

0751P AQUATHERM IN MECHANICAL PIPING

Branded worksection

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Worksection abstract

This worksection *Template* is applicable to piping, valves, fittings and accessories commonly used for mechanical systems including chilled, condenser and heating water, steam, condensate, and liquid fuels. It covers piping in a variety of materials including steel, copper and plastic, and includes valves, fittings, supports, and accessories. The worksection is based on AS 4041. The worksection also covers strainers and isolating, non-return, throttling, level control, pressure relief, air relief, and pressure-reducing valves. It does not include thermostatic, solenoid, motorised modulating, or refrigerant valves.

Guidance text

All text within these boxes is provided as guidance for developing this worksection and should not form part of the final specification. This *Guidance* text may be hidden or deleted from the document using the hidden text *Hide* and *Delete* functions of your word processing system. For additional information visit FAQs at www.natspec.com.au.

Optional style text

Text in this font (blue with a grey background) covers items specified less frequently. It is provided for incorporation into *Normal* style text where it is applicable to a project.

Related material located elsewhere in NATSPEC

Related material may be found in other worksections. See for example:

- *0721 Packaged air conditioning* also includes some refrigeration piping applicable to split systems.
- *0736 Space heating*.
- *0748 Chilled beams*.
- *0755 Medical gas systems*.
- *0812 Tapware* includes thermostatic mixing valves and plumbing tapware.
- *0815 Drinking water dispensers*.
- *0823 Cold and heated water* covers drinking water.
- *0824 Fuel gas* includes natural, LPG and similar fuel gases (but not laboratory or industrial type gases like acetylene).

Material not provided by AQUATHERM

This branded worksection *Template* includes generic material which may not be provided by the Product Partner including:

- Copper piping.
- Steel piping.
- Stainless steel piping.
- PVC piping.
- Valves.
- Steam separators, humidifiers and condensate pumps.
- Instruments, sensors and meters.

Documenting this and related work

You may document this and related work as follows:

- If specifying AQUATHERM blue pipe TI (Thermal Insulated), edit *0752 Mechanical piping insulation* so that there is no duplication.
- Note that the sizes of AQUATHERM pipe differ from those of metal pipes in common use in Australia.
- For AQUATHERM piping note that for a design life of 50 years, the maximum working temperature should be less than 75°C.
- For AQUATHERM piping note that for a design life of 25 years, the maximum working temperature should be less than 80°C.
- For AQUATHERM piping note that for a design life of 10 years, the maximum working temperature should be less than 90°C.

- Refer to AIRAH DA16 for water piping.
- General plant access requirements are included in **ACCESS FOR MAINTENANCE** in the *0171 General requirements* worksection. Make sure suitable plant access details for special or critical situations are included in the drawings.
- It is preferable to include piping schematics that show valving, demountable joints etc.
- This worksection contains text, including *Optional* style text, which may be changed to *Normal* style text for use in design and construct projects. See NATSPEC TECHreport TR 03 for information on specifying Design and Construct for mechanical services.

The *Normal* style text of this worksection may refer to items as being documented elsewhere in the contract documentation. Make sure they are documented.

Specifying ESD

The following may be specified by retaining default text:

- The AQUATHERM blue pipe system complies with the Environmental Product Declaration (EPD), verified by NSF Sustainability, a division of the not-for-profit, third party, global public health organization NSF International. Declaration Number EPD10069. Date of issue: 11th December 2015. Copy available from AQUATHERM.
- A Life Cycle Assessment (LCA) of polypropylene pressure pipe systems has been prepared by Thinkstep AG. Copy available from AQUATHERM.
- See the *Aquatherm environmental benefits at a glance* matrix for a full list of AQUATHERM ESD benefits. Copy available from AQUATHERM.
- Measures relating to commissioning to improve performance and reduce mechanical systems energy consumption.
- Durable components, particularly for corrosion resistance.

Refer to the NATSPEC TECHreport TR 01 on specifying ESD.

1 GENERAL

AQUATHERM, founded in 1973, is a German manufacturer of polypropylene (PP-R) pipe systems.

AQUATHERM's product range includes potable water, recycled water and mechanical and civil services, such as HVAC systems, compressed air and wet sprinkler pipe systems.

Annually, over 38,000 km of pipe (Ø16 - Ø630 mm) and over 40 million fittings are produced, stored and dispatched all over the world.

AQUATHERM has subsidiaries in Germany, Italy, England, USA and Canada and has more than 70 marketing partners around the world.

All Innovation, Engineering and Production remains in Germany.

1.1 RESPONSIBILITIES

General

Requirement: Provide mechanical piping, including AQUATHERM piping, as documented.

Documented is defined in *0171 General requirements* as meaning contained in the contract documents.

1.2 DESIGN

This worksection can be used to document the contractor's design and documentation responsibilities. If the design, or completion of the design, is not the responsibility of the contractor, delete this clause and associated requirements.

Refer to NATSPEC TECHreport TR 03 on specifying design and construct for mechanical services. It discusses some of the issues and presents a range of approaches for preparing design and construct specifications that can be applied more generally.

Design pressures

Design temperatures may also be a factor.

Design pressures: To AS 4041 but not less than the maximum hydrostatic head at the location, given the pump shut off head for the maximum impeller size for the pump casing.

AQUATHERM pipe: Conform to the AQUATHERM permissible working pressures. Design and install AQUATHERM pipe to AQUATHERM's design and installation guidelines.

AQUATHERM guidelines are available from AQUATHERM. Refer to **MANUFACTURER'S DOCUMENTS, Technical manuals.**

Piping system

Requirement: Provide piping systems complete with all necessary piping, valves, supports, guides, drains, vents, expansion compensation and all fittings necessary for their safe and efficient operation.

Design: Design mechanical piping systems, as documented.

The *Optional* text in this clause may be used when the contractor is to design and select the mechanical piping systems. Use *0701 Mechanical systems* to describe design parameters for mechanical systems, as a whole.

Selection parameters included in the **SELECTIONS** schedules should not be repeated here. The schedules' *Guidance text* includes suggestions for modification to suit design and construct projects.

Use the **Piping schedule** to define the piping systems required.

Piping design, application and calculations

Standards: Conform to the recommendations of one or more of the following:

- AIRAH Design Application Manuals.
- ASHRAE Handbooks.
- CIBSE Guides.

Methods of calculation: Manual or software that employs the data and methods in the applicable standard.

Documentation

This is a partial list of items only. Edit to suit the project. Drawings relating to whole systems should be included in *0701 Mechanical systems*.

Drawings: Show the following on the drawings:

- Piping schematics and layouts including demountable joints, valving, and instruments.
- Piping material and grade.
- Piping supports including means for handling hydraulic thrust.
- Provisions for system and component isolation.
- Details of removal provisions for insulation on items requiring regular maintenance.
- Details of weatherproofing for external piping.
- Details of protection for underground piping.

Valves and pipeline components for water systems

Complete to suit the project. The valve types are included in the respective **Water valve table**.

Requirement: Provide the following valves and pipeline components:

- Isolating valves: On both sides of each component requiring isolation including coils, pumps, heat exchangers, tanks chillers and boilers and at the following locations: [complete/delete]

List locations e.g. at branches to plant rooms, branches to floors.

- Non-return valves: On the discharge of pumps operating in parallel and in other locations required for safe and proper system operation.

List other locations to suit the project.

- Throttling and balancing valves: On the discharge of pumps, at each coil and other item of heat transfer equipment and in other locations required for safe and proper system operation.

List other locations to suit the project.

- Check valves: On the discharge of pumps operating in parallel and at other locations required for the safe and efficient operation of the system.

List other locations to suit the project.

- Strainers: On the suction side of pumps, before each automatic control valve and in other locations required for safe and proper system operation.

List other locations to suit the project.

- Level control valves: On the makeup water to cooling tower basins and tanks.

List locations.

- Pressure-reducing valves: [complete/delete]

List locations.

- Pressure relief valves: To statutory requirements.
- Vacuum breaker valves: [complete/delete]

List locations.

- Venting provisions: Conform to **DRAINS, VENTS AND GRADING**.
- Drains and drain valves: Conform to **DRAINS, VENTS AND GRADING**.
- Dial thermometers: [complete/delete]

List locations.

- Pressure gauges: [complete/delete]

List locations.

- Water flow measurement: [complete/delete]

List locations and type of device required (e.g. pitot type sensor or flow meter).

- Gauge valves: On each pressure gauge and at each point with provision for connecting a pressure gauge.
- Thermometer wells: Conform to **PROVISIONS FOR INSTRUMENTS**.
- Pressure tappings: Conform to **PROVISIONS FOR INSTRUMENTS**.
- Test plugs: Conform to **PROVISIONS FOR INSTRUMENTS**.

Valves and pipeline components for steam and condensate systems

Complete to suit the project. **Valves and pipeline components for water systems** may be used as a guide.

Requirement: Provide the following valves and pipeline components:

- [complete/delete]

Provide a list similar to that for water systems above.

Valves and pipeline components for liquid fuel systems

Complete to suit the project. **Valves and pipeline components for water systems** may be used as a guide.

