
- SHTM 04-01 Parts A, B and D
- relevant manufacturer's instructions

4.7. 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.

4.8. The use of copper 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 copper. However, it should be noted that sacrificial anodes should not be used.

4.9. A protective aluminium foil should be applied to the pipework system surface first under all circumstances prior to insulation, with not less than a 50mm overlap at the joints. Unless letters of assurance are received from the insulation and pipework manufacturers stating their product will not be adversely effected by the other.

Pipes

4.10. All copper piping used in the hot and cold-water services system should comply with the following:

- BS EN 1057:2006+A1,2010

Pipe fittings and valves

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

> Note 51: Pipework normally selected for use within NHS Premises are generally for use with press-fitting fittings or in some cases on smaller diameters for use with compression fittings.
>
> Pipework exceeding 100mm diameter will require to be flanged.

4.12. 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.

4.13. 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 copper 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 non-dezincifiable materials. Maintenance will be reduced and simplified, however, with the adoption of ¼ turn ball or butterfly valves
- only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used

4.14. Where servicing ball valves are required at fitments, these shall be of non dezincifiable construction with compression ends suitable for direct connection to copper pipework. Removal will be simplified by the incorporation of disconnection unions.

Cleanliness requirements

4.15. As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in all NHS 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 American Society or Testing Materials (ASTM): B280-86 Clause 12.

Workmanship, finish and appearance

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

Packaging and transportation

4.17. 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 52: Any pipes delivered unprotected or with open ends should be rejected.

4.18. 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

Note 53: Anyone involved in pipework installations should be competent, have sufficient training and hands on experience in the methods of pipework jointing, particularly the installation of crimped joints.

These crimped joints **MUST** be correctly cut and assembled in line with manufacturers detailed installation instructions. Upon completion, a percentage of crimped joints should be removed for detailed inspection and metallurgical examination.

4.19. 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.

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

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

4.22. Where expansion bellows are used, they should be of stainless-steel construction 316S with copper ends to BS EN 1057:

- of a design incorporating internal sleeving (to minimise the accumulation of debris in crevices)
- be finished with open ended copper pipework, compressing coupling or flanged ends which meet the materials requirements and are appropriate to the size of pipe to which they are to be fitted

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

4.24. 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 4.2, below, or as advised and confirmed by the pipe manufacturer.

Table 4.2 - Support bracket spacing; 60°C

Pipe outside diameter (mm)	Maximum interval Horizontal (metres)	Maximum interval 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

4.25. 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.

4.26. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (such as pumps, and so on). This is especially important where different materials are being introduced into the system. A good example is Chlorine dioxide (ClO_2), where the pipework pertaining to the (ClO_2) generation is plastic and inserted into the stainless pipework. Therefore, in order to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

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

Fire sleeves

4.28. Fire sleeves for stainless steel pipework should comply with the requirements of paragraph 2.32 and should be made of stainless steel and be sealed with a Class ‘O’ fire resistant infill which is chloride free.

Installing the pipework

4.29. 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: 2018. When this method of jointing is employed, it is important 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.

4.30. 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.

4.31. While the thermal expansion/ contraction of stainless steel is less than thermoplastic pipework nevertheless it must be considered 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 54: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

5. PVC-U pipework specification

General

5.1. Requirements specific to the design and installation of unplasticised polyvinyl chloride (PVC-U) pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

5.2. PVC-U pipework and fittings intended for the conveyance of potable cold water for use in all domestic cold-water services within NHS Scotland premises should comply with the requirements of British Standard (BS) EN 1452: 2009.

Note 55: The curing time for solvent joints can present significant challenges during maintenance, particularly when urgent repairs are required. Extended cure times - which vary by diameter, temperature, and pressure rating - can delay system reinstatement and disrupt clinical operations. This limitation should be carefully considered during material selection and system design, especially in critical healthcare environments where rapid return to service may be necessary.

5.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

Note 56: 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.

5.4. The working pressures and operating temperatures of PVC-U pipework and fittings are listed for guidance in Table 4.1. Consideration should be given as to whether the pipework material allows for temperature monitoring.

5.5. 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 806 part 1 - 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A and B
- SHTM 04-01 C and D
- Health and Safety Executive (HSE): Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice (ACCP) and guidance (2013)

5.6. 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 ultraviolet 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-U piping used in the cold-water systems of domestic hot and cold water (DHCW) services systems in NHS Scotland premises should be to BS EN 1452: 2009/ 2010.

Pipe fitting and valves

5.9. All associated pipe fittings (such as unions and flanges) should be manufactured to the composition, properties and conditions specified in:

- BS EN 1452-1:2010 (for unions)
- BS EN 1451¬-2: 2009 (for unions)
- BS EN 1092-3: 2003 (for flanges)

5.10. 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

5.11. At the date of compiling this SHTM, the information given in BS EN 1452 is still based on the Imperial Unit system.

