HVCA

INSTALLATION AND TESTING OF PIPEWORK SYSTEMS

Heating and Ventilating Contractors' Association

PART SEVEN – CONDENSER AND COOLING WATER

TR/20

TR/20 Installation and Testing of Pipework Systems

TR/20 Part 7

Condenser and Cooling Water

Acknowledgements

Members of the drafting panel who compiled this guide

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FOREWORD

TR/20 is published against a background of significant change within the building services engineering sector over recent years. Of particular note has been the industry wide campaign to raise standards and performance through the Construction Best Practice Programme.

Much effort has been and continues to be made to raise the productivity, performance and competence standards of our sector.

To support this programme HVCA has undertaken to provide a number of measures designed to demonstrate and achieve positive differentiation of their members. One such measure has been to undertake a fundamental review of TR/10, the previous HVCA standard for Installation work 'Heating Hot and Cold Water Supply'.

As a result of this review TR/20 replaces TR/10 and emerges as a new standard for 'The Installation and Testing of Pipework Services' for the building services engineering sector. It embraces a comprehensive range of pipework services and is structured as a set of 10 'stand alone' sectionalised specifications.

The objective of TR/20 is to provide a pipework installation specification that will ensure compliance with accepted good practice. It is intended that this standard specification will be used generally as a means of measurement and assessment of a contractor's performance and, specifically, to demonstrate compliance and competence under the HVCA Inspection and Assessment arrangements.

It is envisaged that TR/20 be used either in the absence of a client specification or by specific reference as an integral part of such a specification.

It is also proposed that TR/20 be used as a quality benchmark whereby any shortfall identified within an alternative specification is drawn to the client's attention.

Unlike its forerunner, TR/20 does not address design or commissioning requirements. These are considered to be very ably addressed by other industry documents already in place published by CIBSE, BSRIA, OFTEC and others, for which appropriate references are provided.

TR/20 also excludes equipment incorporated within or connected to the pipework installation. The specification and selection of equipment is considered to be a responsibility of the system designer who should ensure that where appropriate the selection is compliant with the client's brief.

Additionally, it is not the policy of the HVCA to promote any particular product or manufacturer.

During the review and drafting process the drafting Sub-committee has consulted widely with individuals and external organisations to ensure that the new standard fully reflects the industry's current good practice.

The resulting publication will, I believe, serve as a recognised benchmark for our industry sector and HVCA members in particular. I take this opportunity to thank all who have contributed to its production and in particular the members of the TR/20 Sub-committee for their tireless efforts and collective contribution of invaluable knowledge and experience.

John Hunt
Chairman Technical Committee

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Section 1 INTRODUCTION

1.0 FOREWORD

This is the seventh section in a suite of publications, intended to set the standards for the installation and testing of pipework systems in non-domestic buildings. It forms the basis for an assessment regime introduced by the **Heating and Ventilating Contractors' Association**, by which new and existing members' competence can be evaluated.

This suite of standards replaces the earlier Standard for installation work - heating, hot and cold water supply (TR/10). The full suite of standards covers a wider range of common mechanical services than its predecessor.

Clients will be able to expect systems falling within the scope of this standard to comply with its requirements when installed by HVCA members.

This standard is not intended to override any other specification as required by the client. Any contractor asked to carry out works below this standard should advise the client.

Where new products or technologies are used, full supporting manufacturers' information shall be available if required, i.e. by the client or assessor.

1.1 OBJECTIVE

The purpose of the cooling water pipework system is to efficiently and safely transport cooling from the condenser or other cooling source to a cooling tower or dry cooler in a controlled manner and to fulfil the expectations of the design/installation team and the client. This may be to remove heat from water/water chiller or other process.

A satisfactory installation depends on the competence of the designers and installers of the system, to meet the needs of the client, in relation to what he is prepared to pay. In short, the level of quality offered and provided by the contractor must correspond to the agreed workmanship expected and paid for by the customer.

The installation will normally follow a set of installation drawings; the installer should maintain a record of the actual installed pipework system for record purposes.

A key factor in achieving this satisfaction is the existence/availability of a common statement or specification that is understood by all concerned. This specification defines the important elements of a system, which will provide the following benefits:

- For the customer, that he has the assurance of competency to a stated standard and that he can expect value for money.
- For the contractor, that he is tendering on a common footing with his competitors and that he is clear as to the standards of workmanship required of him.
- For them both, that they have a definition of common intent.

The HVCA believes that the interests of the industry's customers and of its member contractors can be enhanced and brought together by the publication of a straight-forward technical specification, (complementary to Statutory Requirements, European and/or British Standards) bringing a clear focus to practical and functional matters.

This publication is therefore primarily intended to:

- Provide information for customers who are appointing (by competition or negotiation) a contractor.
- Provide a workmanship standard, (if not specified by others) for pipework installation.
- Provide a standard of workmanship that may be verified by independent assessment.

This publication (or extracts from it) is suitable for embodiment into contract documents by both customers and contractors as appropriate.

1.2 STANDARD OF WORKMANSHIP

The standard of workmanship set by this publication is intended to be appropriate to most normal commercial and industrial installations and, relates to good practice in installation and energy use without unnecessary elaboration. The HVCA intends this to be a significant aid in producing installations that will, given correct operation and with proper maintenance, provide satisfactory service over many years.

Where clients have their own special requirements, the particular requirements should be agreed between customer, designer and installing contractor.

1.3 QUALITY ASSURANCE

This publication can be used as one criterion that will assist customers, in performing their important role of defining the standard of installation they require.

The HVCA anticipates that this publication will be complementary to quality assurance schemes and quality assessment schedules. Where forming the basis of an independent certification scheme, it represents Best Practice in standards of installation.

1.4 SCOPE

This publication covers pipework usually found in non-residential premises, for cooling water systems.

This publication relates to projects in the U.K. It is not intended for overseas work. However, some of its provisions will be appropriate or may form a basis for overseas work.

The publication does not cover matters relating to design or commissioning for which reference should be made to the appropriate CIBSE or BSRIA documents.

This publication makes use of terms "should", "shall" and "must" when prescribing procedures:

- The term "must" identifies a requirement by law at the time of publication.
- The term "shall" prescribes, a procedure which, it is intended to be complied with, in full and without deviation.
- The term "should" prescribes, a procedure which, it is intended to be complied with unless, after prior consideration, deviation is considered to be acceptable.

1.5 PUBLICATION AND REVIEW

User feedback of the document will be welcomed to assist in continued updating.

1.6 OPERATING CONDITIONS

This document is for condenser and cooling water pipework operating up to 10 bar (gauge).

Maximum and minimum temperatures will be specified by the designer according to the application. Most HVAC applications would fall within the range -5°C to 60°C.

1.7 DESCRIPTION OF SERVICE

This document covers pipework used in the following types of condenser and cooling water systems, as installed in commercial and industrial buildings. Condenser and cooling water systems are classified as open circuit or closed circuit.

1.7.1 Open circuit systems

Open circuit systems are open to atmosphere; e.g. as in an open cooling tower.

1.7.2 Closed circuit systems

Closed circuit systems are closed to atmosphere and may be pressurised by a diaphragm type expansion vessel. These systems are used with dry coolers and indirect cooling towers.

Section 2
MATERIAL AND JOINTING METHODS

2.1 PIPING MATERIAL

The most common material for open condenser cooling water systems is galvanised steel or plastic tube. Black mild steel tube with standard works finish of anti-corrosive lacquer, recoated where necessary on site, is commonly used for closed condenser cooling water systems.

Overflows, vents above the water line and drains, shall be galvanised mild steel or copper tube, stainless steel or other propriety non rusting materials, see Table A

The designer should have given consideration, to ensure that any mixing of materials does not have any adverse effects. Galvanised fittings should be used with galvanised pipe.

2.2 SELECTION TABLE

This table gives guidance for different materials used, jointing methods and locations.

2.3 THREADING - STEEL PIPEWORK

Threaded joints may be used on steel pipework for sizes 65mm and below for pressures not exceeding 7 bar (gauge) with site made joints. Where closely controlled workshop machine threading is used, pressures up to 10 bar (gauge) are permissible. Threaded joints into valves, heat exchangers pumps and similar equipment are permissible up to 10 bar, provided threads are strictly of the correct form and length.

Joints shall be to BS 21, made using jointing material compounds and hemp, to BS 6956 as appropriate or PTFE tape to BS 7686, BS EN 751-3. Jointing compound shall not be used with PTFE tape.

Table A: STEEL – Condenser and Cooling Water

STEEL	Accessible			Without Direct Access or Permanently Concealed	
	Up to 50mm	65-150mm	>150mm	Up to 150mm	>150mm
Galvanised or Mild Steel Tube BS 1387 Med. Weight.	✓1	✓1			
Galvanised or Mild Steel Tube BS 1387 Heavy Weight	✓	✓		✓	
Mild/Steel Tube BS EN 10216 or 7/ API 5L			✓		✓
Threaded	✓1				
Welded	✓6	✓6	✓6	✓6	✓6
Flanged	✓	✓	✓		
Grooved	✓3	✓			
Mech. Press Fit	✓4	✓4			
Pulled Bends	✓6			✓6	
Malleable Cast Iron Fittings	✓1				
Weldable Fittings	✓6	✓6	✓6	✓6	✓6

Table A: PLASTIC

Plastic Pipework And Fittings See Section 6	✓	✓	✓		

Table A: COPPER

COPPER	Accessible			Without Direct Access or Permanently Concealed	
	Up to 65mm	67-159mm	>159mm	Up to 159mm	>159mm
Copper Tube BS EN 1057 (was BS 2871 Part 1 Table X)	✓				
Pulled Bends	✓			✓	
Compression	✓2				
Capillary	✓				
Brazed	✓	✓	✓	✓	✓
Push Fit	✓4	✓4			
Press Fit	✓5				

Table B: STAINLESS STEEL

STAINLESS STEEL	Accessible			Without Direct Access or Permanently Concealed	
	Up to 50mm	65-150mm	>150mm	Up to 150mm	>150mm
Stainless Steel	✓	✓	✓	✓	✓
Welded	✓	✓	✓	✓	✓
Press Fit	✓4	✓4			

1. Excluding sizes 20, 40 and 65mm, for medium weight tube.
2. Not recommended above 54mm.
3. Not normally used below 50mm.
4. Only to be used with tube recommended by tube manufacture.
5. Only available in sizes up to 22mm and subject to low temperature and working pressure
6. Not for galvanised pipe

Note: Proprietary materials, as manufacturer's recommendations.

Fittings used on condenser and cooling water, for open circuit systems, shall be galvanised malleable iron, with BSPT taper external and preferably parallel internal threads. Alternatively, taper internal threads to BS 143 and BS 1256 may be used.

2.4 WELDING - STEEL PIPEWORK

Steel tube jointed by welding is mandatory for pipework which is to be buried, embedded or that may be difficult for access after installation. No pipework shall be installed in permanently inaccessible positions, unless agreed beforehand by the Client. If required, a leak detection system may be fitted.

Galvanised steel tube should not be welded. In certain cases it may be appropriate to form parts of the system out of welded plain steel tube which is subsequently galvanised eg flow headers.