Requirement: Provide the following valves and pipeline components:

- Automatic air vents: [complete/delete]
- Automatic control valves: Where required for the correct operation of steam using equipment.
- Ball float valves: [complete/delete]
- Combined sight glass and non-return valve: [complete/delete]
- High domestic hot water temperature cutout: [complete/delete]
- Isolating valves: [complete/delete]
- Non-return valves: [complete/delete]
- Pressure reducing valve sets: [complete/delete]
- Pressure relief valves: [complete/delete]
- Safety valves: [complete/delete]
- Steam humidifiers: [complete/delete]
- Steam operated condensate pumps: [complete/delete]
- Steam separators: [complete/delete]
- Steam traps: [complete/delete]
- Strainers: [complete/delete]
- Strainers: [complete/delete]
- Vacuum breaker valves: [complete/delete]
- [complete/delete]

1.3 COMPANY CONTACTS

AQUATHERM technical contacts

Website: www.aquatherm.com.au.

1.4 CROSS REFERENCES

General

Requirement: Conform to the following:

- 0171 General requirements.

0171 General requirements contains umbrella requirements for all building and services worksections.

List the worksections cross referenced by this worksection. 0171 General requirements references the 018 Common requirements subgroup of worksections. It is not necessary to repeat them here. However, you may also wish to direct the contractor to other worksections where there may be work that is closely associated with this work.

NATSPEC uses generic worksection titles, whether or not there are branded equivalents. If you use a branded worksection, change the cross reference here.

- 0701 Mechanical systems.

0701 Mechanical systems deals with matters common to more than one Mechanical worksection.

- 0752 Mechanical piping insulation.
- 0753 Water treatment.
- 0771 Automatic controls.

1.5 STANDARD

General

Standard: To AS 4041.

1.6 MANUFACTURER'S DOCUMENTS

Technical manuals

Website: www.aquatherm.com.au

Refer to the 'TECHNICAL' tab on the AQUATHERM homepage.

1.7 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- ABS: Acrylonitrile butadiene styrene.
- EPDM: Ethylene propylene diene monomer.
- PP-R: Polypropylene random copolymer.
- PTFE: Polytetrafluoroethylene.

Edit the **Abbreviations** subclause to suit the project or delete, if not required. List alphabetically.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Accuracy: The closeness of the agreement between the result of a measurement and the true value of the particular quantity being measured.
- Closed system: A water distribution or circulation system in which the water does not come into contact with air during circulation and to which, in normal operation, no water is added.
- Error: The measured value minus the true value of the particular quantity being measured.
- Open system: A water distribution or circulation system that is not a closed system.
- Resolution: The smallest difference between indications of a displaying device that can be meaningfully distinguished.

The term precision should not be used for accuracy. Resolution is also sometimes referred to as precision.

For a digital displaying device, resolution is the change in the indication when the least significant digit changes by one step. For analog devices resolution is usually the scale smallest division.

The distinction between accuracy and resolution is important. A digital thermometer may have a resolution of 0.1 K but an accuracy of only 1.0 K at the particular temperature, because of calibration drift, measurement method or for other reasons.

See also 0171 General requirements for the definition of tolerance.

Edit the **Definitions** subclause to suit the project or delete, if not required. List alphabetically.

1.8 SUBMISSIONS

Products and materials

State if certificates are required regarding valves or instruments and their compliance with specified standards, design pressures etc.

Calibrated balancing valves: For each type and size of valve, submit a manufacturer's calibration chart relating pressure drop to fluid flow across the valve opening range. Submit independent test reports giving accuracy and repeatability tolerances.

Automatic/dynamic system balancing valves: For each type and size of valve, submit a manufacturer's report verifying a flow rate control accuracy of $\pm 5\%$ or better is maintained over the selected pressure differential control range.

Tests

0171 General requirements covers tests in **Definitions** and calls for an inspection and testing plan under **SUBMISSIONS, Tests**.

Hydrostatic testing: Submit test results of completed installation.

Detail the tests required in **PRODUCTS** or **EXECUTION**, as appropriate, and list the submissions required here.

Subcontractors

Installer training: Submit evidence that persons installing AQUATHERM piping systems have received training from AQUATHERM.

AQUATHERM can offer training, free of charge, and can be conducted at their warehouse or on site.

Warranty

Requirement: Submit AQUATHERM's standard warranty on completion.

Contact AQUATHERM for details of warranty conditions.

2 PRODUCTS

2.1 GENERAL

Product substitution

Other products: Conform to **PRODUCTS, GENERAL, Substitutions** in 0171 General requirements.

The 0171 General requirements clause sets out the submissions required if the contractor proposes alternative products. Refer also to NATSPEC TECHnote GEN 006 for more information on proprietary specification.

Storage and handling

Requirement: Conform to *AQUATHERM PP-R Handling, transport & storage instructions*.

A copy of the document can be obtained from AQUATHERM.

2.2 AQUATHERM BLUE PIPE

AQUATHERM blue pipe is constructed from multi-layer, fibre reinforced, polypropylene ($\varnothing 20$ (OD) – $\varnothing 630$ mm (OD)) and has excellent resistance to corrosion.

AQUATHERM blue pipes have a very low internal pipe roughness (smooth bore), which results in a low pressure loss and therefore less energy loss and smaller pumps. AQUATHERM blue pipe is suitable for pressurised aerated water (e.g. condenser water) and non-aerated water (e.g. chilled and heating water) system and for gases including compressed air. AQUATHERM blue pipe is also suitable for vacuum applications. Consult AQUATHERM for pressure and temperature limits and chemical resistance. AQUATHERM blue pipe is also available in MF UV ultraviolet restraint grade.

General

Requirement: Provide AQUATHERM blue pipe MF, SDR7.4, SDR11 or SDR17.6, as documented.

Standards: To the ISO 21003 Series, ASTM F2389, DIN 8077 and DIN 8078.

Ring stiffness: SN16 tested to EN ISO 9969.

Locations exposed to sunlight: Provide AQUATHERM blue pipe MF UV.

Joining

Non-demountable joints: Conform to AQUATHERM fusion jointing recommendations. Provide socket fusion welding for AQUATHERM blue pipe sizes $\varnothing 20$ - $\varnothing 125$ mm and butt welding for AQUATHERM blue pipe sizes $\varnothing 160$ - $\varnothing 630$ mm.

Demountable joints: Select from:

- Welded AQUATHERM PP-R flange adapters: $\varnothing 32$ mm (DN 25) - $\varnothing 630$ mm (DN 600).

AQUATHERM flanges can be supplied for the OD pipe sizes $\varnothing 32$ mm (DN25) - $\varnothing 630$ mm (DN600).

- Fusion welded AQUATHERM PP-R screwed unions: $\leq \varnothing 75$ mm (DN 65).

- Fusion welded AQUATHERM PP-R / Brass transition fittings: ≤ DN 50 (2" BSP) Female and ≤ DN 100 (4" BSP) Male.
- Fusion welded AQUATHERM PP-R / Stainless steel transition fittings: ≤ DN 50 (2" BSP) Female and Male.

AQUATHERM PP-R flanges: Metal backed as follows:

- PN10 / PN16 to EN 1092-1, DIN 2501 drilled PP / steel (Ø32 mm (DN 25) - Ø400 mm (DN 400)).
- Steel epoxy coated (Ø450 mm (DN 500) - Ø630 mm (DN 600)).

Flange hardware: Provide galvanized steel bolts and nuts. In aggressive environments provide stainless steel bolts and nuts.

If environment is known, amend text above to suit. Nominate stainless steel bolts and nuts in aggressive environments.

Fittings

Requirement: Select from the following:

- Fusion welded AQUATHERM PP-R fittings.
- Fusion welded fittings fabricated from AQUATHERM PP-R pipe.

Construction:

- Injection moulded socket fusion fittings for AQUATHERM blue pipe sizes Ø20 - Ø125 mm.
- Injection moulded butt welded fittings for AQUATHERM blue pipe sizes Ø160 - Ø250 mm.
- Mechanically fabricated fittings for AQUATHERM blue pipe sizes Ø315 - Ø630 mm.

Expansion compensation

Requirement: Conform to AQUATHERM recommendations for expansion compensation, supports and guides.

2.3 AQUATHERM TI THERMALLY INSULATED PIPE

AQUATHERM TI blue pipe is intended primarily for buried applications. AQUATHERM TI consists of AQUATHERM blue pipe factory insulated with polyurethane and a PE outer casing. AQUATHERM TI has the advantages of AQUATHERM pipe and is suitable for conveying fluids such as chilled and heating water at temperatures between - 20°C and + 90°C.

When AQUATHERM TI blue pipe is buried in correctly designed trenches, no thrust blocks or provisions for expansion or contraction are required.

The AQUATHERM TI blue pipes have a low internal pipe roughness (smooth bore), which results in a reduced pressure loss and therefore reduced energy loss and smaller pumps.

If installing AQUATHERM TI within a building subject to the NCC, note that some sizes of AQUATHERM blue pipe TI (Thermal Insulated) have an R-Value less than the minimum NCC Deemed-To-Satisfy value required by BCA J5.8, for some temperature ranges. Consult AQUATHERM for values. If using sizes for temperature applications that do not meet the Deemed-To-Satisfy requirements of the NCC, conformance to the NCC performance requirements must be verified using one of the methods in BCA Section J. Alternatively, pipes of these sizes can be AQUATHERM blue with site applied insulation to *0752 Mechanical piping insulation*.

Pre-insulated pipe

Standards:

- AQUATHERM blue medium pipes (Ø32 - Ø355 mm): ISO 21003 Series, ASTM F2389, DIN 8077 and DIN 8078.
- Polyurethane (PUR): EN 253.
- Polyethylene (PE 80) casing pipes (Ø90 - Ø500 mm): DIN 8075.