5.12. 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
- 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 57: Attention is drawn to the fact that plastic pipes are identified by their outside diameters as opposed to the nominal bores by which metallic pipe are designated.

Table 5.1 - PVC-U pipework (inch) - working pressures/ operating temperatures – 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

Note 58: 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.

Table 5.2 - PVC-U pipes and fittings (BS EN 1452)

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"

Cleanliness requirements

5.13. As stated in Section 2 of this SHTM it is imperative that a high standard of cleanliness is maintained in pipework installations in all NHS Scotland 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 American Society or Testing Materials (ASTM): B280-86 clause 12.

Workmanship, finish and appearance

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

Packaging and transportation

5.15. 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 59: Any pipes delivered unprotected or with open ends shall be rejected.

5.16. 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

5.17. 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 60: To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework standard and external and internal pipe dimension.

Note 61: The use of solvents which contain n-hexane and propylene oxide should not be permitted.

5.18. 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 affected, 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 62: 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-U flanges, having dimensions in accordance with BS EN 1092-3: 2003, should be provided for connections to cisterns or pumps.

Pipework system

5.20. 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

5.21. 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.

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 0.5 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

5.24. Fire sleeves should be used where PVC-U pipes of 54mm outside diameter (2-inch nominal size) and above penetrate fire barriers. They should comply with the requirements of paragraph 2.32 and 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, using 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)

5.25. 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
- exercise particular care in storing, handling and installing 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 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.

5.29. 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.

5.30. 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 63: 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 that the full curing period is maintained before any joint is complete.

Note 64: Consider the effect that disinfection products (oxidants) can have on glues/ solvents and joint materials. When working with joints that require gluing, ensure that the correct glue is selected. Any glue/ solvent should be compatible with chlorine dioxide (ClO_2) or other shock treatment chemicals used.

5.32. 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 must be maintained, with pipes either running parallel or crossing each other, thermal insulation should be applied.

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

5.34. 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.

5.35. 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 5.3, or as advised and confirmed by the pipe manufacturer.

Table 5.3 - Support bracket spacing; 20°C

Pipe outside diameter (Mn)	Pipe outside diameter (Inch)	Maximum interval Horizontal metres	Maximum interval 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

5.36. 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.

5.37. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (such as pumps, and so on) This is especially important where different materials are being introduced into the system. A good example is (ClO_2), where the pipework pertaining to the ClO_2 generation is plastic and inserted into the stainless pipework. Therefore, to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

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

5.39. Thermal expansion/ contraction of the material must be considered 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 65: The manufacturer's guidance and recommendations should be adopted at both stages of work.

6. PVC-C pipework specification

General

6.1. Requirements specific to the design and installation of chlorinated polyvinyl chloride (PVC-C) pipework systems are contained within this section. These are in addition to the general requirements outlined within Section 2.

6.2. 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 NHS Scotland premises should comply with the requirements of the following:

- Deutsche Industrie-Norm (DIN) 8079
- DIN 8080
- DIN 1988
- British Standard (BS) 7291: 2010 (Parts 1)
- BS 5955-8: 2001

Note 66: The curing time for solvent joints can present significant challenges during maintenance, particularly when urgent repairs are required. Extended cure times, which vary by diameter, temperature, and pressure rating, can delay system reinstatement and disrupt clinical operations. This limitation should be carefully considered during material selection and system design, especially in critical healthcare environments.

6.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

6.4. The working pressures and operating temperatures of PVC-C pipework and fittings are listed for guidance in Table 6.1, below. Consideration should be given as to whether the pipework material allows for temperature monitoring.

Table 6.1 - PVC-C pipework (metric) - working pressures/ operating temperatures – pipe, fittings and valves

Product	Size	Pressure 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

Product	Size	Pressure at 80°C
Pipe	16mm – 50mm	6 Bar
Pipe	63mm – 160mm	4 Bar

Note 67: 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 - 65°C, in some exceptions there may be occasions that this may increase to 70°C for a short duration. Note: Maximum temperature must not exceed 95°C at a maximum pressure of 3.5 Bar.

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

- BS 5955-8: 2001
- BS 806 part 1 - 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A and B
- SHTM 04-01 C and D
- Health and Safety Executive (HSE): Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice (ACOP) and guidance (2013)
- 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 the effects of ultraviolet radiation including daylight.

6.7. 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

6.8. All PVC-C piping used in domestic hot and cold water (DHCW) services pipework systems in NHS Scotland premises should be to BS 7291, Parts 1: 2010 or DIN 8079/ DIN 8080/ DIN 1988.