2.5 FLANGES

Flanges shall be to BS 10, 1560 or 4504, as appropriate. Particular attention should be given to the selection of the correct PN designation for the application. On steel pipework, flanges shall be forged steel bossed slip-on pattern to PN6 Code 112 (up to 6 bar) or PN16 Code 112 (up to 16 bar), or mild steel plate flanges to PN6 Code 101 or PN16 Code 101. Bored to suit OD of tube, for welding neck and bore and drilled to the appropriate Table.

Steel flanges shall be jointed with inside-bolt-circle flat ring composition gaskets, with metric hexagonal head black bolts and nuts with washers.

Flanges on copper work should be bi-metal, bronze, or gunmetal as appropriate.

Suitable jointing materials shall be employed. Asbestos material must not be used.

2.6 GROOVED JOINTS

As an alternative to flanged or threaded joints, mechanical grooved joints may be used in accessible positions for sizes 50 to 300mm. It is necessary to check the temperature and pressure ratings, as these can vary with manufacturer. They can be used where small axial or lateral movement is required, to compensate for vibration or expansion. Care is required to ensure that the appropriate type of joint is used. Where mechanical grooved joints are used, they shall be applied and installed in accordance with the manufacturer's instructions and fitting procedures.

It is important that the correct size of grooved coupling is used to suit the outside diameter of the pipe.

As a general rule there are special support requirements compared to that of a threaded, welded or flanged system, due to the flexibility of these fittings. The support is usually mounted adjacent to the joint and not mid-length. (See manufacturer's recommendations).

2.7 PRESSED FIT

It is essential that pipework and fittings are compatible for the application intended. They may be used on: stainless steel, steel and copper. The pipe sizes vary with the material and manufacturer. It is necessary to check the temperature and pressure ratings, as these can vary with manufacturer.

Fittings are available for the following materials and nominal pipe sizes: -

Copper	12 to 108mm OD
Steel	12 to 108mm OD
Stainless	12 to 108mm OD

A proprietary electro-mechanical tool is applied to the fitting which is permanently deformed to grip the tube; with water tightness achieved by a factory fitted seal ring in the end bead.

Care should be taken to ensure that due space allowance is made for use of the tool head. Consideration should also be given to the weight of such tools when working overhead with the larger sizes.

2.8 COMPRESSION, CAPILLARY, BRAZED JOINTS or PUSH FIT

Copper pipe systems shall be installed using compression, capillary joints, brazed joints or push fit. The standard delivered lengths of copper tube are random and can vary with bore size.

2.8.1 Compression Joints

Compression joints shall also comply with BS 864 Part 2 or BS 2051 Part 1, but their use should be restricted to readily accessible locations

Copper tubes, dimensions can vary with grade and type and the fittings for pipes also vary. These are between 6mm to 54mm OD.

Non-manipulative types of compression fittings are not normally considered appropriate for system pressures above 2 bar.

2.8.2 Capillary Joints

Lengths of pipework and fittings for pipe sizes up to 67mm shall be assembled with capillary joints, using fittings complying with BS EN 1254 (BS 864 Part 2). They shall be of copper with either integral solder ring, or end feed type joined with soft solder.

Sizes 67mm and above, shall be assembled with gunmetal fittings of the wedge ring type.

2.8.3 Brazed Joints

Preparation for brazing shall be in accordance with BS 1723. Only manufactured fittings not subject to de-zincification and suitable for application, shall be used.

Making and sealing the joint using flame heat shall be in accordance with BS 723, Part 2, Section 1. Use silver brazing filler alloy suitable for application.

2.8.4 Push Fit

Copper tube (also certain types of plastic tube) can be joined with push fit type fittings.

The working pressure and temperature limitations should be checked as they vary between different manufacturers. Push fit assemblies generally have lower operating pressures than that of other types of jointing at the same temperatures. Push fit fittings are generally only available for smaller sizes of pipework. Push fit fittings normally comprise of guide ring/collar, grab ring and "O" ring seal, contact with mineral oils should be avoided as these may affect the "O" ring.

2.9 PROPRIETARY SYSTEMS

It is important to check both the temperature and pressure ranges of these systems. Proprietary pipework systems shall be assembled and supported in accordance with manufacturer's instructions.

Section 3
STEEL PIPEWORK CONSTRUCTION AND ASSEMBLY

3.1 PIPING MATERIALS

It is important that the correct type and grade of pipework is used to suit the operating pressure, temperature, pipe size, jointing method and type of service. This section covers the construction and assembly of steel pipework, for the following types and grades:

- Steel tube to BS 1387 - Heavy weight grade.
  BS 1387 is a materials and dimensional specification, up to 150mm diameter.
- Steel tube to BS 1387 - Medium weight grade.
  BS 1387 is a materials and dimensional specification, up to 150mm diameter.
- Seamless carbon steel tube to BS EN 10216 or 7, (a manufacturing specification), steel grade S360 or S430.
- Electric resistance welded (ERW) carbon steel tube to BS EN 10216 or 7. The grade of steel needs to be specified at the time of procurement, i.e. ERW320, ERW360 or ERW430.
- API 5L Line Pipe
  Carbon steel tube, grades A and B.

The grade and type of steel tube used with mechanically press fitted types of proprietary joints, shall be in accordance with the fitting manufactures specified requirements. Depending on the manufacturer selected the tube will vary. However, it is not uncommon to have unalloyed carbon steel tube to DIN 2394.

3.1.1 Pipe Finish

Steel pipework is available in the following standard finishes:-

- Black steel with manufacturer's standard works varnish finish.
- Black steel self-coloured, untreated with plain works finish.
- Galvanised finish.
- Mild steel pipework with plastic coating.
- Pre-insulated steel pipework.

For pipework installations of open condenser and cooling water systems galvanised finish is normally employed. Black steel tube with standard anti corrosion lacquer finish is used for closed condenser and cooling water systems.

Welded assembly black mild steel pipework can also be used, but galvanised, after manufacture.

3.2 THREADED ASSEMBLY

3.2.1 Threaded Joints

Tube ends shall be threaded BSPT.

Threading shall be to BS 21 with taper external and either parallel, or preferably, taper internal threads mated with appropriate jointing material. If taper internal threads are used, special care shall be taken to ensure that permitted tolerances in threading are not exceeded.

3.2.2 Bends and Fittings

Pulled bends shall not be used for galvanised piping. Deviations in galvanised pipe shall be formed from standard fittings.

Elbows, branches and reducers shall be malleable cast iron with BSPT taper internal and preferably taper or alternatively parallel, external threads to BS 143 and BS 1256. Standard radius (1½D) elbow and branch fittings shall be used. Square elbows shall not be used. Swept tees and long radius bends are generally not essential. Galvanised fittings shall be used with galvanised pipe.

Three-piece malleable iron unions with conical seating, shall be used for threaded joints to equipment required to be removable.

Connectors with long threads and back nuts shall be avoided.

Bushes should be used, where reducing fittings are not available as standard and space prohibits the use of reducers.

Threaded reducing fittings should be concentric vertical or eccentric horizontal, to facilitate venting or draining requirements.

3.3 WELDED ASSEMBLY

3.3.1 Welding Methods

Tube ends shall be prepared for welding with the ends as indicated in Table B.

Table B:

	Tube grade and size (nominal)	
End preparation	**Medium**	**Heavy**
Cut square	**≤ 40mm**	**≤ 20mm**
35° Bevel	**≥ 50mm**	**≥ 25mm**

Welding shall be by oxy-acetylene method or electric arc method, in accordance with the current HVCA Code of Practice TR/5, "Welding of carbon steel pipework". Welding standards shall be subject to Appendix 1 of TR/5, relating to physical tests. Non-destructive testing (NDT), shall not be applied to condenser and cooling water pipework, unless agreed by the Client and Installer.

All welders shall hold a current Engineering Services SKILLcard, applicable to the conditions issued by the HVCA, having passed the tests laid down in the HVCA Code of Practice TR/5, or equivalent recognised Class 1 (BS 1821 and BS 2633) or Class 2 (BS 2640 and BS 2971).

3.3.2 Welding Fittings

Pulled Bends

For sizes 50mm and below, pulled bends may be used, where space and appearance permit. These may be pulled cold if standard formers and bending machines are used. Centre line radii shall be approximately 3 x OD.

Elbows

For sizes 65mm and above and for 15mm to 50mm where pulled bends cannot be accommodated, long radius elbows, centre line radius 1½D, shall be used. Short radius elbows, (radius 1D), shall not be used, unless previously agreed with the client.

Fittings shall be of the same quality and weight of steel as the tube. The wall thickness of fittings may be slightly greater than that of the tube, provided it is within the tolerances laid down in the HVCA Code of Practice TR/5. If otherwise, the bore of the fitting shall be increased to match the tube by machining.

Cut and shut or segmented bends shall not be used except for unavoidable cases, where the fittings specified above are not applicable.

Branches

Branches may be welded in square. No fittings are required, although welded shoes are permitted. Attention is drawn to the HVCA Code of Practice TR/5, in regard to the spacing and reinforcement.

Reducers

Reducer fittings shall be used. Alternatively for reductions not exceeding two pipe sizes, the larger tube may be swaged down. Bores shall be matched as for elbows. Reducers shall be either concentric or eccentric, to suit venting or draining requirements.

Blank Ends

Sizes 15mm and below may be closed by welding over.

Sizes 20mm to 50mm, blank ends may be made by welding a 6mm thick disc in place For 65mm and above use of a welding cap or flanged. For working pressures in excess of 3.5 bar (gauge) a disc should not be used.

3.4 FLANGED ASSEMBLY

The correct type of flange and joint rings shall be used for the test pressure and operating temperature of the system. Particular attention should be paid to the diameter and length of bolts and associated type of nuts and washers, used to assemble flanged joints.

Flanges may be screwed pattern or bored for welding as appropriate. Screwed flanges shall not be used for welding. Flanges for galvanised pipe shall be galvanised screwed pattern.

Composition joint rings inside the bolt circle, shall be provided between flanges and shall be suitable for the particular application. The joint ring shall not obscure the pipe bore. Asbestos joint rings must not be used.

The bolts and nuts of flanged joints when drawn up tightly with a washer under the nut, shall not expose less than two threads or 3mm of thread projecting beyond the nut.

Flanges shall be installed where a section of piping needs to be removable for access, or for sectional testing purposes.

Flanges shall be to BS 4504 and shall be of the same type of material, as the pipeline to which it is welded.

Asbestos material must not be used.

3.5 GROOVED ASSEMBLY

3.5.1 Joints

There are two methods of forming grooves in pipe: Roll grooving and Cut grooving.

The method chosen will depend on the pipe wall thickness and application. Depth and width of groove will depend on fittings used.

Roll grooved is the most widely used, the groove is machine cold formed and no

metal is removed. This method presses the groove into the pipe, leaving a non-smooth bore. As the groove configuration has rounded edges, this reduces the available pipe movement. Standard roll grooved pipe will provide lower expansion/contraction or deflection, of the same size standard cut grooved pipe. The usual maximum pipe thickness is up to 9.5mm. Check the machine manufacturer's operating details prior to use.

As cut grooving takes longer, it is generally only chosen because of the greater pipe thickness, or that a smooth bore is required. The groove cut into the pipe is almost the same depth as a thread cut on the pipe. The machine ensures that an even and concentric cut is produced. It is again important to ensure that the machine is correctly set and used for the pipe being cut. When cutting both aluminium and plastic pipe, a radii is required at the bottom of the groove.