Requirement: Provide AQUATHERM blue pipe SDR11/SDR17.6 MF TI.

Composition: AQUATHERM blue pipe with rigid polyurethane foam insulation and high density polyethylene outer casing.

Insulation R-Values: To AQUATHERM TI standard R-Values.

Note that for use above ground within buildings, some of the R-Values for AQUATHERM TI pipe sizes are less than the NCC Deemed-To-Satisfy requirements of BCA J5.8, for some water temperatures. Consult AQUATHERM for values. A performance solution to NCC with verification to BCA Section J, may be required.

Joining

Conform to AQUATHERM fusion joining recommendations. Provide socket fusion welding for AQUATHERM blue medium pipe sizes Ø32 - Ø125 mm and butt welding for AQUATHERM blue medium pipe sizes Ø160 – Ø355 mm.

Insulation

Insulation of AQUATHERM supplied fittings: Pre-insulated.

Insulation of joints: Insulate site joints to AQUATHERM recommendations.

AQUATHERM TI insulation sockets include preformed factory made PUR rigid foam insulation elements. No mixing of chemicals (Polyol and Isocyanate) in situ, is required.

Insulation of other components: To match the R-Value of the connecting pipe.

Fittings

Requirement: Conform to **AQUATHERM BLUE PIPE, Fittings**.

Expansion compensation

Requirement: Conform to AQUATHERM recommendations for expansion compensation, supports and guides.

2.4 COPPER PIPING

Copper is often preferred to steel for pipes less than DN 200 because of its lower labour cost despite its higher material cost.

Pipes

Standard: To AS 1432 Type B or as documented, hard drawn.

Document Type in the **Piping schedule**.

Type A may be required for high working pressure installations or where its thicker walls give greater corrosion resistance (e.g. some corrosive steam condensate). Type D may be adequate for low pressure open systems, e.g. condenser water.

Jointing

Edit to suit the project.

General: Select from the following except where a specific jointing method is documented:

- Silver brazed capillary joints (no size limitation).
- Brass flanges with brass nuts and bolts (no size limitation).
- Screwed brass unions: ≤ DN 50.
- Flare compression joints: ≤ DN 20 and only where no vibration occurs.
- Proprietary grooved joints (no size limitation).

It is preferable to show specific joint types (e.g. unions) on schematics or other drawings.

Fittings

Capillary fittings including adaptor capillary fittings with threaded ends or compression-type connector ends: To AS 3688, of copper or dezincification-resistant copper alloy.

Compression fittings including adaptor compression fittings with connector-ends for screwed or capillary joints: To AS 3688, flared type, of copper or dezincification-resistant copper alloy.

Unions: Bronze, proprietary manufacture, with ground or accurately machined face joints.

Flanges: Brazing metal to AS 2129. Expand pipes into flanges and braze.

Bends and tees: Provide sweep tees and long radius type bends.

Centreline radius of bend or tee branch: ≥ 1.5 times the pipe diameter.

Permanent joints

General: Provide brazed slip joints. Provide either capillary fittings, or expand one pipe over the other leaving a minimum clearance and an effective overlap.

Slip joint overlap table

Nominal pipe size, DN	Overlap (mm)
≥ 15, < 20	12
≥ 20, < 32	15
≥ 32, < 50	25
≥ 50, < 80	30
≥ 80, < 125	35
≥ 125, < 200	40

2.5 STEEL PIPING

Steel pipe for closed systems

Black steel pipe: If water in the system does not come into contact with the atmosphere while circulating, provide pipe to one of the following standards:

- AS 1074.
- EN 10216-1.
- EN 10217-1.
- API Spec 5L.
- ASTM A53/A53M.

Galvanized steel pipe: Medium to AS 1074 and hot-dip galvanized to AS/NZS 4792.

ASTM A53/A53M provides the following definitions of types of pipe:

- Type F – Furnace-butt-welded pipe, continuous welded; Pipe produced in continuous lengths from coiled skelp and subsequently cut into individual lengths, having its longitudinal butt joint forge welded by the mechanical pressure developed in rolling the hot-formed skelp through a set of round pass welded rolls.
- Type E – Electric-resistance-welded pipe: Pipe produced in individual lengths or in continuous lengths from coiled skelp and subsequently cut into individual lengths having a longitudinal butt joint wherein coalescence is produced by the heat obtained from resistance of the pipe to the flow of electric current in a circuit of which the pipe is a part, and by the application of pressure.
- Type S – Wrought steel seamless pipe: Wrought steel seamless pipe is a tubular product made without a welded seam. It is manufactured by hot working steel and, if necessary, by subsequently cold finishing the hot-worked tubular product to produce the desired shape, dimensions and properties.

Grades A and B refer to chemical composition. Grade A is recommended for close coiling or cold bending but Grade B is not precluded for cold bending.

Other terms in common use include:

- BW – Butt welded tubes: Tubes manufactured from hot or cold flat rolled strip, with a longitudinal seam and furnace butt welded by a continuous process.
- ERW – Electric resistance welded tubes: Tubes manufactured from hot or cold flat rolled strip, longitudinally welded continuously by the passage of an electric current across the abutting edges or along the edges before the closure under welding pressure without the addition of filler metal.
- S – Seamless tubes: Tubes manufactured by a seamless process, and hot finished or cold finished.
- SAW – Submerged arc welded tubes: Tubes manufactured from plate, sheet or strip with either a single or double longitudinal seam or a spiral seam and welded across the abutting edges by automatic submerged arc welding process using at least two runs, one of which is inside of the tubes.

For non-critical applications where corrosion is not a concern, steel pipe has traditionally been specified to AS 1074. This is manufactured by process variously known as continuous welded (CW), butt welded (BW) or electric resistance welded (ERW). In most cases the product is the same and is often branded as complying with several standards. The weld line is believed to be the principal source of corrosion in pipe of this kind. AS 4041 limits the application of CW and BW pipe in Table 1.5.

Pipe for aerated systems

General: If water in the system comes into contact with the atmosphere while circulating, provide seamless pipe, or welded pipe to API Spec 5L Grade B.

Where the potential for corrosion is a concern, and there is a need to use steel, consider standards other than those listed for closed systems. Consider also additional protection such as cathodic.

An alternative is to specify seamless pipe, which is not made in Australia. ASTM A53/A53M, ASTM A106/A106M and EN 10216-1 are among the many standards covering seamless pipe.

Jointing

General: Select from the following except where a specific joint method is documented:

- Black steel pipe:
 - . Butt welded.
 - . Welded-on flanges.
 - . Proprietary grooved joints.
- Galvanized steel pipe:
 - . Screwed and socketed up to 50 mm size.
 - . Galvanized screwed flanges.

- . Proprietary grooved joints.
- . Underground pipe: Welded and hot-dip galvanized after fabrication to AS/NZS 4680.

AS/NZS 4680 informative Appendix E covers additional paint protection for galvanizing.

Pipework galvanized before cutting threads: Paint exposed cut threads with cold galvanizing paint.

Fittings

Welded pipe: Butt weld fittings (e.g. bends and tees).

Bends and tees: Provide sweep tees and long radius type bends.

- Centreline radius of bend or tee branch: ≥ 1.5 times the pipe diameter.

Steel for fabricated pipe fittings: Same grade and wall thickness as the pipe.

Non-vertical lines: Eccentric reducing fittings installed to avoid gas binding, liquid retention or both.

Fittings for galvanized steel pipe:

- Centreline radius of bend or tee branch: ≥ 3 times the pipe diameter.
- Screwed fittings: To AS ISO 7.1.

2.6 STAINLESS STEEL PIPING

Pipes

General: Pipe to ASTM A312/A312M, or spiral butt welded from stainless steel sheet.

Type: 316L.

Wall thickness:

- Piping \leq DN 150: At least 1.6 mm.
- Piping $>$ DN 150, $<$ DN 305: At least 2 mm.

Outside diameter tolerance: ± 1.5 mm.

Jointing

General: Select from the following except where a specific jointing method is documented:

- Butt welded.
- Welded-on flanges.
- Proprietary grooved joints.

It's preferable to show specific joint types (e.g. unions) on schematics or other drawings.

Fittings

Material: Stainless steel of the same grade and wall thickness as the pipe.

Unions: Type 316 stainless steel, proprietary manufacture, with ground or accurately machined face joints.

Flanges: Angle face rings, galvanized steel backing flanges and reinforced neoprene gaskets.

Fabricate so that only stainless steel or the gasket material is in contact with the fluid within the pipe.

Bends and tees: Provide sweep tees and long radius type bends.

- Centreline radius of bend or tee branch: ≥ 1.5 times the pipe diameter.

Hardware: Provide stainless steel nuts bolts and washers of the same grade as the pipe.

Welding

General: Fully butt weld using gas tungsten arc welding process. Passivate joints after welding.

2.7 PVC PIPING

Oriented PVC (PVC-O) pipes are available in higher pressure ratings than unplasticised PVC (PVC-U).

AS/NZS 1477 contains dimensions for two size series of PVC pipes. Series 1 is for pipes in metric sizes and Series 2 is for pipes with sizes compatible with cast iron pipes and fittings. AS/NZS 4441 specifies requirements for PVC-O pipe for use below ground and above ground where not exposed to sunlight, and for operational temperatures below 45°C.