Pipe fittings and valves

6.9. Unless specified otherwise, all associated pipe fittings (such as unions and flanges) should be PVC-C manufactured to the composition, properties and conditions specified in BS 7291, Parts 1: 2010.

6.10. 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 non-dezincifiable materials
- also, only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used

6.11. 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

6.12. As stated in Section 2 of this document, it is imperative that a high standard of cleanliness is maintained in pipework installations within all NHS Scotland 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 American Society or Testing Materials (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 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 68: 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, 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 1: 2010.

Note 69: To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework standard and external and internal pipe dimension.

Note 70: The use of solvents which contain n-hexane and propylene oxide should not be permitted.

6.17. 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:

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

6.18. 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 71: Locations for demountable unions and flanges should be selected by the designer in conjunction with the site supervisor.

6.19. 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

6.20. 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

6.21. 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.

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 should be a 0.5 metre (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.

6.24. 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 1.0 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 0.5 metre.

Fire sleeves

6.25. Fire sleeves should be used where PVC-C pipes of 50mm outside diameter and above penetrate fire barriers. They should comply with the requirements of paragraph 2.32 and 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, using 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

6.26. 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
- exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet 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 in accordance with the manufacturer's printed instructions and as detailed within the contract documents.

6.28. 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.

6.29. 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
- they should have no toxicological implications

6.30. 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 72: 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.

6.31. Great care should be taken to ensure that only the manufacturer's installation procedures are followed and that the full curing period is maintained before any joint is complete. Comments regarding the use of hacksaws as set out in paragraph 2.39 apply here.

Note 73: Consider the effect that disinfection products (oxidants) can have on glues/ solvents and joint materials. When working with joints that require gluing, ensure that the correct glue is selected. Any glue/ solvent should be compatible with chlorine dioxide (ClO_2) or other shock treatment chemicals used.

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

Note 74: This may vary according to the manufacturer and should be confirmed by the manufacturer of the system being installed.

6.33. 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 2.44 and/or prescribed by the manufacturer, are maintained. Where an existing heat source must be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

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

6.35. As stated in paragraph 2.44, 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.

6.36. 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 6.2, below, or as advised and confirmed by the pipe manufacturer.

Note 75: 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.

Note 76: For support centres using support tray, consult relevant manufacturer's literature.

Table 6.2 - Support bracket spacing; 60°C (without support tray)

Pipe outside diameter (mm)	Maximum interval Horizontal (metres)	Maximum interval 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

6.37. Where a support bracket is being used to support several 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. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (such as pumps). This is especially important where different materials are being introduced into the system. A good example is ClO_2, where the pipework pertaining to the ClO_2 generation is plastic and inserted into the

stainless pipework. Therefore, to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

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

6.39. 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.

6.40. Thermal expansion/ contraction of the material must be considered 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 77: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

7. Polybutylene pipework specification

General

7.1. 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 2.39 is particularly relevant.

7.2. PB pipework and fittings intended for the conveyance of potable cold water and hot water service for use within NHS Scotland premises should comply with the requirements of the following.

- Deutsche Industrie-Norm (DIN) 16986/ 16969
- DIN 1988
- British Standard (BS) 5955 Part 8: 2001
- BS 7291, Parts 1 and 2: 2010

7.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

7.4. The working pressures and operating temperatures of PB pipework and fittings are listed for guidance in Table 7.1, below.

Table 7.1 - PB pressure ratings - pipe, fitings and valves

Product	Size	Pressure rating at 80°C
Fittings	16mm - 110mm	10 Bar
Valves	20mm - 63mm	5 Bar
Pipe	16mm - 110mm	10 Bar

Note 78: 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 79: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

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

- BS CP 312
- BS 806 part 1 - 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A and B
- SHTM 04-01 C and D
- Health and Safety Executive (HSE): Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice (ACOP) and guidance (2013)
- 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 effects of ultra-violet (UV) radiation including daylight.

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

Pipes

7.8. All PB piping used in domestic hot and cold water (DHCW) services pipework systems in NHS Scotland 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

7.9. Unless specified otherwise, all associated pipe fittings (such as manifolds, unions and flanges) should be of PB manufacture generally in accordance with BS 7291,Parts 1 and 2: 2010 and dezincification (DZR) brass fittings (see paragraph 2.21) manufactured generally in accordance with BS EN 1254-1: 1998, and be fully compatible with the pipe system they are to be installed with.

7.10. 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 90º to direction of pump flow with non-rising valve spindle
- chlorinated polyvinyl chloride (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: 2009 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

7.11. 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

7.12. As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all 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 American Society or Testing Materials (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 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 80: 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 the jointing should be carried out in strict accordance with the manufacturer's printed instructions.

Note 81: To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework standard and external and internal pipe dimension.