Particular attention needs to be given where galvanised pipe is used. This concerns any local repair to the galvanising after cutting, plus manufacturer's dimensional requirements when galvanising after groove cutting.

There are some special requirements compared to that of a threaded, welded or flanged system. Due to the flexibility of these fittings, the support is usually mounted adjacent to the joint and not mid-length. (See manufacturer's requirements).

3.5.2 Fittings

Particular attention should be paid to the selection of the gasket for the mechanically grooved fitting, ensuring that the correct type and grade of material is used to suit the system temperature and service. Most manufacturers mark gaskets with the grade code and some use colour coding. When making the joint, it is important to lubricate the gasket prior to assembly over the pipe ends, otherwise there is the possibility of pinching. Care should be taken to limit any lubricant entering the pipework.

Electrical continuity clips shall be used when earth continuity of the steel pipework is required. Fittings are available in various types and materials, such as heavy duty, rigid joints, malleable iron, ductile iron, stainless steel and steel etc., the correct type should be selected for the application.

3.6 PRESS FIT ASSEMBLY

It is essential that pipework and fittings are compatible, both with each other and for the application intended. They can be used on; stainless steel and steel. The pipe sizes vary, as do the temperature and pressure ratings, with the material and manufacturer.

Steel	12 to 108mm OD
Stainless	12 to 100mm OD

The press-fitting and pipe are pressed, with the appropriate tool, to form a strong and permanent joint. This operation also deforms the factory fitted seal ring in the end bead, ensuring the connection remains watertight.

3.7 SUPPORT AND FIXINGS

Supports and anchors must only be fitted to structural members or substrate fixings which are capable of carrying the design loads including the influence of expansion. If there is any doubt then a structural engineer should be consulted. Guidance on the use of concrete fixings is provided in leaflets published by the Construction Fixings Association.

Supports and fixings, whether standard patterns or purpose - made, shall be appropriate in style and material to the pipe and to the structure to which fixed, with due regard to application.

Pipe supports shall be arranged as near as possible to joints and changes in direction. They shall support the piping neatly, without excessive deflection between supports and so that it is free to move.

Where swinging pipe hangers are used, they shall be able to move freely for the full distance necessary. The support rod shall be not less than 300mm long and shall be clear of the full thickness of any insulation. Hemispherical washers shall be used on swinging hangers. Pipes of similar operating temperature and material may be double hung from the same support rod.

Sliding supports, to accommodate linear movements, shall be faced with PTFE permanently attached. Rollers shall be avoided.

Vertical steel pipework shall be supported at the base of the riser and guided at intervals, not exceeding those in Table C. Branches from a riser pipe shall not be used as a means of support for the riser pipe.

The Designer shall supply full information to enable provision to be made in the structure for the fitting of supports and fixings during construction. The installer shall be responsible for any necessary marking out.

Steel pipework shall normally be supported at intervals not exceeding those in Table C. Additional supports may be required to carry the load of in-line fittings and accessories.

Additional pipe supports to half the spacing tabled shall be provided on horizontal low-level pipe runs, where these might be used as footrests.

Additional pipe supports may be required on larger sizes to limit the point load imposed on the structure.

When suspending pipework with grooved or press-fit types of fittings, particular attention should be given to the rigidity of the assembly and the influence of thermal forces.

Table C: Steel Pipework Supports

Pipe size mm	Horizontal m	Vertical m
15	2.0	2.5
20	2.5	3.0
25	3.0	3.3
32	3.3	4.3
40	4.0	4.6
50	4.5	5.8
65	5.2	7.3
80	5.8	8.2
100	6.7	11.0
125	7.0	12.0
150	8.0	12.0
200	9.5	14.0
250	10.5	18.0

Note: The forgoing table gives the maximum intervals for supports. Additional supports may be required to suit specific application.

3.8 EXPANSION AND CONTRACTION

Due allowance for the expansion of pipework shall be made to limit pipeline stresses, to provide the controlled movement of pipes and to ensure that forces applied to equipment and to the building are not excessive.

The expansion rate for steel is:

1.14mm per metre, per 100K rise in temperature.

3.8.1 Natural Flexibility

Pipeline flexibility to control expansion stresses shall preferably be provided by the changes in direction or fabricated pipe offsets.

Wherever possible, expansion loops should be in one piece. If the total length of the tube in the bends is such as to prevent this, then joints shall be made in the long arms as near the centre as possible. No joint shall be made in the crown of the bend or in the short arms.

3.8.2 Expansion Devices

Only where inherent pipeline flexibility is not practicable shall proprietary expansion devices be used, installed in strict compliance with the supplier's instructions. These instructions should cover the design and installation of the necessary guides and anchors, including information on the resulting loads that will be imposed on the building structure by the expansion devices and anchors. Where practicable, hinged and articulated bellows should be used instead of axial bellows.

If the use of axial bellows cannot be avoided, the following points shall be observed:

- They must be used only on straight sections of pipework between anchors.
- Movement at bellows must be guided axially with no lateral movement.
- Axial bellows shall not be used on freely suspended pipelines.
- Axial bellows demand that the structure is capable of withstanding the high loads imposed by guides and anchors.
- The effect of the bellows operating forces on press-fit, mechanically grooved and proprietary joints should be verified with the manufacturer.

3.8.3 Anchors and Guides

Rigid mild steel pipe anchors capable of carrying the maximum loads resulting from the expansion arrangements shall be provided. Agreement with the client shall be obtained for the location of the loadings imposed by the attachment of anchors and guides to the structure or other base.

3.8.4 Cold Draw

Cold draw of steel piping or cold stretch of bellows shall be made during pipework erection, as required by the design of the

expansion arrangements, employing suitable temporary spacer pieces during erection.

3.9 CONSTRUCTION AND ASSEMBLY

3.9.1 Cleanliness

Tubes shall be free from burrs, rust, scale, dirt and obstructions before erection. Open ends left during site progress, shall be closed with tight fitting metal, plastic plugs or caps.

All joints shall be cleaned and trimmed.

Precautions shall be taken to avoid dirt and debris finding its way into the system water, in particular: -

a) Attached to internal surfaces of pipeline and components, e.g. scale or oil.
b) Introduced during installation process, e.g. soil, hemp, paste, swarf or building materials.
c) Generated within the pipeline by corrosive or chemical action, e.g. involving fluxes, corrosion inhibitors or anti-freeze.

It is essential to minimise the amount of foreign material introduced to the system during assembly. All tubes and fittings shall be clean and rust free. No open ends should be left prior to final closure.

3.9.2 Pipe Sleeves

There shall be no pipeline joints within the thickness of walls or floors. Pipework shall not be embedded in the structure unless specifically identified as part of the design.

Where pipes pass through walls or floors a pipe sleeve shall be built in, comprising a length of tube, of the same material as the pipeline, or other equivalent proprietary purpose made sleeve. The sleeve shall be sufficient in length for the sleeve to finish not less than 3mm, nor more than 12mm clear of the finished wall or floor. The sleeve should be of internal diameter at least 25mm greater than the OD of the pipe passing through. A greater clearance may be necessary to accommodate expansion movement and insulation. Where necessary to effect a noise or fire barrier, the space between the pipeline and the sleeve shall be packed with appropriate material.

Plastic coated pipework should have the coating removed where a fire barrier is penetrated

Pipes passing through external walls, floors and roofs shall be installed with puddle flanges or sleeves as appropriate, sealed against water, gas, vermin, dust and the spread of fire.

No sleeving shall be used that will impair the fire resistance of any structure. Where pipe sleeves pass through fire barriers, the annular space between pipe and sleeve, or insulation and sleeve shall be packed with non-flammable and fire resistant material to form a fire/smoke stop of required rating. Apply 12mm deep cold mastic seal to both ends within sleeve. In areas where floors are washed down sleeves shall be installed with 100mm protrusion above the floor finish.

3.9.3 Alignment

Pipelines shall follow the lines of the building both horizontally, vertically, around projections such as columns, except where pipes are not visible but satisfactorily routed across e.g. roof spaces where out of sight. Pipelines shall be run in appropriate positions in relation to the building, other services and appliances. Due allowance for draining and venting, shall be made.

3.9.4 Spacing and Clearance

Pipework, inclusive of any insulation, shall be not less than 25mm clear of walls and any other fixture. Low level horizontal pipework shall be fixed not less than 100mm clear above floors.

Section 4
COPPER PIPEWORK CONSTRUCTION AND ASSEMBLY

4.1 PIPING MATERIALS

4.1.1 Grades and Types

Copper pipe is made in various Hardness Grades and Standards. It is important that the correct type of copper tube is used for the specific type of service, operating temperature, pressure and jointing method.

- Half-hard copper tube to BS EN 1057 R250 (BS 2871 Part 1 Table X), supplied in straight lengths, is the most common type used in condenser cooling system pipework.
- Half-hard copper tube to BS EN 1057 R220/R250 (BS 2871 Part 1 Tables W & Y), supplied in straight lengths, is used for pipework which is buried, embedded or difficult to access.
- Half drawn copper tube to BS EN 1057 R290 (BS 2871 Part 1 Table Z), has a lower maximum working pressure than the foregoing grades. It is not suitable for bending and should not be formed or annealed and shall be used with silver brazed joints.

The maximum working pressure for each type of copper tube will vary, with the size of tube and temperature conditions. The relevant British Standard should be consulted, to establish the maximum pressure for which a particular size is suitable. Larger sizes have lower maximum working pressures, at the same temperature condition for the same type of tube.

4.1.2 Finish

Copper tube is available with the following finishes:

Manufacturer's works self-coloured.

Chromium plated.

Plastic coated.

For pipework condenser and cooling water installations, the copper tube finish will normally be the manufacturer's standard self-coloured works finish. Where an alternative finish is required by the client, this should be specified separately.

Copper tube must be carefully handled and stored to avoid scratching. Compression fittings will not seal on pipework with deep longitudinal scratches.

4.2 JOINTING METHODS

Copper piping shall normally be assembled with capillary, compression, flanged, push fit, brazed joints or press fit joints. Proprietary jointing methods may be used and should only be carried out in accordance with the manufacturer's recommendations.

4.3 CAPILLARY JOINT AND FITTING ASSEMBLY

4.3.1 Capillary Method of Assembly

Pressure limitations imposed by the British Standard on the use of soft solder for capillary fittings and of compression fittings (where acceptable), shall be observed and when necessary, silver brazing shall be used. Joints in inaccessible positions shall be avoided, but when there is no alternative, they shall preferably be silver brazed. Where suitably skilled craftsman are not available for silver brazing, integral solder ring fittings for sizes up to 54mm may be used, provided special care is taken and close supervision is given.

Forming techniques may be used, only for straight couplings on BS EN 1057 (BS 2871 Table X and Table Y) tube and for branches on Table Y tube.

4.3.2 Capillary Fittings

Capillary fittings for sizes up to 67mm, shall comply to BS EN 1254 (BS 864 Part 2). They shall be of copper and either integral solder ring or end feed jointed with soft solder. Sizes 67mm and above shall be gunmetal and of the wedge ring type.

All fittings shall be installed in accordance with the manufacturer's instructions. Flux and solder shall be used according to the fitting manufacturer's recommendations, being chosen to avoid any corrosion of the piping before flushing and filling.

Fittings made of duplex brass (having a Zinc content above 30%), shall NOT be used.