PVC pipe operating at temperatures above 20°C may require de-rating to AS/NZS 4441 Annex C.

Standards

Unplasticised pipes and fittings (PVC-U): To AS/NZS 1477.

Oriented PVC (PVC-O) pipes: To AS/NZS 4441.

Solvent cement: To AS 3879.

Installation

Standard: To AS/NZS 2032.

Jointing

Permanent joints: Solvent cement.

Demountable joints:

- Piping \leq DN 50: Threaded fittings.
- Piping $>$ DN 50: Flanges with backing rings.

Exposure to sunlight

Requirement: If exposed to sunlight, provide either UV protected pipe and fittings or paint with UV resistant paint.

See AS/NZS 1477. This is primarily applicable to imported pipe and fittings larger than DN 150.

2.8 VALVES AND FITTINGS – GENERAL**Components**

Valve size: Equal to the nominal pipe size, unless a smaller size is necessary for throttling purposes or flow measurement.

Insulated valves: Extended shafts or bodies to butterfly and ball valves to allow full thickness of insulation without restricting movement of hand-wheel or lever.

Automatic control valves: Conform to 0771 *Automatic controls*.

Connections:

- Valves \leq DN 50: Screwed to AS ISO 7.1.
- Valves $>$ DN 50 and valves in headers: Flanged to AS 2129.

Handwheels and handles: Removable, with the direction of closing marked permanently on handwheels.

Copper alloy valves: Dezincification resistant and stamped accordingly.

Valves for water circuits open to air including open condenser water circuits:

- Copper pipe: Body bronze for sizes \leq DN 50.
- Non-metallic pipe: As documented for the respective pipe material.

Installation

Valves: If practicable, install with the stem horizontal.

Non-return valves: Provide at least 6 pipe diameters of straight pipe on the upstream side.

Flow measuring valves: Install with pressure tapings accessible and to manufacturer's recommendations.

Valve identification

Valve identification can be valuable on large or complex systems with many valves. May be omitted for small and simple systems.

General: Tag all valves and flow measuring devices for identification purposes. Provide a circular brass disc attached to the valve by a stainless steel wire drawn through the holes in the disc on each valve provided with operating handwheel or lever stamp the valve identification mark on the disc in characters 10 mm high.

Valves without operating handwheels: Mark by aluminium or brass strap 20 mm wide by 90 mm long stamped in the same manner as the valve identification discs. Attach by wire to the body of the valves.

2.9 WATER VALVE TYPES**General**

Drinking water: To PCA B1 and PCA B2.

Non-drinking water below 99°C other than steam condensate: To the **Water valve table**.

Water valve table

The valve types below are typical only and require editing to suit each project.

Valve function	Valve type
Isolating valves \leq DN 50	Copper alloy gate, ball or diaphragm
Isolating valves \geq DN 65	Butterfly, cast iron gate or diaphragm

Valve function	Valve type
Non-return valves ≤ DN 50	Copper alloy lift or swing check
Non-return valves ≥ DN 65	Cast iron lift or swing check
Throttling or balancing valves ≤ DN 50	Copper alloy globe, needle or diaphragm
Throttling or balancing valves ≥ DN 65	Cast iron globe or diaphragm
Throttling or balancing valves (No size limitation)	Calibrated balancing
Level control valves ≤ DN 50	Copper alloy ball float
Level control valves ≥ DN 65	Cast iron ball float
Pressure relief valves ≤ DN 50	Copper alloy
Pressure relief valves ≥ DN 50	Cast iron
Strainer ≤ DN 50	Copper alloy
Strainer ≥ DN 65	Cast iron
Pressure reducing valves ≤ DN 50	Copper alloy
Pressure reducing valves ≥ DN 65	Cast iron
Automatic air vents ≤ DN 50	Copper alloy
Bleed valves ≤ DN 50	Ball
Gauge valves ≤ DN 50	Ball
Drain valves ≤ DN 50	Ball

2.10 WATER VALVES AND FITTINGS

Plastic ball valves etc. are also available.

Selection

Working pressure rating: Minimum 1.4 MPa and to suit the system pressure range.

Working temperature rating: To suit the system operating temperature range.

Valves for drinking water: To AS/NZS 3500.1.

Gate valves

For general isolation function. Should not be used for throttling.

Type: Straight-through flow, solid wedge type, inside screw design, medium pattern.

Standards:

- Bronze valves: To AS 1628.
- Flanged cast iron valves: To AS/NZS 2638.1 (metal seated) and AS/NZS 2638.1 (resilient seated).

AS 1628 also covers gate valves but only up to DN 100. AS/NZS 2638.1 only covers valves with a maximum operating temperature of 40°C.

Construction:

- Body:
 - . ≤ DN 80: Bronze.
 - . > DN 80: Cast iron.
- Disk: Bronze.
- Gland seal: PTFE.
- Seats: Integral seats for bronze valves, replaceable bronze seats for cast iron valves.

Ball valves

Type: Full bore pattern with handle parallel to the direction of flow when the valve is fully open.

Construction:

- Body: Bronze.
- Ball: Hard chromed brass.
- Gland seal: Adjustable.
- Seat: PTFE.

Reduced bore ball valves: Constructed as for full bore ball valves. May be used for drains, air vents and gauges.

For quick action (90° turn) isolating function consider including this *Optional* style text by changing to *Normal* style text.

Butterfly valves

For throttling and isolating functions.

Body type may be changed to standard un-tapped lug type, but the extra cost is small and tapped lugs permit dismantling pipe on one side of the valve without draining down the other.

Geared operators are specified for butterfly valves used for throttling and balancing. With the flow control characteristics of butterfly valves lever actuators are almost useless for accurate control of flow.

Disk fixing methods are specified. Secure fixing is required as disks that are only screwed to the shaft can shear off the screws if the seat material swells or foreign matter lodges between the seat and disk. Once this happens there may be no way of shutting down the system to fix the valve.

Type: Tapped lug type.

Standard: To EN 593.

Operation:

- ≤ DN 150: Positive locating operating bar, parallel to the disk with notched plate.
- > DN 150: Geared or motorised operator.
- All sizes used for throttling and balancing: Geared operators.

Construction:

- Body: Cast aluminium or cast iron.
- Shaft: Stainless steel.
- Disc: Bronze generally, stainless steel for condenser water systems. Disc fixing method: Select from the following:
 - . One-piece disc and shaft.
 - . Disc keyed and screwed to shaft.

Contractor to select type.

- Seat: Bonded EPDM selected for compatibility with the fluid and water treatment chemicals.

Adverse reaction between the seat and fluid may cause the seat to swell, preventing proper movement of the disc or full sealing.

Non-return valves

See AS 1628 Section 6 for swing and lift action limitation.

Flanged valves for water: To AS 4794.

Disc type:

- Body: Stainless steel or bronze.
- Disc and spring: Stainless steel.

Swing type: To AS 1628.

- Body: Bronze.
- Plates: Bronze or stainless steel.

Dual flap type:

- Body: Cast iron.
- Pin and spring: Stainless steel.
- Seat: Integral nitrile rubber.
- Plates: Bronze or stainless steel.

Globe valves

For flow regulation (throttling) and isolating functions. Proprietary valves are available combining throttling/isolating.

Type: Inside screw design.

Construction:

- Body:
 - . ≤ DN 50: Bronze.
 - . > DN 50: Steel.
- Stem and gland: Forged brass.

Calibrated balancing valves

Note tolerance requirements for calibrated balancing valves. Without this information the calibration is questionable and consequently any water balancing done using them is questionable.

Certificates are called for in **SUBMISSIONS**.

Type: Continuously adjustable graduated with a limit stop for precise setting of the maximum valve opening, a numeric indication of valve opening position and pressure tappings across the variable orifice.

Accuracy and repeatability errors: $\pm 5\%$ or better over the normal measuring range of the valve.

Handwheel scale resolution: $< 2.5\%$ of full scale.

Construction:

- Body:
 - . \leq DN 50: Dezincification resistant copper alloy of Brinell hardness > 130 .
 - . $>$ DN 50: Cast iron.
- Seat: PTFE.

Automatic/dynamic system balancing valves

Caution should be exercised if using these to control flow to coils fitted with two-way valves. The automatic balancing valves are intended to maintain constant flow whereas the two-way valves work by varying flow. One action therefore fights the other except at maximum system flow rates. The automatic balancing valve may reduce the control authority of the automatic control valve.

On a 2-way valve system, these valves maintain design peak flow but the action of the automatic/dynamic valve is contrary to that of the control valve at reduced flows. As the control valve shuts to reduce coil flow, the automatic/dynamic valve opens to maintain it. The automatic/dynamic valve, in effect, defeats the authority of the control valve over the coil. AIRAH DA24 reports the case of a control valve that disassembled itself because of the vibration caused by this effect.

Type: Pre-calibrated special purpose valve which automatically controls flow rate within $\pm 5\%$ tolerance, with an internal spring loaded cartridge control mechanism and external tappings for pressure and temperature.

Construction:

- Body: To suit the piping and fluid as documented.
- Cartridge: Passivated stainless steel, spring loaded type, incorporating a variable ported piston stamped with the manufacturer's identification number.

Pressure relief valves

Type: Direct acting, spring loaded with adjustable setting.

Standard: To AS 1271.

Construction:

- Body: Bronze or cast iron as documented.
- Valve disc and seat: Bronze.

Pressure reducing valves

Type: Self-actuated, spring loaded with adjustable setting.