7.17. 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, using the correct tools for assembly, melting and jointing times in accordance with the manufacturer's instructions
- electrofusion, using 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

7.18. 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 82: Locations for demountable unions and flanges should be selected by the designer in conjunction with the site supervisor.

7.19. 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

7.20. 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 PB

7.21. 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.

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

7.23. 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.

7.24. 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

7.25. Fire sleeves should be used where PB pipes of 50mm outside diameter and above penetrate fire barriers. They should comply with the requirements of paragraph 2.32 and 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, using 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

7.26. 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
- exercise particular care in storage, handling and installation, of all piping and fittings to avoid deterioration due to ultraviolet light (including daylight) and impact damage

7.27. 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.

7.28. 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.

7.29. 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 PB 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.

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

7.31. 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 must be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

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

7.33. As stated in paragraph 2.44, 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.

7.34. 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 7.2 or as advised and confirmed by the pipe manufacturer. The use of this support system increases the distance between supports and therefore reduces number of support brackets required.

Note 83: Some manufacturers supply a metal support tray system for use with pipework up to and including 63mm diameter.

7.35. 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.

7.36. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (for example pumps and so on). This is especially important where different materials are being introduced into the system. A good example is chlorine dioxide (ClO_2), where the pipework pertaining to the ClO_2 generation is plastic and inserted into the stainless pipework. Therefore, to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

7.37. 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.

7.38. 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 7.2 - Support bracket spacing; 60°C (without support tray)

Pipe outside diameter (mm)	Maximum intervals Horizontal (metres)	Maximum intervals 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

7.39. 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.

7.40. Thermal expansion/ contraction of the material must be considered 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 84: For support centres using support tray, consult relevant manufacturer's literature.

8. PE-X pipework specification

General

8.1. Requirements specific to the design and installation of cross-linked polyethylene (PE-X) pipework system are contained within this section. These are in addition to the general requirements outlined within Section 2, paragraph 2.39 is particularly relevant.

8.2. PE-X pipework and fittings intended for the conveyance of potable cold water and hot water service for use within NHS Scotland premises should comply with the requirements of the following:

- Deutsche Industrie-Norm (DIN) 4726
- DIN 16892
- British Standard (BS) 7291, Parts 1 and 3: 2010.

8.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

8.4. The working pressures and operating temperatures of PE-X pipework and fittings are listed for guidance in Table 8.1. Consideration should be given as to whether the pipework material allows for temperature monitoring.

Table 8.1 - PE-X pipework - working pressures/ operating temperatures – 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

Note 85: 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 - 70°C.

Note 86: Maximum temperature must not exceed 105°C at a maximum pressure of 3 Bar.

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

- BS 806 part 1 - 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A and B
- SHTM 04-01 C and D
- Health and Safety Executive (HSE): Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice (ACOP) and guidance (2013)
- relevant manufacturer's instructions

8.6. 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 ultraviolet (UV) radiation including daylight.

8.7. 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

8.8. All PE-X piping used in domestic hot and cold water (DHCW) services pipework systems in NHS Scotland premises should be to BS 7291, Parts 1 and 3: 2010, DIN 4726/ DIN 16892.

Pipe fittings and valves

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

8.10. 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
- only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used

8.11. 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

8.12. As stated previously, it is imperative that a high standard of cleanliness is maintained in all 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 American Society or Testing Materials (ASTM): B280-86 Clause 12.

Workmanship, finish and appearance

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

Packaging and transportation

8.14. 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 87: Any pipes delivered unprotected or with open ends should be rejected.

8.15. 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

8.16. 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.

Note 88: To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework standard and external and internal pipe dimension.

8.17. 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 - 2 (DZR) complete with pipe support inserts for use with pipework 15mm - 28mm diameter
- couplings specifically designed for the connection of PE-X piping for diameter 35mm - 100mm

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

Pipework system

8.19. 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

8.20. 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.

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

8.22. 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

8.23. Fire sleeves should be used where PE-X pipes of 50mm outside diameter and above penetrate fire barriers. They should comply with the requirements of paragraph 2.32 and 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, using 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

8.24. 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
- exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage

8.25. 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.

8.26. 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 must be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

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

8.28. As stated in paragraph 2.44, 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.

8.29. 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 8.2 or as advised and confirmed by the pipe manufacturer.

Table 8.2 - Support bracket spacing; 60°C

Pipe outside diameter (mm)	Maximum interval Horizontal (metres)	Maximum interval 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

8.30. 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.

8.31. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (for example pumps and so on) This is especially important where different materials are being introduced into the system. A good example is Chlorine dioxide (ClO_2), where the pipework pertaining to the ClO_2 generation is plastic and inserted into the stainless pipework. Therefore, to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

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

8.33. 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.