4.4 COMPRESSION JOINT AND FITTING ASSEMBLY

4.4.1 Compression Method

Compression joints are designed to be used without jointing compound. Thread lubricants are recommended for sizes above 22mm OD, to reduce assembly forces and provide a more reliable joint.

4.4.2 Compression Fittings

Compression fittings for sizes up to 35mm shall comply with BS EN 1254 (BS 864: Part 2). All fittings shall be installed in accordance with the manufacturer's instructions. Particular care shall be taken, to ensure the level of tightness of the completed joint complies with their recommendations.

The use of internal reducers should be avoided wherever possible.

The use of compression fittings to connect to other than BS EN 1057 (BS 2871 Part 1 Table X) copper tube, may necessitate the use of an appropriate tube liner.

4.5 FLANGED JOINTS

On pipelines 67mm and above, flanges shall be installed where a section of piping needs to be readily removable for access, demounting or for testing.

Flanges for BS EN 1057 (BS 2871 Table X and Table Y) tube, shall be two part metal type, with gunmetal or low zinc brass inserts for brazing to the tube.

The steel backing rings of two part metal flanges, shall be drilled to BS 4504 PN6 code 307 (up to 6 bar) or PN16 code 307 (up to 16 bar) to match the equipment. Two part metal flanges shall be jointed with corrugated metal or inside-bolt circle flat ring composition gaskets with hexagonal head bolts, nuts and washers. Where gunmetal or bronze flanges are used, the bolts, nuts and washers, shall be of the same material as the flanges.

4.6 PUSH FIT ASSEMBLY

4.6.1 Push Fit Method

Push fits do not require the use of solder, pastes, or threading. Joints can be made without the need for tools and no heat is required to assemble. They also have the advantage of being easily disconnected. A tool is required for disconnection.

Care should be taken in the use of these products in relation to their operating temperature and pressure ranges. Refer to the manufacturer's details.

4.6.2 Push Fit Fittings

Most fittings are suitable and approved, for use in small-bore and micro-bore central heating systems. Confirmation should be obtained from the manufacturer for their suitability, temperature and pressure range.

4.7 BRAZED ASSEMBLY

4.7.1 Brazing Method

Joints in inaccessible locations after installation shall preferably be silver brazed.

Care should be taken in the brazing operation. As there is a health risk due to the cadmium content of some silver brazing alloys. When overheated, the cadmium vaporises and these vapours are highly toxic if inhaled. A similar reaction can occur under these conditions with some of the flux constituents.

Care also needs to be taken with fluxes used for brazing. These can, if swallowed or rubbed into the eyes, cause irritation in varying degrees. They may also affect the skin if not removed.

4.7.2 Brazing Fittings

Brazing fittings are manufactured using copper, DZR Brass and Gunmetal to BS EN 1254 (BS 864 Part 2). Fittings are specifically manufactured for brazing and are not suitable for soft solder jointing.

In all cases, the manufacturer's recommendations should be observed.

4.8 PRESS FIT ASSEMBLY

4.8.1 Method

Press-fitting and pipe are pressed to form a permanent joint. The pressfitting operation also deforms the factory-fitted seal ring in the end bead, ensuring the connection remains watertight.

The copper pipework grade and type must comply with the manufacturer's recommendations for the type of propriety pressed-on fitting employed to join straight lengths of pipework and components. Attention is drawn to the limitations of temperature and pressure advised by the fitting manufacturers for their products.

Press-fittings can be used on 12mm to 108mm OD. The temperature and pressure ratings should be check, as these can vary with manufacturer.

4.8.2 Fitting

It is essential that pipework and fittings are mutually compatible and suitable for the application intended and that they are suitable for use on copper pipework. The pipe sizes vary, as do the temperature and pressure ratings, with the material and manufacturer.

Copper 12 to 108mm OD

The press-fitting and pipe must be pressed, with the appropriate tool, to form a strong and permanent joint.

4.9 PULLED BENDS

For sizes up to 54mm pulled bends may be used for BS EN 1057 (BS 2871 Table X and Table Y) tube where space and appearance permit. Standard formers and bending machines shall be used.

4.10 SUPPORT AND FIXINGS

Supports and fixings, whether standard patterns or purpose - made, shall be appropriate in style and material to the pipe and to the structure to which fixed, with due regard to application. Supports in contact with the tube shall be non-ferrous.

Pipe supports shall be arranged as near as possible to joints and changes in direction. They shall carry piping neatly, without excessive deflection between supports and so that it is free to move.

Where swinging pipe hangers are used, they shall be able to move freely for the full distance necessary. The support rod shall be not less than 300mm long and shall be clear of the full thickness of any insulation. Hemispherical washers shall be used on swinging hangers. Pipes of similar operating temperature and material, may be double hung from a single support rod.

Sliding supports, to accommodate linear movements, shall be faced with PTFE permanently attached. Rollers shall be avoided.

Vertical copper pipework shall be supported at the base of the riser and guided at intervals not exceeding those in Table D. Branches from a riser shall not be used as a means of support for the riser.

The installer shall supply full information to enable provision to be made in the structure for the fitting of supports and fixings during construction. The installer shall also be responsible for any necessary marking out.

Copper pipework shall normally be supported at intervals not exceeding those in Table D. Intermediate supports may be required to carry the load of in-line accessories.

Additional pipe supports to half the spacing tabled shall be provided on horizontal low-level pipe runs, where these might be used as footrests.

Additional pipe supports may be required on larger sizes to limit the point load imposed on the structure.

When suspending pipework with press-fit types of fittings, particular attention should be given to the rigidity of the assembly and the influence of thermal forces.

Table D – Copper Pipework Supports

Copper pipes shall be suported at intervals not exceeding the following:

	Maximum support interval	
Pipe size mm	**Horizontal m**	**Vertical m**
15	**1.5**	**2.0**
22-28	**2.0**	**2.5**
35-42	**2.5**	**3.0**
54	**2.7**	**3.0**
67-108	**3.0**	**3.7**

Care needs to be made in the supporting of copper pipework, to ensure that dissimilar metals are not in contact with each other.

4.11 EXPANSION AND CONTRACTION

4.11.1 Pipework

Provision for expansion shall be as defined in Section 3.8.

Expansion of Copper Pipework

The expansion rate for copper tube is: - 1.7mm per metre per 100K rise in temperature

For any unavoidable cases involving constrained movement, bellows shall be used with properly designed guides and anchors.

Nominal expansion movement of copper pipework shall be accommodated by the free support of piping.

4.11.2 Expansion Devices

Only where inherent pipeline flexibility is not practicable shall proprietary expansion devices be used, installed in strict compliance with the supplier's instructions. These instructions shall cover the design and installation of the necessary guides and anchors, including a statement of the resulting loads that will be imposed by the guides and anchors on the building structure. Where practicable, hinged and articulated bellows may be used, instead of axial bellows.

If the use of axial bellows cannot be avoided, the following points shall be observed:

- They must be used only on straight sections of pipework between anchors.
- Movement at bellows must be guided axially with no lateral movement.
- Axial bellows shall not be used on freely suspended pipelines.
- Axial bellows demand that the structure is capable of withstanding the high loads imposed by guides and anchors.
- The effect of the bellows operating forces on press-fit, mechanically grooved and proprietary joints should be verified with the manufacturer.

4.11.3 Anchors and Guides

Rigid mild steel pipe anchors capable of carrying the maximum loads resulting from the expansion arrangements shall be provided. Agreement with the client or his representative shall be obtained for the location of the loadings imposed by the attachment of anchors and guides, to the structure or other base. Care is required to ensure that dissimilar metals are not in direct contact with each other, at the anchor point of the copper pipeline.

4.12 CONSTRUCTION AND ASSEMBLY

4.12.1 Cleanliness

Tubes shall be free from burrs, corrosion, scale, dirt and obstructions before erection. Open ends left during progress shall be closed with tight fitting metal, plastic plugs or caps. All joints shall be cleaned and trimmed.

Precautions shall be taken to avoid the quantity of solid material finding its way into the system water, in particular:

a) Attached to internal surfaces of pipeline and components (e.g. scale or oil).
b) Introduced during the installation process (e.g. soil and building materials).
c) Generated within the pipeline by corrosive or chemical action, (e.g. involving fluxes, corrosion inhibitors or anti-freeze).

4.12.2 Pipe Sleeves

There shall be no pipeline joints within the thickness of walls or floors. Pipework shall not be embedded in the structure, unless specifically identified as part of the design.

Where pipes pass through walls or floors a pipe sleeve shall be built in, comprising a length of tube, of the same material as the pipeline, or other equivalent proprietary purpose made sleeve. The sleeve shall be sufficient in length for the sleeve to finish not less than 3mm nor more than 12mm clear of the finished wall or floor. The sleeve shall be of internal diameter at least 25mm greater than the OD of the pipe passing through. A greater clearance may be necessary to accommodate expansion movement and insulation. Where necessary to effect a noise or fire barrier, the space between the pipeline and the sleeve shall be packed with appropriate material.

Plastic coated pipework should have the coating removed where a fire barrier is penetrated.

Pipes passing through external walls, floors and roofs shall be installed with puddle flanges or sleeves as appropriate, sealed against water, vermin, dust and the spread of fire.

No sleeving shall be used that will impair the fire resistance of any structure. Where pipe sleeves do pass through fire barriers, particular attention needs to be made to the Building Regulations for plastic pipes passing through fire compartments. The use of propriety intumescent sleeves may be required. In areas where floors are washed down, sleeves shall be installed with 100mm protrusion above the floor finish.

4.12.3 Alignment

Pipelines shall follow the lines of the

building both horizontally, vertically, around projections such as columns, except where pipes may be satisfactorily run across e.g. roof spaces where out of sight. Pipelines shall be run in appropriate positions in relation to the building, other services and appliances. Due allowance for draining and venting, shall be made.

4.12.4 Spacing and Clearance

Pipework, inclusive of any insulation, shall be not less than 25mm clear of walls and any other fixture. Low level horizontal pipework shall be fixed not less than 100mm clear above floors.

Section 5
STAINLESS STEEL - PIPEWORK CONSTRUCTION AND ASSEMBLY

Whilst stainless steel can be used for cooling water systems, the extent of its use it not considered to warrant a full section in this specification. Mention is made within other sections were stainless steel can be used, however it does not provide a full listing.

Note: Stainless pipework should not be installed in chlorine rich atmospheres (such as swimming pools) due to the risk of stress corrosion

Section 6
PLASTIC PIPEWORK CONSTRUCTION AND ASSEMBLY

6.1 INTRODUCTION

This section of the document provides an overview of the application range of plastic pipework. Plastic products are now widely used in commercial building applications and developing rapidly. The inherent corrosion resistance of plastic pipe is particularly useful in open condenser and cooling systems. Most products are suitable for the temperatures and pressures normally associated with condenser and cooling water for air conditioning and similar systems but consideration should be given to the potential impact of increases in temperature and pressure under fault conditions.

See HVCA Publication TR/11 for more detail and manufacturer's data, for this reason, the following information is for guidance only.

Multi-Layer - PE or PEX layers with aluminium interlayer.
PE 100 - High Performance Polyethylene (was known as HDPE)
PP - Polypropylene
PVDF - Polyvinylidene Fluoride

Note: Consult manufacturer's information prior to selection for ranges.