Construction:

- Body: Bronze or cast iron as documented.
- Valve disc and seat: Bronze.

Ball float valves

Type: Copper or plastic float with stainless steel or copper alloy linkage.

Copper alloy valves: To AS 1910. Bronze body, needle and pins.

Cast iron valves: Cast iron body, bronze needle and pins.

Strainers

Selection: 15 kPa maximum pressure drop.

Construction:

- Body: Bronze or cast iron as documented.
- Screen: Stainless steel.

Specify size of mesh e.g. for rocks, sand.

Strainers > DN 65 diameter: Fit a 25 mm ball valve for blowdown.

Automatic air vents

Type: Float operated.

Construction:

- Body: Copper alloy.
- Float: Non-metallic or stainless steel.
- Seat: Stainless steel.

Vacuum breaker valves

Type: Ball valve operation.

Construction:

- Body: Copper alloy or stainless steel.
- Valve and seat: Stainless steel.

2.11 STEAM AND CONDENSATE VALVES AND FITTINGS

This clause is relevant to smaller systems and requires editing to suit large and/or high pressure systems.

General

Standard: To AS 1271.

Selection

Working pressure rating: Minimum 1.4 MPa and to suit the system pressure range.

Working temperature rating: To suit the system operating temperature range.

Limitations on size and type:

- Isolating valves:
 - . Ball valves: ≤ DN 50 cold water and cooled condensate pipe system.
 - . Gate valves: Cold water and cooled condensate pipe system.
 - . Globe valves: No limitations.

Ball valves

Type: Full bore pattern with handle parallel to the direction of flow when the valve is fully open.

Construction:

- Ball: Hard chromed brass.
- Body: Bronze.
- Gland seal: Adjustable.
- Seat: PTFE.

Reduced bore ball valves: Constructed as for full bore ball valves. May be used for drains, air vents and gauges.

Consider including this *Optional* style text by changing to *Normal* style text.

High domestic hot water temperature cutout

Type: Automatic high temperature cutout to stop steam flow to domestic hot water heating vessels.

Operation: Provide a temperature sensor in a sensor pocket in the domestic hot water heating vessel and connected to a spring loaded mechanism and manually reset cutout device coupled to a two port steam control valve.

Control valve: Install in the steam line to the domestic hot water heating vessel.

Capillary: Provide minimum length capillary tube between the sensor and the high limit cutout.

Non-return valves

Disc type:

- Body: Stainless steel or bronze.
- Disc and spring: Stainless steel.

Swing type:

- Body: Bronze or cast iron as documented.
- Plates: Bronze or stainless steel.

Combined sight glass and non-return valve

Body: Gun metal.

Valve: Stainless steel ball in copper discharge tube.

Sight: Toughened glass.

Globe valves

Type: Inside screw design.

Construction:

- Body:
 - . ≤ DN 50: Bronze.
 - . > DN 50: Steel.
- Stem and gland: Forged brass.

Pressure relief valves

Description: Direct acting, spring loaded with adjustable setting.

Standard: To AS 1271.

Construction:

- Body: Bronze or cast iron as documented.
- Valve disc and seat: Bronze.

Pressure reducing valve sets

Requirement: Provide pressure reducing valve sets consisting of:

- Pressure reducing valve: Pilot actuated, spring loaded, two port, balanced type with adjustable setting and construction as follows:
 - . Body: Bronze or cast iron as documented.
 - . Pilot and main diaphragm: Phosphor bronze or stainless steel.
 - . Trim: Stainless steel.
 - . Valve disc and seat: Stainless steel.
- On the high pressure side:
 - . 100 mm dial pressure gauge.
 - . Isolating valve.
 - . Steam strainer.
- On the low pressure side:
 - . Isolating valve.
 - . High lift relief valve with vent to atmosphere and drained to waste.
 - . 100 mm dial pressure gauge with the reduced pressure set point marked in red inside the case.

Ball float valves

Type: Copper or plastic float with stainless steel or copper linkage.

Copper alloy: To AS 1910. Bronze body, needle and pins.

Cast iron: Cast iron body, bronze needle and pins.

Safety valves

Type: High lift pop type safety valves fitted with appropriate spring range and sized to pass the full capacity of the system it is protecting.

Vent piping size: The greater of:

- Valve outlet size.
- Larger size required to eliminate back pressure on the valve.

Installation: Install vent piping so as not to stress the valve body and pipe to a safe location.

Steam traps

Description: Inverted bucket with integral strainer.

Other trap types may be preferable for some situations.

Construction:

- Body: Cast iron.
- Seat: Stainless steel.
- Strainers: Stainless steel.

Strainers

Selection: 15 kPa maximum pressure drop.

Construction:

- Body: Bronze or cast iron as documented.
- Screen: Stainless steel.

Strainers > DN 65: Fit a 25 mm ball valve for blowdown.

Automatic air vents

Type: Float operated or thermostatic type selected to suit the application.

Construction:

- Body: Copper alloy.
- Float: Non-metallic or stainless steel.
- Seat: Stainless steel.

Vacuum breaker valves

Type: Ball valve operation.

Construction:

- Body: Copper alloy or stainless steel.
- Valve and seat: Stainless steel.

2.12 STEAM SEPARATORS

Consider whether these are needed.

Steam quality is critical for some applications e.g. pre-vacuum sterilisers (but to a lesser extent with downward displacement sterilisers). The diffuser-vortex type of separator is much more efficient (and costly) than the baffle type.

General

Requirement: Provide steam separators at the following locations and as documented:

- At the main steam header: Baffle type.
- At pre-vacuum sterilisers: Diffuser-vortex type.

Baffle type

Type: Free moisture removed by impingement on internal baffles.

Efficiency: > 70% of entering particulates and mist at 30 m/s entering velocity.

Construction: Cast iron.

Diffuser-vortex type

Type: Three stage diffuser-vortex type consisting of a first stage expansion (decreased velocity) separation, second stage with abrupt direction change and centrifugal flow and third stage with vortex separation.

Efficiency: > 95% of entering particulates and mist at 30 m/s entering velocity.

Size: Provide separators selected for an entering velocity of 25 to 35 m/s at required maximum flow rate.

Construction: Fabricated mild steel.

2.13 STEAM HUMIDIFIERS**General**

Type: Direct injection duct mounted steam humidifier complete with steam control valve, steam separator, steam trap and drain.

Construction

Separator: Stainless steel.

Steam lance: Stainless steel.

2.14 STEAM OPERATED CONDENSATE PUMPS**General**

Type: Self-contained pumps suitable for the duty complete with the necessary steam and condensate piping and fittings and vents.

Installation: To manufacturers recommendations. Provide flow counter with each pump.

2.15 LIQUID FUEL VALVE TYPES

See 0754 *Liquid fuels* for discussion of materials. Copper and zinc (including galvanized steel) are not recommended for systems with steel underground tanks or serving diesel engines.

The valve types below are typical only and require editing to suit each project.

Liquid fuel valve table

Function	Valve type
Isolating valves ≤ DN 50	Copper alloy gate, ball or diaphragm
Isolating valves ≥ DN 65	Cast iron gate or diaphragm
Non-return valves ≤ DN 50	Copper alloy lift or swing check
Non-return valves ≥ DN 65	Cast iron lift or swing check
Throttling valves ≤ DN 50	Copper alloy needle
Throttling valves ≥ DN 65	Cast iron globe or diaphragm
Throttling valves ≤ DN 100	Copper alloy globe or diaphragm
Strainer ≤ DN 50	Copper alloy
Strainer ≥ DN 65	Cast iron

2.16 LIQUID FUEL VALVES AND FITTINGS

Standard

Underground petroleum storage systems: To AS 4897.

Selection

Pressure rating: Minimum 1.4 MPa and to suit system pressure range.

Temperature rating: To suit the system operating temperature range.

Gate valves

Type: Straight-through flow, solid wedge type, inside screw design, medium pattern.

Standards:

- Bronze valves: To AS 1628.

Construction:

- Body:
 - . ≤ DN 80: Bronze.
 - . > DN 80: Cast iron.
- Seats: Integral seats for bronze valves, replaceable bronze seats for cast iron valves.

Ball valves

Type: Full bore pattern with handle parallel to the direction of flow when the valve is fully open.

Construction:

- Body: Bronze.
- Ball: Hard chromed brass.
- Gland seal: Adjustable.
- Seat: PTFE.

Reduced bore ball valves: Constructed as for full bore ball valves. May be used for drains, air vents and gauges.

Consider including this *Optional* style text by changing to *Normal* style text.

Non-return valves

Swing type: To AS 1628.

- Body: Bronze to AS 1628.
- Plates: Bronze or stainless steel.

Dual flap type:

- Body: Cast iron.
- Pin and spring: Stainless steel.
- Seat: Integral nitrile rubber.

- Plates: Bronze or stainless steel.

Globe valves

Type: Inside screw design.

Construction:

- Body:
 - . ≤ DN 50: Bronze.
 - . > DN 50: Cast iron.
- Stem and gland: Forged brass.

Pressure relief valves

Description: Direct acting, spring loaded with adjustable setting.

Standard: To AS 1271.

Construction:

- Body: Bronze or cast iron.
- Valve disc and seat: Bronze.

Strainers

Selection: 15 kPa maximum pressure drop.

Construction:

- Body: Bronze or cast iron.
- Screen: Stainless steel.

Specify mesh size.