8.34. Thermal expansion/ contraction of the material must be considered 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 89: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

8.35. 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.

8.36. 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).

9. Multi-layer pipework specification

General

9.1. Requirements specific to the design and installation of multi-layer pipework system are contained within this section. These are in addition to the general requirements outlined within Section 2, paragraph 2.39 is particularly relevant.

9.2. Multi-Layer pipework and fittings intended for the conveyance of potable cold water and hot water service for use within NHS Scotland premises should comply with the requirements of the following:

- Deutsche Industrie-Norm (DIN) 16836
- British Standard (BS) 806 part 1-5
- BS 21003- 1
- BS 21003-2:2008 + A1:2011
- BS 21003- 3
- BS 21003- 5

9.3. The manufacturer of the system proposed for use shall have submitted the materials within the system to Water Research Centre (WRc) plc/ Water Regulations Advisory Scheme (WRAS) or similar approved for Water Byelaws compliance for toxicological assessment.

9.4. The working pressures and operating temperatures of multi-layer pipework and fittings are listed for guidance in Table 9.1. Consideration should be given as to whether the pipework material allows for temperature monitoring.

Table 9.1 - Multi-Layer pipework – working pressures/ operating temperatures – 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	8 Bar
Pipe	32mm – 110mm	8 Bar

Note 90: The pressure ratings above are for guidance only. The relevant manufacturer should be consulted, and technical data sheets viewed to advise on temperature/ pressure relationship at the maximum operating temperature of the materials. Normal operating temperatures will be in the range 10°C - 70°C.

Note 91: Maximum temperature must not exceed 95°C at a maximum pressure of 3 Bar. Consult the Manufacturers Technical Data Sheet for specific details relevant to the Pipework and fittings installed.

9.5. The whole of the multi-layer pipework installation should be installed, tested, disinfected and commissioned in accordance with the requirements of the following:

- BS 806 part 1 - 5
- BS 21003- 1
- BS 21003-2:2008 + A1:2011
- BS 21003- 3
- BS 21003- 5
- Scottish Health Technical Memorandum (SHTM) 04-01 Parts A and B
- SHTM 04-01 C and D
- Health and Safety Executive (HSE): Legionnaires' disease: The control of Legionella bacteria in water systems (L8). Approved code of practice (ACOP) and guidance (2013)
- relevant manufacturer's instructions.

9.6. 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 ultraviolet (UV) radiation including daylight.

Pipes

9.7. All multi-layer piping used in domestic hot and cold water (DHCW) services pipework systems in NHS Scotland premises should be to BS 21003, Parts 1,2,3,5 and DIN 16836.

Pipe fittings and valves

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

9.9. Valves for multi-layer 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

- only pipe thread lubricants and sealants specifically approved by the pipe manufacturer should be used

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

Cleanliness requirements

9.11. As stated in Section 2 of this document it is imperative that a high standard of cleanliness is maintained in all Scottish Healthcare Properties 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 American Society or Testing Materials (ASTM): B280-86 Clause 12.

Workmanship, finish and appearance

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

Packaging and transportation

9.13. 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 92: Any pipes delivered unprotected or with open ends should be rejected.

9.14. 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

9.15. 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.

Note 93: To ensure pipework is compatible throughout the project It is crucial that as part of the design brief and procurement process pipework and fittings are sourced from one manufacturer, or a group of manufacturers who manufacture to the same pipework standard and external and internal pipe dimension.

9.16. Unless indicated otherwise, the pipe joints in multi-layer pipework should be made by compression type joints Mechanical joints in piping should be made in accordance with BS 7291-3 and BS EN ISO 21003-2.

9.17. The specification for these should be dependent on the manufacturer of the multi-layer 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 - 2 (DZR) complete with pipe support inserts for use with pipework 15mm - 28mm diameter
- couplings specifically designed for the connection of multi-layer piping for diameter 35mm - 110mm

Note 94 adding inserts reduces the pipe diameter of the bore which will generate additional frictional losses.

Note 95 when using press/ crimped fittings sufficient space shall be required to use the crimping device.

Note 96 different manufacturers may use different press/ crimping tools.

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

Pipework system

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

- multi-Layer piping
- multi-Layer pipework valves, or (if applicable) gunmetal gate valves and connectors
- multi-Layer pipework bends, tees and tap connectors
- DZR compression fittings for use with multi-layer pipework

9.20. 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.

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

9.22. No multi-layer 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 multi-layer pipework, should be made with stainless steel pipe and clearance between multi-layer piping and hot surfaces exceeding the working temperature of the material should be not less than 0.5metre.

Fire sleeves

9.23. Fire sleeves should be used where multi-layer pipes of 50mm outside diameter and above penetrate fire barriers. They should comply with the requirements of paragraph 2.32 and 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, using 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

9.24. 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
- exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light (including daylight) and impact damage

9.25. 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.