Both wall thickness and reinforcement vary with materials.

The common materials used for sizes above 50 mm for condenser and cooling water systems are PVC-U and ABS, both of which are relatively rigid. PVC-U is not used for operating temperatures below 0°C. PVC-C is predominantly used for mains water services.

6.2.1 Pressure and Temperature Relationship

Maximum safe working pressure is usually quoted at 20°C, but the pressure rating reduces very quickly as temperature increases, e.g. PEX 12bar @ 20°C or 3bar @ 90°C.

Application	Temp °C Range subject to pressure	Typical Pressure Range @ 20°C	ABS	PB	PEX	PVC-C PVC-U	Multi-layer	PE 100 (HDPE)	PP	PVDF
Condenser and Cooling Water Systems	–5°C to 60°C	0 - 5 bar	✓	✓	✓	✓	✓	✓	✓	✓
		5 - 10 bar		✓	✓		✓		✓	✓
		10 - 20 bar		✓	✓		✓			✓

Expansion Rate	ABS	PB	PEX	PVC-C	Multi-layer	PE 100 (HDPE)	PP	PVDF
Indexed to that of Copper: CU=1	5.7	7.3	9.5	4.5	3	6.7	6.2	6

6.2 PLASTIC PIPEWORK APPLICATION SELECTION

Note: Consult manufacturer's information prior to selection for ranges.

Both wall thickness and reinforcement vary with materials.

ABS - Acrylonitrile - Butadiene - Styrene
PB - Polybutylene
PE-X - Cross Linked Polyethylene
PVC-C - Chlorinated Polyvinyl Chloride
PVC-U - Unplasticised Polyvinyl Chloride

Manufacturer's literature must be consulted and recommendations closely followed with due regard to the potential for elevated temperatures and pressures to be experienced under fault conditions.

6.3 JOINTING METHODS

Jointing Methods - Guidance Selection

	ABS	PB	PEX	PVC-C PVC-U	Multi-layer	PE 100 (HDPE)	PP	PVDF
Threaded	✓					✓		
Solvent	✓			✓				
Flanged	✓	✓	✓	✓		✓		
Thermal Fusion		✓					✓	✓
Butt-Weld						✓	✓	✓
Socket Weld							✓	✓
Electrofusion		✓				✓	✓	
Compression		✓	✓		✓Note			
Push-fit						✓		

Note: Multi-layer pipes and PE pipes with oxygen barrier layers may be designed for use with proprietary fittings, the tail of which is inserted into the pipe. The use of standard compression fittings may not provide continuity of the oxygen barrier.

Always refer to manufacturer's instructions for jointing techniques and use the appropriate method for the pressure and temperature.

The main jointing methods are:

6.3.1 Threaded

Threads or threaded fittings may be used to connect some plastic systems to ancillary equipment, pumps, filters etc.

Not all plastic pipework is suitable for threads to be cut. It depends on the material and physical characteristics of the pipe and the anticipated operating conditions. Check with manufacturer.

The use of thread cutting equipment shall be restricted to thick-walled 25mm pipe and above to limited operating pressures. Metric pipes are not normally produced with an outside diameter compatible with BSP thread requirements.

Threads are normally BS 21 taper form, using dies reserved for plastic pipes with full depth threads cut in one operation without lubricant. PTFE jointing material should be used on ABS and PVC pipes, see manufacturers information for other materials.

Pre-threaded adapter fittings are available which can be solvent welded to ABS and PVC pipes.

Tightening should only be done by hand, or at most supplemented by an extra quarter turn via strap wrench. Over tightening causes damage and is unnecessary. Anaerobic adhesive thread sealants can chemically attack ABS and PVC and should not be used.

6.3.2 Solvent Welding

This technique offers stronger jointing than mechanical jointing and is cheaper. It is also used for reducing bushes when adapting fittings to different pipe sizes.

The approved solvent cements will withstand the same conditions as the pipe being jointed. Only use cements recommended by the manufacturer and obtain specialist advice if solvent welding different materials together, e.g. ABS to PVC. Not all types of plastic pipework are suitable for solvent welding.

The manufacturer's instructions should be followed for the preparation of pipework and application of solvent cement to ensure satisfactory joints.

Solvent cements can have a limited shelf life, whether opened or not. Check prior to use.

Joints should not be made:

- in wet conditions, rain etc
- using dirty brushes
- using dirty or oily cleaning rags
- using inappropriate cements or cleaners

Vapours are flammable, smoking and naked flames shall be avoided.

Always ensure adequate ventilation, since vapours are narcotic and potentially lethal, as well as being flammable. Solvent

welding should not be used in confined spaces without adequate ventilation.

Solvent cement jointing of one type of plastic to another is not recommended, although it may be possible if the limitations involved are accepted (check with manufacturers).

Note: Solvent cements and cleaners are hazardous and inflammable. Precautions must be taken in their use to protect the health and safety of those affected. Refer to manufacturers' information, and any assessments made under COSHH (Control of Substances Hazardous to Health) and CHIP Chemicals (Hazard Information & Packaging for Supply) Regulations.

Cement should be locked within a secure place when not in use. Old cement containers must be properly disposed of with due regard to the Waste Regulations and possible solvent abuse. Never place old solvent cement containers in an open skip.

Test pressure should not be applied until a minimum of 24 hours has elapsed following jointing.

6.3.3 Flanges

As with all types of jointing, the relevant manufacturer's information should be consulted. Particular care is required with respect to bolt tightening sequence and torque applied to bolts to avoid distortion.

To ensure an effective seal the gasket and flange faces should be clean and free from dirt or other obstructions.

Full face flange fittings (for plastic to plastic) to BS 4504; generally require purpose designed backing rings to spread the bolt load and full-face gaskets. Use of the correct backing ring and gasket is essential.

6.3.4 Thermal Fusion

Thermal fusion requires considerable skill to prevent heat damage and to obtain satisfactory joints. Manufacturers' advice should be sought concerning maximum permissible temperatures and the suitability of any given pipe for such welding. Only trained operatives should be used.

6.3.5 Butt-Welding

Butt-welding is thermal welding in which the actual ends of the pipe and/or fitting are welded using a heated platen.

The heated platen is withdrawn quickly and the pipe and fitting are forced together under pressure to achieve a weld. Butt-welding requires specialised equipment and a high degree of skill. Training is vital to achieving the desired weld strength. Weld strength is such that performance under pressure exceeds the strength of the pipes or fittings being jointed.

Note: Butt-welding creates a weld bead, both internally and externally. These are often left in place, but can be removed using special tooling if necessary.

6.3.6 Socket Welding

Employs a similar technique to that of butt fusion in heating the surfaces to be joined, in this case involving the application of heat to the inside surface of the socket, as well as the outside of the pipe. Training and the correct equipment are essential.

6.3.7 Electro-fusion

Electro-fusion is commonly used for HDPE and PB. Not all types of plastic pipework are suitable for electro-fusion.

Note: There are many types of electro-fusion fitting now, not simply couplers, see manufacturers' information.

Any contamination of the surfaces to be joined will affect the integrity of the joint, so it is important that they be cleaned and prepared according to the manufacturer's recommendations.

6.3.8 Compression Fittings

Manufacturer's instructions should always be followed, with respect to preparation of pipework to ensure satisfactory joints.

Some plastic pipe can be used with standard brass compression fittings, but most manufacturers provide alternative plastic fittings, which offer easy and quick installation.

Internal support sleeves (typically copper, brass or stainless steel) are used for polythene and polybutylene pipes. This is to prevent progressive deformation of pipe (creep) and eventual leakage. It is vital to check that the support sleeves will not be adversely affected by, or adversely affect, the liquids being carried in the pipe. Support sleeves are not interchangeable between different manufacturers.

Some manufacturers recommend the use of an appropriate lubricant to avoid

damage to the pipes and fittings, through the use of excessive mechanical force during assembly. The choice and application of lubricants, should be in accordance with the manufacturer's recommendations for the particular material.

6.3.9 Push-fit

Manufacturer's instructions should always be followed, with respect to preparation of pipework to ensure satisfactory joints.

Push fit fittings normally consist of a guide ring, grab ring, O-ring seal within a plastic housing. Some fittings provide non-dismantleable permanent fixing, while others can be dismantled or enable the pipe to be removed by depressing the collet.

Some, but not all, plastic pipe fittings can accept copper pipe of the same external diameter.

6.4 ELECTRICAL CONDUCTIVITY

Plastic cannot be used for earthing purposes.

No plastic is sufficiently conductive to function as part of an earthing system. Therefore when replacing a section of metal pipework (used for earthing purposes) with a plastic system, it is necessary to maintain electrical continuity using a bonding lead spanning the plastic section and firmly attached with conductive clips/clamps to the metal pipework.

Static electricity can build up when handling pipes leading to minor shocks and/or sparking. This may pose a risk when used in certain environments.

6.5 EXPANSION RATES

The route chosen for the pipework and the design of brackets and clips should allow for the thermal expansion of plastics, which is far higher than for metals. See details in section 6.2. Manufacturer's recommendations should be obtained and applied to all design/installation practice.

Expansion loops or suitable compensators may be required, but ideally the design of the system should make use of the pipe's natural flexibility.

6.6 SUPPORTS

Supports should be of sufficient width to provide low point load on the underside of the pipe. Manufacturers normally give advice on minimum recommended support-areas, in addition to support intervals. In certain cases, continuous supporting (e.g. tray) may be required to prevent sagging.

Support for plastic pipework generally should provide lateral restraint, whilst permitting axial movement (due to thermal expansion). Pipe clips should be chosen to allow axial movement at all temperatures.

Proprietary plastic pipe clips should be used as a first choice. Metal clips should be sized not to compress the pipe. Ensure that screws in single screw fixings do not protrude the countersink.

Hanger type supports do not provide good lateral restraint and this can lead to snaking. They are not generally suitable, unless braced in two directions.

Heavy pipeline components should not be supported by plastic pipework.

To allow the pipe's flexibility to be fully utilised, it is best not to place clips too close to changes in direction. When using pipe clips to constrain a bend, account should be taken of the potential loads on the clip.

Manufacturers' recommendations on minimum radius bends must be respected. For tight bends in soft pipe materials, propriety formers may be available.

6.7 ULTRA-VIOLET LIGHT (UV)

Plastics are vulnerable to UV, however their degree of vulnerability varies with the material and the level of stabilisation. Most condenser and cooling water systems will have at least some of the pipework installed outside.

Should the installation be considered vulnerable to sunlight, including where pipes in buildings pass windows, covering is recommended.

Storage of exposed pipes for prolonged periods of time is also best avoided. A simple covering solves the problem.

PE-X generally needs to be covered, as few protective pigments are available.

6.8 MIXING OF PIPE AND FITTINGS

In order to ensure security of performance, it is advisable to use pipe and fittings from the same manufacturer, or the recommended fittings or where this is not possible, to pressure test the proposed combination.

PVC and ABS pipework and fittings, are frequently available in both metric and inch systems. Adapters exist to facilitate change from

one to the other, but the two are not otherwise interchangeable.

Where mixing metal and plastic systems, it is generally recommended that no soldered joints be made closer than 0.5m to an installed plastic-to-metal adapter in the same pipeline.