2.17 PRESSURE GAUGES

General

Standard: Bourdon tube type to AS 1349.

Scale range: Full scale between 130% and 200% of maximum working pressure.

Construction:

- Case: Glass filled nylon. Minimum diameter 100 mm.
- Lens: UV stabilised polycarbonate.
- Dial: UV stabilised polycarbonate.
- Indicating pointer: Adjustable.
- Configuration: Direct mounting, bottom entry.
- Bourdon tube material: Stainless steel for hot water systems. Phosphor bronze for other services.

Installation

Mounting: Mount gauges vertically and in locations free from vibration.

Gauge cocks: Provide gauge line connection cocks.

Pressure fluctuations: If necessary, eliminate needle fluctuations caused by pressure fluctuations, by either of the following:

- An orifice or restrictor.
- A capillary tube pressure pulse damper.

Pressure gauge connections: For gauges not permanently connected, seal outlets of isolating valves with flared seal cap nuts.

e.g. gauges at commissioning connections.

2.18 THERMOMETERS

Dial thermometers

Type: Mercury in steel.

Accuracy: Within ± 1% of full scale deflection or better.

Construction:

- Case: Glass filled nylon. Minimum diameter 100 mm.
- Lens: UV stabilised polycarbonate.

- Dial: UV stabilised polycarbonate.
- Indicating pointer: Adjustable.
- Bulb: Stainless steel Type 36.
- Configuration: Direct mounting, bottom entry.

Installation: Install thermometers vertically, in locations free from vibration, with the bulb in a thermometer well.

2.19 SENSING POINTS

Test plugs

Selection: Suitable for the service fluid and up to the maximum system pressures and temperatures.

Material: Machined brass hexagon body with norel synthetic rubber cores and gasketed brass hexagon screw cap.

Installation: Screwed into sockets welded to pipes and extended above insulation.

Thermometer pockets

Arrangement: Arrange for use with glass stem thermometers. Locate so thermometer bulb or sensing tip is close to the centre of the pipe.

Construction: Use the same material as the pipe. Weld or braze to pipes. Fill pockets with conductive medium.

Length: Extended above insulation.

Pipe enlargement: If thermometer pocket would otherwise decrease the pipe cross sectional area by more than 25%, provide a length of larger diameter pipe to mount the pocket.

Thermometer wells

Type: Stainless steel, separable type that enable the sensing element to be withdrawn without draining the system.

Installation: Screw wells into a boss welded to the pipe, to suit the installed sensing element and extended above insulation. Fill wells with conductive medium.

2.20 WATER FLOW MEASUREMENT

For other measurement devices refer to ISO 5167-1, ISO 5167-2, ISO 5167-3, ISO 5167-4 and ISO 5167-5.

Pitot tube low loss type sensors are specified below and are commonly known as Annubars (trade name). They require less straight pipe and have much lower pressure drop than orifice plates but length of straight before and after as specified by the manufacturer is still critical to achieving their accuracy.

Pitot type sensors

Type: Low loss pitot type averaging sensor, with 2 flared isolating valves for connection of pressure lines.

Material: Stainless steel.

Installation: Conform to the manufacturer's recommendation for installation, connection and valving. Provide manufacturers recommended straight lengths of pipe upstream and downstream of tapping point. Mount in the piping using an adaptor bushing and welding boss.

Accuracy: Within $\pm 1.5\%$ over the range of flow anticipated.

This is a typical value and is affected by the turn down ratio.

Stability: Within $\pm 0.125\%$ over five years.

Repeatability: $\pm 0.1\%$.

These are typical values. Consult manufacturer's data.

Marking: Provide a stamped tag showing normal, maximum and minimum flows, pipe size, serial number and related data.

Flow meters

General: Graduated meters incorporating variable pulsation dampening control, integral equalising valve, 2 bleed valves, and a direct reading scale linear to flow rate. Provide nylon connecting hoses suitable for a pressure of 1030 kPa.

Connecting hoses are also available in other materials.

Function: To read directly the flow rate in the pipe with a scale appropriate to the expected flow rate.

3 EXECUTION

3.1 INSTALLATION

General

Requirement: Install piping in straight lines at uniform grades with no sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

Layout: Follow the line of walls, ceilings, etc., and include all necessary offsets and arrange to avoid interference with the building or other services.

Arrangement: Arrange and support piping so that it remains free from vibrations whilst permitting necessary movements. Minimise the number of joints.

Spacing: Provide at least 50 mm clear between pipes, flanges, unions and couplings and between these and building elements, additional to insulation.

This clearance is recommended by BSRIA TN 10/92. See BSRIA TN 10/92 for more details.

Dissimilar metals: Join dissimilar metals with fittings of electrolytically compatible material and as follows:

- Flanges: Provide insulating flange kit.
- Proprietary grooved piping systems: Provide proprietary thermoplastic lined dielectric isolating fitting.

AQUATHERM pipes: Install to AQUATHERM installation guidelines including provision of AQUATHERM propriety clipping or other as recommended by AQUATHERM.

AQUATHERM guidelines are available from AQUATHERM. Refer to **MANUFACTURER'S DOCUMENTS, Technical manuals.**

Connections

Requirement: Arrange connections to plant to permit dismantling of the plant without disturbing other pipes and to permit removal of the plant without cutting or removal of the piping, or cutting or damaging building elements. Provide union on at least one side of each screwed valve and screwed pipeline component requiring removal for inspection or maintenance. Make all connections to plant by one of the following methods:

- Flare compression joints (up to 20 mm copper and only where there is no vibration).
- Screwed brass unions (up to 50 mm size and for pressures up to 800 kPa).
- Bolted flanges (no size limitation).
- Proprietary grooved joints (no size limitation).

0171 General requirements **SERVICES INSTALLATION, Piping** prohibits the embedding of pipes that operate under pressure in concrete or surfacing material. If embedding is to be permitted the instructions to that clause provide some alternative text.

Hydraulic separation of components

Requirement: Install pipeline components to manufacturers recommendations and the following:

The following are typical values recommended by pump and valve manufacturers.

- Pump discharge to check valve: ≥ 5 diameters of straight pipe. The flexible connection (if used) and reducer (if used) may be included in calculating this length.
- Before pump suction: ≥ 5 diameters of straight pipe. The flexible connection (if used) and reducer (if used) may be included in calculating this length.

Accessibility

General: To **ACCESS FOR MAINTENANCE** in 0171 General requirements.

3.2 CLEANING

External preparation

General: Remove scale, rust, burrs and grease and make sure that surfaces are clean and dry.

Protection: During construction, prevent the entry of foreign matter into the piping system by temporarily sealing the open ends of pipes and valves with purpose-made covers of pressed steel or rigid plastic.

3.3 SUPPORTS

Support systems

General: Provide hangers, brackets, saddles, clips, and support system components, incorporating provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on adjacent pipes or transmitted to them during operation and maintenance.

Support type: Proprietary metallic-coated steel channel section with clamps and hangers sized to match external diameter of pipe being supported.

Vertical pipes: Provide anchors and guides to maintain long pipes in position, and supports to balance the mass of the pipe and its contents.

Saddles: Saddle type supports may only be used for pipes no more than DN 25.

Dissimilar metals: If pipe and support materials are dissimilar, provide industrial grade electrically non-conductive material securely bonded to the pipe to separate them. Provide fixings of electrolytically compatible material.

Uninsulated pipes: Clamp piping supports directly to pipes, subject to electrical isolation of dissimilar metals.

Insulated pipes:

- Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20 mm.
- Spacer material: Rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.

The temperature limit for cork insulation is 90°C so it may not be suitable for some hot pipes despite this being a common practice. Alternatives to cork include high density (> 100 kg/m³) polyurethane and phenolic foam as well as glass wool, rock wool and polyester.

- Vapour barriers: For cold pipes, apply aluminium foil tape over the circumference of the spacer to form a vapour barrier. Fit to spacer before installation of the bracket on the pipe.
- Metal sheathing: Provide a 0.55 mm thick metallic-coated steel band between the aluminium foil tape and the support for the full width of the spacer.

Coordinate vapour barriers and metal sheathing with *0752 Mechanical piping insulation*. For cold pipes the vapour barrier (and metal sheathing if documented) allows the pipe insulator to continue the metal sheathing and vapour barrier respectively, without having to remove the support bracket.

Support spacing

Pipe support spacing requirements vary considerably from application to application. For more information see NATSPEC TECHnote DES 019.

See AS 4041 Table 3.28.2 for spacing of steel pipe supports. See also AS/NZS 5601.1 Table 5.5, for gas pipe support spacing, which also conflicts (more conservative).

Ferrous pipes: To AS 4041 Table 3.28.2.

Copper pipes: To AS 4809 Table 6.2.

AQUATHERM pipes: To AQUATHERM recommended temperature related support spacing.

Other non-ferrous pipe: To AS/NZS 3500.1 Table 5.6.4.

Proprietary grooved jointing systems: Provide a support within 1 m of each coupling.

Hanger size table

Outside diameter of pipe or sheathing (mm)	Minimum hanger diameter (mm): Light series	Minimum hanger diameter (mm): Heavy series
< 20	6	6
≥ 20, < 35	10	10
≥ 35, < 65	12	12
≥ 65, < 120	12	16
≥ 120, < 220	16	16
≥ 220, < 275	16	20
≥ 275, < 325	20	24
≥ 325, < 410	24	30

Delete if conflict with selected proprietary system. For gas pipes, see AS/NZS 5601.1 Table 5.5.