Great care should be exercised to ensure that, where practical, the multi-layer 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 must be maintained, with pipes either running parallel or crossing each other, thermal insulation in accordance with paragraph 2.27 should be applied.

9.26. On no account should ladders, scaffold or other building items be propped up against the multi-layer pipework installation.

9.27. As stated in paragraph 2.44, pipework should be set as close as possible to any local projections. However, with multi-layer piping any offsetting required should be formed using fittings or bending of the pipes in accordance with manufacturer's directions.

9.28. All multi-layer pipes should be supported by pipe clips or support brackets (either supplied or approved by the pipe manufacturer) The type and the distance of the pipe fixings will vary depending on the pressure, temperature and the type of fluid carried. The pipe size, weight of pipe, weight of fluid carried, and any insulation should also be taken into consideration. Pipe fixings can also vary between coil and straight length of pipe.

9.29. There are also online calculators to assist in spacing distances between supports. Table 9.2 gives an example of a manufacturers clamping distances The manufacturers/ technical guidance should be followed.

Table 9.2 - Example of Manufacturers Support bracket spacing

Dimension da x s (mm)	Maximum distance between pipe clamps horizontal (m)	Maximum distance between pipe clamps Vertical	Weight of pipe filled with water of 10 °C/ without insulation Coil (kg/m)	Weight of pipe filled with water of 10 °C/ without insulation Straight length (kg/m)
16 x 2.00	1.2	1.55	0.218	0.218
18 x 2.00	1.2	1,6	0.273	0.273
20 x 2.25	1,3	1.7	0.388	0.388
25 x 2.5	1.5	1.95	0.529	0.529
32 x 3.00	1.6	2.10	0.854	0.854
40 x 4.00	1.7	2.20	-	1.310
50 x 4.50	2.00	2.60	-	2.062
63 x 6.00	2.20	2.85	-	3.265
75 x 7.50	2.40	3.10	-	4.615
90 x 8.50	2.40	3.10	-	6.730
110 x 10.00	2.40	3.10	-	9.959

9.30. 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.

9.31. Support brackets and mechanisms are crucial throughout, due in part to the weight loading and vibrations caused by mechanical components (such as pumps and so on) This is especially important where different materials are being introduced into the system. A good example is Chlorine dioxide (ClO_2), where the pipework pertaining to the ClO_2 generation is plastic and inserted into the stainless pipework. Therefore, to prevent premature ageing, wear and fracturing it is important that the weight of stainless steel plus water is not bearing on the polyvinyl-chloride (PVC), which cannot support such loading. It is also important to recognise that PVC to stainless flange bolting must be completed to the correct torque and sequence to equalise stresses.

9.32. Multi-Layer pipework in exposed positions should be supported using the piping manufacturer's standard pipe clip.

9.33. Where multi-layer piping is supported using other than standard multi-layer 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.

9.34. Thermal expansion/ contraction of the material must be considered 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 97: The manufacturer's guidance and recommendations should be adopted at both stages of the work.

9.35. The high co-efficient of linear expansion for multi-layer 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.

9.36. 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).

10. Water filtration

General

10.1. This section gives guidance on the filtration of incoming cold-water supplies for domestic use in NHS Scotland Premises.

10.2. Quality of water is coming under increasingly 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 cause deterioration of adjacent material surfaces. To avoid these potentially damaging circumstances, all incoming cold-water supplies destined for domestic use within NHS Scotland premises should be filtered. Further guidance on this issue can be found in Scottish Health Technical Memorandum (SHTM) 04-01 Part A.

Requirements

10.3. 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

10.4. Filtration should not be installed as a means of sterilising or disinfecting incoming water supplies.

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

Responsibilities

10.6. 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.

10.7. It should be noted that the Control of Substances Hazardous to Health (COSHH) Regulations 2002 impose a personal responsibility on managers to enforce codes of practice relating to potentially harmful micro-organisms.

Description

10.8. 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 and so on) assisted by chemical and/ or bacterial activity, woven meshes and screens made of metals, fabrics, ceramics and polymeric membranes.

10.9. 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.

10.10. As a guide, suspended materials are normally classified as shown in Table 10.1, below.

Table 10.1 - 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

10.11. 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

10.12. 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 dissolved and in solution.

10.13. The level of filtration within NHS Scotland premises where thermoplastic pipework systems are installed should be 5 microns absolute.

10.14. The level of filtration within NHS Scotland where stainless steel pipework systems are installed should be 0.5 micron absolute. (However, refer to Water Filtration guidance in The Design and Operational Considerations Section of this SHTM).