6.9 PRESSURE FLUCTUATION

The flexibility of some forms of plastic pipe means that they are unlikely to suffer minor damage from vibration, but pressure pulsation's and water hammer, can lead to excessive movement. More rigid forms could suffer from mechanical fatigue cracking if exposed to excessive vibrations. These issues should be considered at the design stage.

6.10 HANDLING

Plastic pipework is a less robust material and special care should be taken in the handling and storage to avoid damage, particularly scratching and abrasions, which could prevent subsequent satisfactory jointing.

6.11 THERMAL INSULATION AND TRACE HEATING

Plastics' lower thermal conductivity adds to the insulation value. However insulation thickness's should not be reduced compared to metal pipe without careful consideration.

When using trace heating be particularly careful to ensure the heating tape and its adhesive are compatible with the plastic being used. The high surface temperature of the tape may necessitate the pre-wrapping of the pipework with a conductor to prevent localised overheating. See Section 10 for more information.

6.12 LOCATION OF PIPEWORK

Plastic pipework in elevated ambient temperatures will behave in the same way as if it were carrying liquids at those temperatures. The use of pipework in hot environments should be carefully evaluated before use, for instance in unvented ceiling voids.

Plastic pipework using mechanical joints and attached to sources of vibration or movement: pumps etc. may be subject to joint failure. Although flexible in itself the mechanical security (tightness) of joints to plastics is not as great as for all-metal joints. Thus, vibration or movement may degrade mechanical joints. This is not a problem for fusion (cement or heat) type joints. Note also that heat transmission from pumps, compressors etc, can damage pipework and joints immediately adjacent. Plastic pipe should not be connected to safety pressure relief valves or combined temperature/pressure relief valves.

6.13 CHEMICAL CLEANING

If chemical cleaning is to be undertaken either internally or externally, refer to the chemical compatibility charts available from the supplier or manufacturer before applying chemicals. See Section 11 for more information.

6.14 EXTERNAL INSULATION AND HIDDEN PIPEWORK

All insulation should be assessed for the compatibility with the plastic pipework used, as should the intended adhesive, to avoid chemical reaction with each other, causing the pipework to fail. Care needs to be exercised when replacing any part of the insulation at a late stage. This is a common cause of pipework failure.

The location of pipework buried in the ground or structures should be identified.

Where electronic pipe detection is essential, then multi-layer pipe (which has an aluminium interlayer) should be considered, or the use of a metallic telltale installed adjacent.

6.15 PLASTIC PIPEWORK AND COOLING SYSTEMS

One question over the suitability of plastics is their permeability to oxygen diffusion. This permeability, which is not shared by metallic pipework, can lead to corrosion problems with steel components.

Where PEX pipes are used on closed condenser and cooling systems they should have an oxygen permeation barrier to minimise corrosion problems elsewhere in the system. This is not a requirement for open condenser and cooling systems as the water may already have high dissolved oxygen levels. Care should be taken in identifying the appropriate pipe, where both may be present on site. Depending on the construction of the pipe, the use of non-manufacture approved fittings may produce a discontinuity in the barrier.

6.16 IDENTIFICATION

Plastics come in many colours and without identification markings. It is easy to incorrectly identify pipe and the installer should take measures

to segregate and mark when receiving and storing. See Section 8 for more information.

6.17 CONSTRUCTION AND ASSEMBLY

6.17.1 Cleanliness

Tubes shall be free from burrs, dirt and obstructions before erection.

Open ends left during progress shall be closed with tight fitting metal, plastic plugs or caps. All joints shall be cleaned and trimmed.

Precautions shall be taken to avoid the quantity of solid material finding its way into the system water, in particular:

a) Attached to internal surfaces of pipeline and components.
b) Introduced during the installation process (e.g. soil and building materials).
c) Generated within the pipeline by corrosive or chemical action, (e.g. involving solvents, corrosion inhibitors or antifreeze).

6.17.2 Pipe Sleeves

There shall be no pipeline joints within the thickness of walls or floors. Pipework shall not be embedded in the structure, unless specifically identified as part of the design.

Where pipes pass through walls or floors a pipe sleeve shall be built in, comprising a length of tube, of the same material as the pipeline, or other equivalent proprietary purpose made sleeve. The sleeve shall be sufficient in length for the sleeve to finish not less than 3mm nor more than 12mm clear of the finished wall or floor. The sleeve should be of internal diameter at least 25mm greater than the OD of the pipe passing through. A greater clearance may be necessary to accommodate expansion movement and insulation. Where necessary to effect a noise or fire barrier, the space between the pipeline and the sleeve shall be packed with appropriate material.

Pipes passing through external walls, floors and roofs shall be installed with puddle flanges or sleeves as appropriate, sealed against water, vermin, dust and the spread of fire.

No sleeving shall be used that will impair the fire resistance of any structure.

Where pipe sleeves do pass through fire barriers, the annular space between pipe and sleeve, or insulation and sleeve shall be packed with non-flammable and fire resistant material to form a fire/smoke stop of required rating. Apply 12mm deep cold mastic seal to both ends within sleeve. In areas where floors are washed down, sleeves shall be installed with 100mm protrusion above the floor finish.

6.17.3 Alignment

Pipelines shall follow the lines of the building both horizontally, vertically, around projections such as columns, except where pipes may be satisfactorily run across e.g. roof spaces where out of sight. Pipelines shall be run in appropriate positions in relation to the building, other services and appliances. Due allowance for draining and venting, shall be made.

6.17.4 Spacing and Clearance

Pipework, inclusive of any insulation, shall be not less than 25mm clear of walls and any other fixture. Low level horizontal pipework shall be fixed not less than 100mm clear above floors.

Section 7 GENERAL REQUIREMENTS

7.1 MAIN EQUIPOTENTIAL BONDING (Cross Bonding)

All incoming metallic services i.e. gas, water, oil etc., at point of entry to the building, MUST have main equipotential bonding conforming to BS 7671 (IEE Wiring Regulations) and the Statutory Electricity Supply undertakers requirements.

With respect to metallic condenser and cooling water systems, if there are any simultaneously accessible - extraneous - conductive parts, equipotential bonding may be necessary in accordance with BS 7671.

Particular attention needs to be paid to metallic condenser cooling water systems, to ensure that the pipework is assembled to maintain a sound metal to metal contact for electrical earth continuity back to the main bond.

During any work that requires connection or disconnection of any installation pipework or fitting, a temporary continuity bond must be attached. This must be fitted prior to starting work and removed only after the system metallic continuity has been re-established.

7.2 VENTING

Air venting and collecting points shall be provided at the top of risers and where necessary, at other high points.

To minimise trapped air pockets during filling, consideration should be given, where space allows, to stagger the positions of flow and return connections off vertical risers.

Venting high points on mains larger than 15mm shall be by main size air bottles, (on risers, bottles not less than 25mm diameter) at the point of rise or drop. They should be formed by a square branch weld or tee extension pipe, terminating in a reducer or cap with 10mm tail pipe to a 10mm needle valve in an accessible position. Air bottles shall be not less than 2 pipe diameters long or 150mm whichever is the greater.

Automatic air eliminators may be fitted at high points difficult for regular access, as identified on the drawings. Drain pipes from these, shall be run to a clearly visible position.

Consideration shall be given to the installation of mechanical air separator devices for closed systems, at a point of highest temperature and lowest pressure, to assist in removal of air.

7.3 DRAINING

Drain points and dirt pockets, shall be provided at the bottom of risers and where necessary at other low points.

Draining low points on condenser, cooling water mains and risers, shall be by main size dirt pockets (at foot of risers, pockets not less than 25mm diameter). Positioned at the point of rise or drop; terminating with a tail pipe and a bronze gland cock with hose union in an accessible position. Drain cocks shall be 15mm, 20mm or 25mm, whichever is closest to the main size.

7.4 EXPANSION

Allowance for the expansion of pipework shall be made adequately to limit pipeline stresses, to provide the controlled movement of pipes and to ensure that forces applied to equipment and to the building are consistent with their construction and characteristics.

Where possible expansion movement shall be accommodated by natural flexibility and the free support of piping, care being taken in the location of fixings to avoid local stress concentrations. See Sections 3.8 and 4.11 also for expansion.

For copper up to 35mm nominal bore, high expansion stresses cannot be accommodated by allowing copper pipe to bend as that may result in work hardening and fracture. For any unavoidable cases involving constrained movement, bellows shall be used with guides and anchors properly designed.

7.5 PROTECTION

7.5.1 Physical

Consideration should be given to protection of the vulnerable pipework where likely to suffer damage.

Protection to buried pipework or pipework in ground ducts subject to flooding, needs to be specified separately to suit the actual job and circumstances.

7.5.2 Corrosion

Where mild steel pipework is exposed to weather or located in damp conditions, then a protective coat of suitable paint should normally be applied to avoid rusting. A suitable primer coat will also be required, this being applied prior to any decorative painting.

7.6 CONNECTIONS TO EQUIPMENT

All equipment that needs to be removed for repair, maintenance or replacement should have a method with suitable fittings to allow disconnection of pipework. The type of fitting will depend on the size and material type: -

i.e. Unions for threaded joints or counter flanges to match the flange on the equipment, grooved couplings etc.

The source of disconnection must be suitably positioned to ensure after disconnection, there is space for removal of the isolated item of plant.

7.6.1 Connections to Existing

The installer shall draw the client's attention to difficulties that may arise when connecting to existing systems, e.g. the presence of imperial dimensioned equipment or the possibility of contamination from unsuitable water in the existing systems.

7.6.2 Connections for Future Extensions

Any branches to serve future extensions shall be terminated with a valve plugged or blanked as appropriate. Branches shall be kept to a minimum length, to avoid dead legs.

7.7 BUILDING FABRIC PENETRATIONS

Pipes passing through external walls, floors and roofs shall be installed with puddle flanges or sleeves as appropriate, sealed against water, vermin, dust

Section 8 ACCESSORIES AND PIPELINE ANCILLARIES

8.1 GENERAL REQUIREMENTS

Threaded accessories and pipeline ancillaries may be supplied with either BS 21 internal taper threads or BS 2779 internal parallel threads, both shall be mated with BS 21 taper external pipe thread.

Ends for accessories and pipeline ancillaries (whether threaded, flanged, wafer, capillary, grooved etc,) shall be chosen to match the pipework. Flanges shall be to BS 4504.

Valves shall be installed so as to permit the full movement of the operating handle or gear.

8.2 VALVE LOCATIONS AND FUNCTION

8.2.1 Isolating Valves

Valves shall be fitted to isolate individual plant items or groups of adjacent plant; main distribution circuits and risers. Where tight shut off is not necessary, gate valves may be used for isolation. Gate valves shall not be used for regulation.

A union shall follow threaded valves, for the isolating of items of equipment, where disconnection is required.

Where valves with wafer ends are used to isolate a flanged item of equipment for removal, a flanged stoolpiece shall be fitted between the valve and the equipment. Wafer valves shall be lugged pattern.

Where butterfly valves are used and there is any risk of excessive shock pressure caused, on opening or closing, by high differential pressure, or by static head against a possible open end, they shall have geared/wheel operation.

8.2.2 Regulating Valves

Regulating valves shall be fitted to return connections of plant as specified by the system designer.

Where it is necessary to carry out flow measurement to regulate and balance, the regulating valve shall form part of a commissioning set, with a close coupled or separate flow measurement metering device.