3.4 FLEXIBILITY

See 0171 *General requirements* **VIBRATION SUPPRESSION** for vibration isolation. For proprietary devices e.g. articulated or axial bellows or ball joints, show on the drawings.

Where the strength of existing structures is deemed insufficient to support an anchor capable of resisting the force exerted through thermal expansion of a particular pipe, the technique of cold springing or cold drawing (i.e. pretensioning the pipe at ambient temperature) may be used to lessen the force exerted by the pipe in the working condition. Alternatively, suitable expansion bellows may be used if held and guided in accordance with the manufacturer's instructions. Bellows used in bending impose less load on anchors than bellows in compression.

Coordinate design of supports with the structural engineer.

General

Requirement: Pipe anchors, offsets or expansion devices and pipe guides to accommodate expansion and contraction, and to minimise the transmission vibration and noise to building structures.

Anchors and guides: Locate anchors and guides at equal distances on each side of expansion devices. Weld or securely clamp anchors to bare pipe. If limitations in the strength of structures prevent the use of expansion devices and anchors, arrange piping to move in lateral and linear directions (e.g. at bends) while not deviating from gradients.

Flexible connections

General: Minimise the transmission of vibration and noise through the piping. Isolate vibrating sources as follows:

- Connections to major plant items: Reinforced rubber type, spherical shape with flanged ends.
- Elsewhere: Flexible reinforced nylon hose.

Alternative: If the piping system uses proprietary grooved joints, the vibration isolation required above may be omitted if the grooved joint system provides not less than the equivalent isolation.

3.5 SLEEVES

See also **BUILDING PENETRATIONS** in 0171 *General requirements*.

General

AQUATHERM pipes: Provide sleeves to AQUATHERM's recommendations.

Location: Provide sleeves that permit normal pipe movement through walls, floors, and other building elements.

Cover plates

General: Where exposed to view provide cover plates fixed to the pipe or insulation sheathing and free to move with respect to sleeve and building surface.

Material: Non-ferrous metal, finished to match the pipe, or of stainless steel, close fitting and firmly fixed in place.

Cover plate sizes table

Nominal pipe size, DN	Cover plate diameter
< 20	65 mm
≥ 20, < 50	100 mm
≥ 50	50 mm larger than pipe

3.6 JOINTS

General

Requirement: Minimise the number of joints. If practicable, provide welded or brazed joints or a proprietary pipe coupling system.

Jointing AQUATHERM pipe

AQUATHERM blue pipes: To **AQUATHERM BLUE PIPE, Jointing**.

AQUATHERM TI pipes: To **AQUATHERM TI THERMALLY INSULATED PIPE, Jointing**.

Training: Use only installation personnel trained by AQUATHERM.

AQUATHERM can offer training, free of charge, and can be conducted at their warehouse or on site. After satisfactorily completing training, trainees will be provided a personal (non-transferrable) AQUATHERM Installers Certificate, valid for two years.

Demountable joints

Show where required on the drawings.

Requirement: Locate as follows:

- At connections to mechanically cleanable heat transfer vessels and pumps.
- At maintenance locations.

Pipes \geq DN 65: Flanges or proprietary grooved joint.

Flanged joints

Metal flanges: Full face flanges with undistorted machined joint faces, to AS 2129.

Minimum flange thickness: 12 mm.

Bolting: To AS 2129 Appendix C and AS 2528.

- Material:
 - . Corrosive environments: Material with equivalent corrosion resistance to, and compatible with, the flanges.
 - . Non-corrosive environments: Zinc-plated steel.

Avoid cadmium plating due to its toxicity.

Flange jointing material: Preformed proprietary type at least 0.8 mm thick.

Installation: Install flanges square with the run of pipe and aligned parallel to each other. Do not correct misalignment by bolting.

Screwed joints

General: To AS ISO 7.1. Do not provide long screws or barrel nipples. Seal threads of screwed connections with degreased PTFE tape or a thread sealing compound.

3.7 DRAINS, VENTS AND GRADING

Preferably show types and locations on the drawings.

Drains

Water systems: Provide dirt pockets with valved drains to the bottom of riser piping and as necessary to drain liquids completely from piping and permit cleaning. To permit access to the full bore of the pipe for cleaning, provide a blank flange or screwed cap at the bottom of the dirt pocket matching the jointing system and pipe size on the rest of the piping.

Open piping systems: Arrange piping and equipment including drain lines so that the system can be fully drained with no undrainable (dead) sections except traps.

This is required by AS/NZS 3666.1 clause 4.7.

Other drains: Provide drains to drip trays, automatic air vents and equipment requiring routine draining.

Drain size: \geq DN 20 and to the **Drain size table** or to match the equipment drain size, if larger.

Drain points: Pipe drains to discharge points via air breaks.

Air inlet points for draining systems: Provide vents for admitting air at high points in the system.

Drain size table

Nominal size of pipe to be drained, DN	Nominal size of drain and valve, DN (minimum)
> 50, \leq 100	20
> 100, \leq 150	25
> 150, \leq 300	32
> 300	50

Air release vents

Preferable show types e.g. vent pipe, valve, air bottle, on the drawings.

Vent type: Provide manual vents except where automatic vents are existing.

Location: Provide 15 mm minimum size air release vents at the following locations in water systems:

- High points of the system.
- Sections of the piping in which air may collect.
- Upstream from each item of heat exchange equipment.

Water system risers: Provide a 150 mm high riser set vertically from the pipe and fabricated from the same diameter and material as the pipe. Provide an automatic air vent at the top of the riser.

Grading

Water systems: Grade to rise in the direction of flow to points of air venting, except where the water piping is exposed in a run with other services, in which case run the water piping to the same grade as the other services.

- Minimum grade: 1 in 200.

Show gradients on drawings.

3.8 PROVISIONS FOR INSTRUMENTS

Location

Expand to suit project or detail on drawings.

Test plugs: Provide in each pipe connection to every heat exchanging device and at other locations documented.

Thermometer wells: Provide for each pipe mounted temperature sensor.

Pressure tappings: Provide test plugs or valved tappings at each pump, automatic control valve and wherever else shown on the drawings.

3.9 UNDERGROUND PIPING

Check statutory requirements for pipes outside the property.

It may be necessary to specify a method for marking the type, location and direction of concealed piping e.g. (for underground lines) engraved brass plates set in concrete blocks at ground level.

Installation

AQUATHERM pipes: Conform to AQUATHERM's installation recommendations including AQUATHERM TI installation and trench detail guidelines.

AQUATHERM guidelines are available from AQUATHERM. Refer to **MANUFACTURER'S DOCUMENTS, Technical manuals.**

Pipe underlay: Bed piping on a continuous underlay of bedding material, at least 75 mm thick after compaction. Grade the underlay evenly to the gradient of the piping.

Bedding material: Sand free from material retained on a 13.2 mm sieve.

Chases: If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom or underlay.

Other services: Separate underground piping from electrical cables and other services by at least 300 mm.

Pipe surrounds

General: Place the material in the pipe surround in layers less than 200 mm loose thickness and compact without damaging or displacing the piping.

Protection: Lay continuously concrete tiles more than 25 mm thick, or PVC tape at least 3 mm thick, in the overlay, 50 to 75 mm clear of the piping, for the length of the piping.

Warning tape: During backfilling lay plastic warning tape 300 mm above buried piping, for the full length of the piping.

- Type: Minimum 100 mm width.

Valves

Requirement: Install in underground control boxes.

Corrosion protection of underground black steel pipe

Delete this subclause if installing AQUATHERM pipe underground.

Protection: Either encase metal piping in continuous PVC-U watertight pipe or provide continuous wrapping over all pipe and fittings using proprietary petroleum taping material installed in accordance with manufacturer's recommendations.

See also **CORROSION RESISTANCE** in 0171 General requirements.

Petroleum taping

This is not required for buried AQUATHERM pipe.

For proprietary petroleum taping material, (e.g. Denso), typical installation may be documented by changing this *Optional* style text to *Normal* style text.

Application: Thoroughly clean and Prime the pipe, then cover fittings and joints with petroleum based mastic. Wrap the pipe and fittings with petroleum based tape to provide a continuous barrier to prevent ingress of water. Provide 50% minimum overlap of tape.

Irregular profiles: If necessary, contour irregular profiles such as weld beads, shoulders, boltheads, nuts and the like with proprietary, petroleum-based corrosion protective mastic strip.

Inspection: On completion, have the treatment system inspected by the manufacturer and submit evidence of the manufacturer's approval.

3.10 STEAM SERVICES

Layout

Branches: Connect branches to the top of steam mains.

Steam lines: Grade in the direction of the flow, fit with separators, drain pockets and steam traps.

Pockets: Provide pockets complete with automatic thermostatic air vents and steam traps at the end of steam mains. Fit automatic thermostatic air vents at the high points of steam lines.

Condensate

Steam traps: Provide steam traps to drain condensate from all lines, low points and at intervals of less than 50 m in horizontal runs.

Piping: Pipe condensate from all steam consuming equipment and collection points into the condensate system.

Pipe sizing: Size condensate lines to minimise the back pressure in steam traps caused by flash steam.

Connections: Connect condensate risers from lifting traps and condensate pumps to the top of the return mains.