Process selection

10.15. Plant should be selected to meet the operational requirements of the particular Unit and satisfy the requirements of the user. 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

10.16. 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 Chartered Institution of Building Services Engineers (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.

10.17. 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 98).

Note 98: 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

10.18. The filtration equipment supplied should satisfy the filtration levels as stated in this guidance.

10.19. For thermoplastic pipework systems the level of filtration should be 5 microns absolute.

10.20. For stainless steel pipework systems the level of filtration should be 0.5 microns absolute.

10.21. 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. 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.

10.22. 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.

10.23. 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.

10.24. To accommodate the variation in flow, and to allow for filter changes and so on, the equipment should be installed with redundancy built in. To allow for maintenance it is recommended that n+1 filters are installed to ensure continuous supply of filtered water

10.25. The filtration plant should be fitted with suitable by-pass connections (isolated and 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.

10.26. Consideration should be given to the provision of flow meters directly connected to hospital computerised Building Management Systems (BMS) 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

10.27. 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.

10.28. The installation of all electrical equipment should comply with:

- BS 7671 Requirements for Electrical Installations (Institution of Engineering and Technology (IET) Wiring Regulations)
- SHTM 06-01
- SHTM 06-02

10.29. 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

10.30. 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 Water Research Centre (WRc) plc/ WaterRegs UK/ Water Regulations Advisory Scheme (WRAS).

Operational experience

10.31. The introduction of domestic water systems filtered water supplies is becoming increasingly common in NHS Scotland premises and is positively encouraged in SHTM 04-01 Part A with benefits clearly identified. To aid 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.

10.32. 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 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.

10.33. 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.

10.34. 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.

10.35. 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 prolonged periods of time and fitted with automatic backwashing and self-cleaning facilities.

10.36. The availability of crossflow 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.

10.37. In addition, as mentioned in this section, 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.

10.38. The arrangement of providing a by-pass loop is no longer supported in SHTM 04-01 Part A guidance. To accommodate the variation in flow, and to allow for filter changes etc, the equipment should be installed with redundancy built in. To allow for maintenance it is recommended that n+1 filters are installed to ensure continuous supply of filtered water

10.39. Since then, experience has shown that rather than provide a by-pass where adopt the extreme remedy outlined in paragraph 9.33, in which the water systems could be contaminated with unfiltered '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.

10.40. One possibility was to incorporate a series of 'dead end' filters into the proposed by-pass loop, as described above identified in paragraph 9.34. 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 could not be accidentally brought into use.

Note 99: In this arrangement drains and vents require to be fitted, and commissioning procedures should comply with SHTM 04-01 Part A.

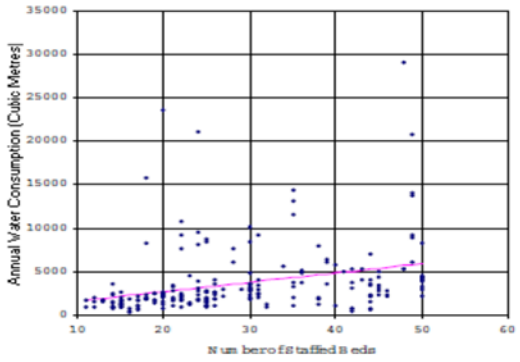
10.41. In operational practice, commonly two units have been installed. These units can be designed on the basis of say 2 x 100% or 2 x 75% duty machines depending upon the design considerations. In this arrangement it has been found best to run the machines alternately and to design the control circuitry 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.

10.42. 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.

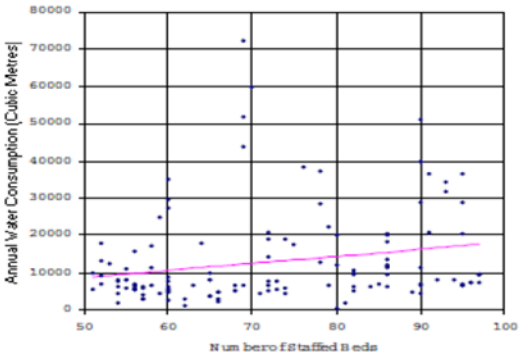
Water Regression Analysis

10.43. Water quality regression analysis can be applied to assess and monitor water quality by identifying trends and relationships between different water quality parameters. Linear regression is a statistical modelling approach that can be used to identify potential quality issues before they impact on water systems.