To obtain adequate valve authority for flow control, regulating valves shall be

sized for the correct pressure drop and should be normally at least one size below that of the pipeline.

The accuracy of flow measurement readings may be affected if the manufacturer's recommended up stream and down stream straight length of pipework is not provided.

Regulating valves shall be lockshield pattern or have tamper resistant devices to protect the settings.

8.3 PIPELINE ANCILLARIES

8.3.1 Safety Valves

Safety pressure relief valves shall be fitted to pressurised closed condenser and cooling systems as specified by the designer.

Discharge piping shall be properly supported and impose no significant load on the safety valve and have an unrestricted drain pipe with a visible discharge point, positioned where injury to persons cannot occur. Discharge piping shall be of a bore not less than that of the outlet of the safety valve, being as short as possible to present the least resistance to flow.

Safety valve set pressure shall be 10% (or minimum of 0.7 bar) above maximum working pressure, with a minimum setting of 1.3 bar (to prevent unnecessary lifting of the safety valve). In no case should it exceed the pressure rating of any part of the system.

8.3.2 Ball Float Valves

An isolating valve is required on the inlet to the ball valve supplying an open system or the service tank of a pressurised closed system. Ball float valves for makeup tanks shall be Type AF (Fluid category 4), or, Type AA/AB (Fluid category 5), air gap

Valves up to 50 mm shall have bronze body and copper or plastic float. Over 50mm, valves shall have cast iron body and copper or plastic float.

8.3.3 Non-return Valves

Valves shall be to BS 5154 or BS 6282 Part 1. For sizes 15-50mm valves shall be threaded to BS 21. For sizes 65mm and above, valves shall have wafer type body or with flanged end connections to BS 4504. Constructional details shall be suitable for the service conditions.

8.3.4 Strainers

Strainers should be fitted at main plant when necessary to protect equipment e.g. automatic control valves, pumps, meters etc. Strainers must be provided with a means of isolation to facilitate cleaning.

8.3.5 Instrumentation and Test Points

Connections for permanent instrumentation, or for temperature and pressure test points, shall be provided as required for the testing and monitoring of the system.

Suitable self-sealing test plugs should be fitted either side of connections to the main plant, plus either side of every primary heat exchanger and automatic control valve.

Permanent instrumentation shall be provided as follows and where indicated on the drawings.

8.3.6 Pressure Gauges

Pressure gauges with a scale reading of twice the working pressure shall be fitted, to give a mid-range reading, to indicate pump suction and delivery pressure. Pressure gauges should be dial type, with a minimum dial size of 75mm, for easy reading. Gauges shall be fitted with gauge cocks.

8.3.7 Thermometers

Thermometers should be selected to be easily readable, mounted in a visible location and selected for the system operating temperature. They should be provided to indicate the flow temperature of any separately pumped circuit. A thermometer should be provided with a separate pocket.

Steel pockets shall not be used on copper pipelines.

8.3.8 Flow Switches and Indicators

Flow switches and indicators shall be installed where specified by the system designer.

Flow indicators shall be installed according to the manufacturers' guidance and in the appropriate orientation. Tapered tube, paddle wheel and turbine flow indicators shall be preceded by a strainer. Isolation valves shall be provided so that the strainer and flow indicator can be cleaned when required.

Paddle switches are not usually sensitive to orientation but must be appropriately sized according to pipe size and flow rate.

8.4 IDENTIFICATION

Identification requirements should be agreed between purchaser and installer. The following is recommended:

8.4.1 Pipeline

a) All insulated pipework should be identified at intervals not greater than 3m, at valve or expansion joint positions, at inlet and exit positions to ducts or buildings and at either side of walls or floors.

b) Identification should be by a colour-coded band applied neatly at right-angles to the pipe axis. Band details and colours shall comply with BS 1710 with colours to BS 4800.

In addition the name of the service should be indicated on an identifying worded band located in a visible position, together with an arrow indicating direction of flow. Flow and return mains should have the letter F or R added to the identifying name.

8.4.2 Valves and Plant

Suppliers shall be requested to label all equipment and packages with identification numbers, to ensure items can be correctly identified.

Labels shall be provided for all valves, except those on room terminals. Labels shall be of a durable nature, showing the valve number and service. A valve chart suitably protected, with a permanent finish, showing the positions and numbering of the valves should be fixed in an agreed position.

Section 9
TESTING

Pipework shall be tested hydraulically to 1.5 X working pressure with a minimum of 5 bar (gauge). Pressure testing shall be carried out in accordance with the HVCA Publication TR/6.

Any components not designed to carry the full test pressure, shall be disconnected and the pipework capped or plugged off for the test. After reconnecting, the reconnected joints should be checked for soundness.

Concealed or buried pipework shall be tested before any permanent covering is applied.

Appropriate personnel should be advised with due notice given in advance, of any pressure tests that need to be witnessed.

Care should be taken when testing plastic pipework, to observe the manufacturer's requirements. This may stipulate testing at significantly higher pressure and different techniques to take into account the elasticity of the pipe material and jointing method.

When pneumatic testing, using compressed air or nitrogen is carried out, caution should be observed. The advice of HVCA Publication TR/6 and guidance given by HSE, shall be followed.

Chemically treated water may be hazardous and care should be taken to avoid any contact, which may occur for example due to leaks during testing.

If there is a delay of more than 48 hours between pressure testing and the start of the cleaning process, systems are best left full of biocide dosed water. This will control bacteria levels and result in less contamination than if the system is drained.

Test results shall be recorded and certified by the installer.

Section 10
THERMAL INSULATION

10.1 APPLICATION

The insulation of condenser and cooling system pipework is mainly for the purposes of frost protection though prevention of condensation may be a factor in some cases. Pipework shall be insulated as specified by the system designer.

The standard of workmanship and guidance given in this document is intended to be appropriate to most normal commercial and industrial applications, in that it relates to good practice, without unnecessary elaboration in installation and energy conservation.

No distinction is made between systems operating continuously or intermittently.

Asbestos materials must not be used.

10.1.1 Installation Considerations

The designer should specify the choice of materials and thickness and finish, which will be determined by the following considerations:

a) **Location of Piping**
Determine whether indoors concealed or exposed in a boilerhouse or plantrooms; installed in ducts or buried; whether outdoors or exposed or weather-protected.

b) **Surrounding Ambient Conditions**
Consider suitability of materials for abnormally high or low temperatures, high humidity, flammable conditions, potentially corrosive atmosphere, protection against rain, wind, condensation and freezing.

c) **Special Conditions**
Establish the need for resistance to the following (as appropriate); fire, vibration, mechanical damage (including crushing); attack by vermin or insects, presence of corrosive fluids; resistance of surface to ingress of oils or flammable liquids: specified maximum temperature on the outer surface of the insulation (for the protection and safety of persons).

d) **Type of Insulating Material**
Wet processes should be avoided, unless application requirements or good appearance are not otherwise achievable.

10.1.2 Workmanship

Incorrectly fitted or finished material can lead to increased running costs and maintenance.

Good workmanship requires adherence to the following: -

a) Surfaces shall be clean, dry and grease-free before application.

b) Rigid sections shall have 'staggered' joints where more than one layer is involved. Sections shall be securely fixed by means of adhesive, wire, bands or other mechanical fixings.

c) Mattresses shall butt firmly together and be properly secured with wire netting or expanded metal, with mechanical fixings.

d) Where cement or composition finishes are to be applied to the outer face of the insulation this shall be suitably "keyed".

e) When applying several layers of wet plasticized insulation, each layer shall be allowed to dry out thoroughly, before the next layer is applied and before any protective covering is fitted.

f) All thermal insulation shall have proper provision to allow for thermal expansion, particularly on pipes and at pipe connections, where movement may produce cracking or other damage in the insulation.

g) Insulation thickness on flanges and valves, where specified, shall be at least equal to that on connecting pipes.

h) In designated hazardous areas, consideration may have to given to the need to have electrically earthed bonding, for example, where metal cladding is applied and a risk of a static potential developing exists.

i) Particular care shall be taken in the insulation of pipework, if electrically traced, (see sub-section 10.2).

j) Where insulated pipes are installed outdoors and exposed to the weather (i.e. to rain and snow or to solar radiation), then the outer covering shall be weatherproof and applied to all of the pipework system. The finish should be reasonably resistant to mechanical damage and not degrade when exposed to sun

light. Fire resistance shall be appropriate to location.

At pipework supports, both insulation and outer covering shall be continuous and not punctured by the supports. The insulation at supports shall be material of sufficient density to take the loads transmitted to the supports.

The covering shall be continuous at fittings and lapped and sealed at joints, flanges and elsewhere as necessary, to prevent ingress of water.

k) Sufficient space shall be allowed between adjacent pipes and between pipe and wall, for application.

In the interests of maintenance and identification, pipes shall be insulated separately, not in groups.

Insulation shall normally be carried over fittings, pipe fixings, other than rollers and chairs. If hard setting is used, the insulation may be carried over pipework fittings, but shall not be carried over fixings of any kind.

On external work, particular care shall be taken at supports to prevent water entering the insulation. Where mains are external or in external ducts; insulation over saddles shall be used. (This may require temporary support of the pipework, until the insulation is completed).

10.2 TRACE HEATING

CAUTION. Potential fire and electrical shock hazard.

Trace heating systems must be installed correctly, to ensure proper operation and to prevent shock and fire.

10.2.1 Pre-Installation Guidelines

Check that the length of trace heating cable is sufficient for the proposed method of installation including any additional length required for valves, fittings and supports. Manufacturer's recommendations should be used to establish the length of cable required.

Check the heating cable and components for in-transit damage. Each reel should have the cable insulation resistance measured.

Check that the pipe has been pressure-tested and is satisfactory.

Check all supports and equipment are installed and that any paint or coating is dry.

Check for and remove any sharp edges or burrs that could cause damage to the cable.

Examine the pipe system and plan the routing of the heating-cable on the pipe. Mark the location of power connections, splices and tees on the pipe.

10.2.2 Installation

To comply with BS 6351, Manufacturers' requirements, Health and Safety at Work Act, COSHH and IEE wiring regulations (BS 7671). To protect against the risk of fire, residual current protection (RCD) must be used on each trace heating circuit.

When using trace heating on plastic pipework, be particularly careful to ensure the heating tape and its adhesive are compatible with the type of pipework material being used. The high surface temperature of the tape may necessitate the pre-wrapping of the pipework with a conductor to prevent localised overheating.

The heating-cable may be installed straight, spiralled, or in multiple runs as required by the design. For straight runs the cable should be fitted at the lowest level.

Vinyl electrical tape should not be used to install the trace heating cable. Manufacturer's recommended installation fixing tapes should be used.

Cable ties are recommended in applications where the pipe surface prevents proper tape adhesion. Ties must be plastic and must be hand-tightened only, to prevent damage to the heating-cable.

Entry glands must be used on heating cable insulation where a metal cladding finish is applied to pipework or surface.

When installing cables on non-metallic pipe/surface, they shall be sandwiched between two layers of Aluminium self adhesive tape.

Only fire resistant insulation should be used, such as fibreglass or flame-retardant foams.

10.2.3 Heating Cable Connections

General requirements for heating cable connections include:-

Connection kits should be positioned on the top of the pipework.

Electrical conduit leading to the power connection kit must have low-point drains to avoid condensation entering the electrical connection.