Steam trap performance monitoring system

Requirement: Provide a proprietary steam trap performance monitoring system consisting of:

- Sensor to each steam trap in the system.
- Steel sensor chambers in the pipework systems as necessary to monitor the correct operation of the steam system.
- Waterlogging sensors in each sensor chamber.
- Monitoring panels for the performance monitoring of steam traps installed in the system.
- Cabling from each sensor to the monitoring panel and all other items required to complete the system.

BMS connection: Connect each monitoring panel to the building management system.

Specify the required BMS points and types.

3.11 TESTING

Completion tests

Cold water: To AS/NZS 3500.1 Section 18.

Wastewater: To AS/NZS 3500.2 Section 15.

Pressure piping as defined by AS 4041: Hydrostatic test.

AQUATHERM pipe: In addition to AS 4041 hydrostatic tests, conform to AQUATHERM pressure test procedures and recommendations. Complete AQUATHERM pressure test records as part of testing documentation.

Completion of AQUATHERM test records is a condition of AQUATHERM's warranty.

AQUATHERM guidelines are available from AQUATHERM. Refer to **MANUFACTURER'S DOCUMENTS, Technical manuals.**

Condensate drains from cooling coils: Hydrostatic testing is not required.

Although exempt from hydrostatic testing, drain integrity testing is required in the respective plant worksections e.g. 0721 Packaged air conditioning and 0724 Air handling plant – combined.

Hydrostatic testing

Preparation for testing: Isolate items of equipment not designed to withstand test pressures. Leave pipe joints exposed to enable observation during tests. Secure pipes and fittings in position to prevent movement during tests. Restrain expansion bellows.

Water pretreatment: Conform to 0753 Water treatment. For steel piping, introduce corrosion inhibiting chemicals. Use chemicals from a water treatment specialist in conformance with the specialist's instructions and under the specialist's supervision. Leave pre-treated water in the system until the system is ready for chemical cleaning and flushing.

Coordinate with 0753 Water treatment. This paragraph is intended to complement the corresponding clause in 0753 Water treatment, and assumes certain contractual demarcations.

Procedure: Test completed piping systems including equipment designed to withstand test pressures. Isolate equipment not designed to withstand the test pressure.

Test criteria: No leaks or loss of pressure over the test period after taking account of changes in ambient temperature.

Test pressures: To AS 4041.

AS 4041 includes in its definition of pressure piping a wide range of systems including fuel oil, low pressure gases and compressed air over 70 kPa. Consider extending hydrostatic testing to include systems not covered by AS 4041, and the PCA, such as vacuum piping and low pressure compressed air piping.

3.12 AQUATHERM WARRANTY

General

Requirement: Complete the installation of AQUATHERM and AQUATHERM TI piping to AQUATHERM recommendations and complete AQUATHERM pressure test records as part of testing documentation to provide AQUATHERM's standard ten year warranty on the pipe system.

Warranty conditions can be provided by AQUATHERM.

4 SELECTIONS

Schedules are a way of documenting a selection of proprietary or generic products or systems by their properties. Indicate their locations here and/or on the drawings. Refer to NATSPEC TECHnote GEN 024 for guidance on using and editing schedules.

4.1 PIPING

Piping schedule

Property	P1	P2	P3
Material			
Class			

Property: Replace P1, P2, P3 with service, e.g. Chilled water, Buried chilled water, Heating water, Buried heating water, Condenser water, Compressed air, Cooling coil drains, Liquid fuel, Steam, Steam Condensate.

Material: e.g. AQUATHERM, AQUATHERM TI, Copper, Steel, Stainless steel, PVC.

AQUATHERM blue pipe can be used for brine, glycol, condensate drains, compressed air, specific (non-medical) gasses and vacuum systems.

AQUATHERM blue pipe SDR7.4/SDR11 MF (Ø20 - Ø450 mm) can be used for above ground chilled water, above ground condenser water and above ground heating water.

AQUATHERM blue pipe SDR17.6 MF (Ø125 - Ø630 mm) can be used for above ground chilled water.

AQUATHERM blue pipe SDR7.4/SDR11 MF TI (Ø32 - Ø355 mm) can be used for buried chilled water, buried condenser water and buried heating water, subject to temperature limitations.

AQUATHERM blue pipe SDR17.6 MF TI (Ø125 - Ø355 mm) can be used for buried chilled water.

Note that AQUATHERM blue pipe is not approved for liquid fuels.

Class: Insert class appropriate to the pipe material and application or omit if standard text is adequate e.g. standard text for copper pipe is AS 1432 Type B so it does not need to be repeated here. For AQUATHERM pipe insert the SDR code. The lower the SDR, the thicker the pipe wall, the higher the pressure rating. AQUATHERM can supply AQUATHERM blue pipe MF TI in a

SDR11 (Ø32 - Ø355 mm) and in a SDR17.6 (Ø125 - Ø355 mm) version. AQUATHERM can supply AQUATHERM blue pipe MF in a SDR7.4 (Ø20 - Ø32 mm), SDR11 (Ø32 - Ø450 mm) and in a SDR17.6 (Ø125 - Ø630 mm) version.

REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

AS ISO 7		Pipe threads where pressure-tight joints are made on the threads
AS ISO 7.1	2008	Dimensions, tolerances and designation
AS 1074	1989	Steel tubes and tubulars for ordinary service
AS 1271	2003	Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
AS 1349	1986	Bourdon tube pressure and vacuum gauges
AS 1432	2004	Copper tubes for plumbing, gasfitting and drainage applications
AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS 1628	1999	Water supply - Metallic gate, globe and non-return valves
AS 1910	2004	Water supply - Float control valves for use in hot and cold water
AS/NZS 2032	2006	Installation of PVC pipe systems
AS 2129	2000	Flanges for pipes, valves and fittings
AS 2528	1982	Bolts, studbolts and nuts for flanges and other high and low temperature applications
AS/NZS 2638		Gate valves for water works purposes
AS/NZS 2638.1	2011	Metal seated
AS/NZS 3500		Plumbing and drainage
AS/NZS 3500.1	2018	Water services
AS/NZS 3500.2	2018	Sanitary plumbing and drainage
AS 3688	2016	Water supply and gas systems - Metallic fittings and end connectors
AS 3879	2011	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 4041	2006	Pressure piping
AS/NZS 4441	2017	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4680	2006	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4792	2006	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
AS 4794	2001	Non-return valves - Swing check and tilting disc
AS 4809	2017	Copper pipe and fittings - Installation and commissioning
AS 4897	2008	The design, installation and operation of underground petroleum storage systems
Aquatherm Handling	2016	AQUATHERM PP-R Handling, transport & storage instructions
PCA	2019	National Construction Code Series Volume 3 - Plumbing Code of Australia
PCA B1	2019	Water services - Cold water services
PCA B2	2019	Water services - Heated water services
API Spec 5L	2018	Specification for line pipe
ASTM A53/A53M	2018	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A312/A312M	2019	Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM F2389	2019	Standard specification for pressure-rated polypropylene (PP) piping systems
DIN 8075	2018	Polyethylene (PE) pipes - PE 80, PE 100 - General quality requirements, testing
DIN 8077	2008	Polypropylene (PP) pipes - PP-H, PP-B, PP-R, PP-RCT - Dimensions
DIN 8078	2008	Polypropylene (PP) pipes - PP-H, PP-B, PP-R, PP-RCT - General quality requirements and testing
EN 253	2019	District heating pipes - Preinsulated bonded pipe systems for directly buried hot water networks - Pipe assembly of steel service pipe, polyurethane thermal insulation and outer casing of polyethylene
EN 593	2017	Industrial valves. Metallic butterfly valves for general purposes
EN 1092		Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated
EN 1092-1	2018	Steel flanges
EN ISO 9969	2016	Thermoplastics pipes. Determination of ring stiffness
EN 10216		Seamless steel tubes for pressure purposes. Technical delivery conditions.
EN 10216-1	2013	Non-alloy steel tubes with specified room temperature properties
EN 10217		Welded steel tubes for pressure purposes - Technical delivery conditions
EN 10217-1	2019	Electric welded and submerged arc welded non-alloy steel tubes with specified room temperature properties
ISO 21003 Series	2008	Multilayer piping systems for hot and cold water installations inside buildings
The following documents are mentioned only in the Guidance text:		
AS/NZS 3666		Air-handling and water systems of buildings - Microbial control
AS/NZS 3666.1	2011	Design, installation and commissioning
AS/NZS 5601		Gas installations
AS/NZS 5601.1	2013	General installations
AIRAH DA16	1994	Water piping
AIRAH DA24	2003	Water systems balancing
Aquatherm Environmental	2015	Aquatherm environmental benefits at a glance
BCA Section J	2019	Energy efficiency
BCA J5.8	2019	Energy efficiency - Air-conditioning and ventilation systems - Pipework insulation
NATSPEC DES 019	2018	Pipe support spacing
NATSPEC GEN 006	2015	Product specifying and substitution

NATSPEC GEN 024	2015	Using NATSPEC selections schedules
NATSPEC TR 01	2019	Specifying ESD
NATSPEC TR 03	2018	Specifying design and construct for mechanical services
BSRIA TN 10	1992	Space allowances for building services distribution systems: Detail design stage
ASTM A106/A106M	2019	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ISO 5167		Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full
ISO 5167-1	2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full
ISO 5167-2	2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full
ISO 5167-3	2003	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full
ISO 5167-4	2003	Venturi tubes
ISO 5167-5	2016	Cone meters