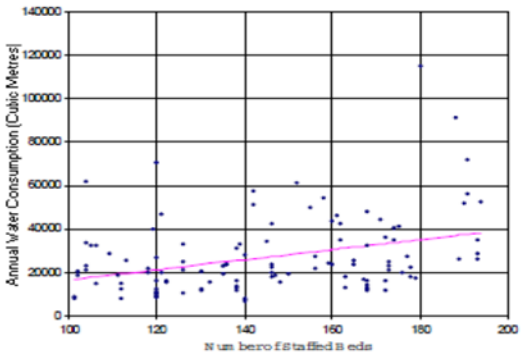
Figure 10.1 - Water regression analysis charts for 1995-6 to 1997-98



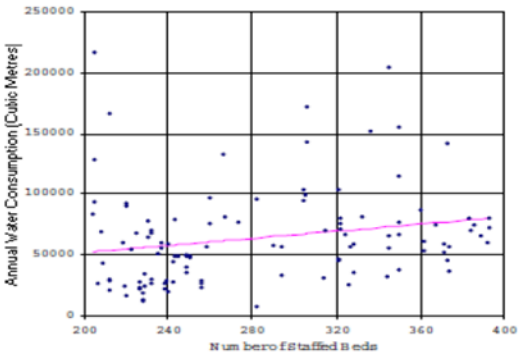
Annual Water Consumption 1995-96 to 1997-98 (10 to 50 Beds)



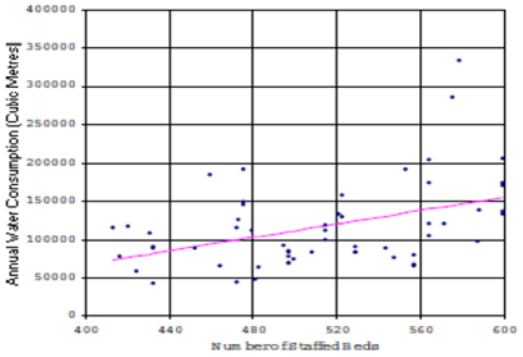
Annual Water Consumption 1995-96 to 1997-98 (50 to 100 Beds)



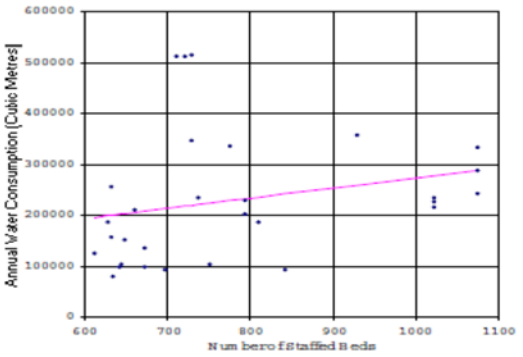
Annual Water Consumption 1995-96 to 1997-98 (100 to 200 Beds)



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)

Abbreviations

ABS: Acrylonitrile Butadiene Styrene

ACOP: Approved Code of Practice

ARHAI: Antimicrobial Resistance and Healthcare Associated Infection

ASTM: American Society or Testing Materials

BMS: Building Management System

BS: British Standard

CIBSE: Chartered Institution of Building Services Engineers

ClO_2: Chlorine dioxide

COSHH: Control of Substances Hazardous to Health [Regulations]

DGH: District General Hospital

DHCW: Domestic hot and cold water

DHSS: Department of Health and Social Security

DIN: Deutsche Industrie-Norm (German Industrial Standards)

DL: Director Letter

DZR: Dezincification

EPDM: Ethylene Propylene Diene Monomer

GRP: Glass- reinforced plastic

HBN: Health Building Note

HSE: Health and Safety Executive

HSG: Health and Safety Guidance

HTM: Health Technical Memorandum

IET: Institution of Engineering and Technology

IPCT: Infection Prevention and Control Team

ISO: International Organisation for Standardisation

MEK: methyl ethyl ketone

MLCP: Multi-Layer Composite Pipe

NPF: National Performance Framework

NSS: National Services Scotland

NTM: Nontuberculous mycobacteria

NWSAG: National Water Services Advisory Group

O&M: Operation and Maintenance

PB: Polybutylene

PE-X: Cross-linked Polyethylene

PPM: Planned Preventative Maintenance

ppm: parts per million

PVC: Polyvinyl-Chloride

PVC-C: Chlorinated polyvinyl chloride

PVC-U: Unplasticised polyvinyl chloride

PWSG: Project Water Safety Group

PWSP: Project Water Safety Plan

PWTAG: Pool Water Treatment Advisory Group

SETAG: Scottish Engineering and Technology Advisory Group

SHTM: Scottish Health Technical Memorandum

SHTN: Scottish Hospital Technical Note

SSD: Sterile Services Department

TIG: tungsten inert gas (welding process)

TVC: Total Viable Count

UKAS: United Kingdom Accreditation Service

UK WBS: United Kingdom Water Byelaws Scheme

UV: Ultra-violet

WHO: World Health Organization

WRAS: Water Regulations Advisory Scheme

WRc: Water Research Centre

WSG: Water Safety Group

WSP: Water Safety Plan

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