Labels that are fitted externally, shall be suitably weather proofed.

The trace heating system shall have a method of temperature control. This is generally provided by a thermostat although more sophisticated methods of control are available.

10.2.4 Heating Cable Testing

Insulation resistance testing is a reliable indicator of the electrical integrity of the system, when all the installation instructions are properly followed.

Electrical insulation resistance testing is recommended prior to the application of any covering material, such as insulation. The test instrument should have a valid calibration certificate.

Section 11 FLUSHING/CLEANING AND WATER TREATMENT

11.1 APPLICATION

This section of the specification draws attention to the need for cleanliness during construction, flushing and cleaning after construction and suitable treatment of the system prior to setting to work. It identifies BSRIA AG 1/2001, to which reference may be made to ensure that suitable provisions are incorporated in the Works to enable cleaning, flushing and subsequent treatment to be undertaken satisfactorily.

11.2 SYSTEM CLEANLINESS

11.2.1 Introduction

Care should be taken to limit the quantity of foreign material, which may enter the system during installation and any item required to be removed during subsequent flushing and cleaning procedures.

The usual sources of foreign material are: -

a) Attached to internal surfaces of pipework, fittings, valves etc., when delivered.

b) Introduced to internal surfaces of pipework, fittings, valves etc., whilst stored.

c) Introduced during construction.

11.2.2 Delivery and Storage

The following are examples of care requirements:

a) All pipework should be inspected on delivery to ascertain cleanliness and be stored in a clean dry environment, with ends covered.

b) All pipework components should be delivered in suitable protective packaging and stored in clean covered bins, or bags, prior to use.

c) Particular care should be taken, when materials are delivered to the workplace to avoid accidental ingress of material prior to construction.

11.2.3 During Installation

The following are examples of care requirements:

a) All pipework and components should be inspected immediately prior to

incorporation into the works and cleaned where necessary. Millscale, rust, casting sand, swarf etc., should be removed prior to assembly.

b) Open ends should be temporarily capped as the work proceeds. Open ends should always be inspected prior to continuation.

c) Good practise should be adopted to limit the amount of excess material introduced by jointing methods employed, (i.e. welding flash, cutting swarf, solder, jointing compounds etc.) and all excess removed where practicable during installation.

11.2.4 During Testing

Detailed advice is given within Section 2.4 of BSRIA AG 1/2001, the following outlines the general considerations. The system will require filling and static flushing as part of the testing procedure.

Care should be taken to ensure that no foreign materials are introduced into the system when filling for hydraulic test purposes.

For closed systems the water source should be confirmed clean by sampling prior to filling. Where doubt exists, an alternative source may be required, or the installation of an in-line filter. It may also be necessary to take steps to prevent the introduction of a biological burden. For this purpose, an in-line steriliser or biocide injector may be used or biocide introduced. This is particularly important if the system is to be left full for more than 48 hours prior to dynamic flushing and chemical cleaning.

11.2.5 Dynamic Flushing

All systems will require flushed out to remove any vagrant material, which may be lodged in the system, regardless of the precautions taken. The BSRIA Application Guide Ref: - AG 1/2001 Section 3.1 provides guidance on suitable methods to be employed. Care should be taken to ensure that the process does not introduce a biological burden to closed systems (see clause 11.2.4).

11.3 FILLING THE SYSTEM

To limit the risk of biofilm development and consequent bacteria-induced problems, it is advisable to delay filling the system for as long as possible. Once filled, the system clean should ideally be commenced within 48 hours.

The rate at which the system fills will be dependent on the available pressure, in relation to the system height and size.

The system will normally be filled via: -

1 a temporary connection from the water mains, in compliance with the current Water Supply (Water Fittings) Regulations. An acceptable connection would incorporate a double check valve assembly, comprising two check valves to BS 6282: Part 1

Alternatively

2 the installation of a temporary tank and pump arrangement.

3 the permanent installation

To avoid problems associated with the adequacy or cleanliness of the supply, a temporary main for the sole use of the Contractor is preferable.

To help minimise the possibility of a bacterial problem, fill water can be treated with a biocide to minimise the risk of biofilm development. All Health and Safety requirements must be taken into account regarding the choice of chemical, since there is a possible risk of contact with site personnel should the system leak or fail during pressure testing.

11.4 CHEMICAL CLEANING

There may be a requirement for the chemical cleaning of the system to supplement the flushing process. This will normally be the subject of an agreement between the Installer and Designer. The BSRIA Application Guide AG 1/2001, provides guidance on suitable methods which may be employed. The following draws attention to specific issues associated with the cleaning process, which the installer should take account of: -

a) All components, which may be detrimentally affected by the cleaning chemical, should be removed or isolated.

b) A competent person should undertake the work, which involves the use of hazardous agents.

c) The chemical cleaning process will generate and dislodge a considerable amount of material. This should be removed by subsequent rinsing, flushing and neutralisation, followed by passivation.

d) The system should be drained as quickly as possible after cleaning, with particular attention to dead legs, to ensure complete removal of chemicals.

e) Closed systems system should be refilled immediately following the cleaning process with treated de-aerated water, to prevent rusting. Care should be taken to avoid the introduction of a biological burden (see clause 11.2.4).

f) Care should be taken with the disposal of all water used in the cleaning and flushing process, which must follow procedures acceptable to the Local Water Undertaking.

11.5 WATER TREATMENT

It will generally be necessary to protect the pipework installation against corrosion during its operating life by the introduction of a suitable inhibitor chemical into the water. This will be dependent upon the quality of the fill water and the mixture of metals employed in the works. Where chemical treatment is considered necessary, a suitable means of introduction needs to be provided. For closed system this may be in the form of a dosing pot. For open systems, where chemical dose rates are likely to be much higher, an automated chemical injection system is likely to be fitted.

Section 12 BIBLIOGRAPHY AND SOURCES

12.1 REFERENCES

HVCA PUBLICATIONS

HVCA TR/5, Welding of Carbon Steel Pipework

HVCA TR/6, Guide to Good Practice for Site Pressure Testing of Pipework

HVCA TR/11, Guide to the use of Plastic Pipework.

For Further Reading,
Copies available for purchase or via the Public Library

CIBSE PUBLICATIONS

CIBSE Guides

CIBSE Commissioning Codes

BRITISH STANDARDS

BS 10: Circular flanges for pipes, valves and fittings

BS 21: Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads.

BS 143 & BS 1256: Specification for malleable cast iron and cast copper alloy threaded pipe fittings.

BS 417: Specification for galvanised mild steel cisterns and covers, tanks and cylinders.

BS 499: Welding terms and symbols. Glossary for welding, brazing and thermal cutting

BS 864: Capillary and compression tube fittings of copper and copper alloy.
Part 2: Specification for capillary and compression fittings for copper tubes.

BS 1212: Specification for float operated valves (excluding floats).

BS 1387: Specification for screwed, socketed steel tubes, tubulars and for plain and steel tubes suitable for welding or for screwing to BS 21 pipe threads.

BS 1394: Specification for power driven circulators.

BS 1414: Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries

BS 1560: Circular flanges for pipes, valves and fittings (Class designated). Steel, cast iron

and copper alloy flanges. Specification for steel flanges

BS 1710: Specification for identification of pipelines and services.

BS 1723: Brazing, specification, guide and testing.

BS 1740: Specification for wrought steel pipe fittings.

BS 1873: Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries

BS 1965: Specification for butt-welding pipe fittings for pressure purposes.

BS 2633: Specification for Class I arc welding of ferritic steel pipework for carrying fluids

BS 2779: Specification for pipe threads for tubes and fittings where pressure-tight joints are not made on the threads (metric dimensions).

BS 2879: Specification for draining taps (screw-down pattern).

BS 2971: Specification for class II arc welding of carbon steel pipework for carrying fluids

BS 3505: Specification for unplasticised polyvinyl chloride (PVC-u) pressure pipes for cold water services.

BS 3974: Specification for pipe supports, pipe hangers, slide and roller type supports.

BS 4504: Specification for Flanges and bolting for pipes, valves and fittings. Metric series.

BS 4677: Specification for arc welding of austenitic stainless steel pipework

BS 4991: Specification for propylene copolymer pressure pipe.

BS 5154: Specification for copper alloy globe, globe stop and check, check and gate valves.

BS 5422: Specification for the use of thermal insulating materials.

BS 5970: Code of practice for thermal insulation of pipework and equipment.

BS 6282: Part1. Specification for check valves of nominal size, up to and including DN54.

BS 6351: Part3. Code of practice for the installation, testing and maintenance of electric surface heating systems.

BS 6700: Specification for design installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.

BS 6956: Jointing materials and compounds.

BS 7531: Specification for compressed non-asbestos fibre jointing

BS 7671: IEE wiring Regulations.

BS EN

BS EN 287: Approval testing for welders - fusion, for austenitic stainless steel

BS EN 287: Part 1 Approval testing for welders for fusion welding. - Steels

BS EN 545: Specification for ductile iron pipes and fittings.

BS EN 598: Specification for ductile iron pipes and fittings.

BS EN 751: Sealing materials for metallic threaded joints.

BS EN 969: Specification for ductile iron pipes and fittings.

BS EN 1057: Specification for copper and alloys for sanitary and heating.

BS EN 1092: Flanges and their joints.

BS EN 1254: Copper and copper alloys, compression plumbing fittings.

BS EN 10216: Seamless steel tubes for pressure purposes. Technical delivery conditions. Non-alloy steel tubes

BS EN 10217: Welded steel tubes for pressure purposes.

BS EN 10242: Threaded pipe fittings in malleable cast iron.

BS EN 10253: Butt-welding pipe fittings. Wrought carbon steel for general use and without specific inspection requirements

BS EN 29453: Soft solder alloys.

BS EN 60073: Basic and safety principles for man-machine interface, marking and identification, coding principles for indication devices and actuators.

BS EN ISO

BS EN ISO 15609: Specification & qualification of welding procedures, metallic materials - Gas

12.2 ABBREVIATIONS

BS	British Standard
BS EN	British publication of European Standard
BS EN ISO	British publication of International Standard
BSPT	British Standard Pipe Thread
BSRIA	Building Services Research and Information Association
CIBSE	Chartered Institution of Building Services Engineers
HVCA	Heating and Ventilating Contractors' Association

12.3 MISCELLANEOUS

Pressure Equipment Regulations (1999, SI 2001)
Pressure System Safety Regulations
Water Fittings and Materials Directory, the Water Research Centre.
BSRIA - Balancing Application Guide 1/79 - Manual for regulating water systems
BSRIA - Pre-commissioning Cleaning Application Guide AG 1/2001
Institute of Gas Engineers - IGE Utilisation Procedure UP1 and 2
HSE Guidance Note PMS, Automatically controlled steam and hot water boilers.
HSE Legionnaire's Disease ref. L8, Approved Code of Practice
IEC 144 refer to BS 5420
IEE Wiring Regulations - Regulations for Electrical Installations, sixteenth edition, by the Institution of Electrical Engineers, refer to BS 7671.
IP 54, refer to BS 4999.
IP 21 S, refer to BS 4999.

NOTE: The numbers of British Standards and other documents are those available at the date of this publication. It should also be noted that in a number of cases hybrid references are used for clarity, most are where standards are in a state of transitional change. Users should ensure that they consult the latest version. The full titles have not always been used.

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