

TECHNICAL SPECIFICATIONS OF

PIPES AND VALVES

GENERAL DESCRIPTION

The work to be performed under this section of the tender consists of the supply, delivery, installation, painting, testing & commissioning, maintenance & servicing (for the duration of the Defects Liability Period) and handing over to the Employer in good working order, suitable for the purpose intended and ready for setting to work the valves, fittings and piping system associated with this project, comprising the following systems and equipment:

- Pipework, Valves and Associated Accessories

The Contractor shall supply and install all pipework, valves, vents, strainers etc. of capacities and types as shown in the drawings and in accordance with the following specifications. This section of the specifications also sets out the requirements, methods, materials quality, standards of workmanship concerning valve, fittings and piping system.

GENERAL REQUIREMENTS

All pipes, valves, strainers and fittings to be installed shall be suitable for the fluid medium, temperature and pressure ranges and other environmental factors likely to be encountered.

All pipework must be constructed so that the effects of contraction and expansion will not damage any other work or the pipework itself. Special care shall be taken in the arrangement of piping to ensure a neat appearance, true alignment and grade.

All pipe and fittings shall be new and have approved manufacture and shall be thoroughly cleaned before erection and flushed out to remove all scales, burrs, etc. prior to start-up.

The arrangement of valves and fittings shall be such that the quantity of joints is minimum.

Horizontal runs of piping shall where practicable be graded down in the direction of flow and drained at low points.

All pipes, valves, fittings, accessories, etc. shall be selected to withstand a minimum continuous duty of 150% of system maximum working pressure or at least 1,400kPa, whichever is higher. Calculations to confirm selection shall be submitted for approval prior to order of all equipment and material.

PIPING

Chilled Water Pipes

Chilled water pipes of nominal bores from 15mm to 150mm shall be Class C heavy gauge galvanised steel conforming to SS 17. Chilled water pipes of nominal bores exceeding 150mm shall be heavy duty galvanised steel and conforming to API Standard 5L Grade B.

For copper pipe, where specified on the drawings, to fan coil units and suspended air handling units, the pipe shall comply with BS 659 or approved equivalent standard.

Condenser Water Pipes

Condenser water pipes of nominal bores from 15mm to 150mm shall be Class C heavy gauge galvanised steel conforming to SS 17.

Condenser water pipes exceeding 150mm shall be heavy gauge galvanised steel conforming to API Standard 5L Grade B.

Condenser Drain Pipes

Drain piping shall be of heavy duty PVC conforming with BS 3505 and insulated with 38mm thick fibreglass, finished with double sided aluminium foil vapour barrier and sheathed with galvanised steel of 0.7mm thickness and painted to approval.

Where the condensate drain pipes are installed on the roof or exposed to weather they shall be of galvanised steel pipes to BS 1387 and appropriately insulated with 38mm thick polyurethane, finished with double side aluminium vapour barrier, waterproof hybrid plastered and painted to approval.

Valves

All valves as shown in the drawings or are considered as required for the satisfactory operation and maintenance of the system, shall be provided and installed. Valves shall be installed in accessible positions for convenience of operation and maintenance. Valves in main plant room located above 2,400mm from floor level shall be provided with chain and pulley for ease of operation. The size of valves shall be of the same diameter as the pipe to which it is connected unless otherwise specified.

All valves shall be manufactured to British, American or Japanese Standards according to the service required. Valves shall be of approved manufacture. Samples shall be submitted to Employer or SO for approval before use. Valves for chilled and condenser water lines shall have a minimum working pressure of 150% of system pressure or 1,400kPa whichever is higher. Valves for condensate drain lines shall have a minimum working pressure 700kPa. In general, all valves shall be selected as follows:

System Working Pressure (psi)	ANSI Class	Material of Valves
Up to 150	125	Cast Iron
> 150 to 250	150	Cast Steel
> 250 to 500	300	Cast Steel

Butterfly or gate valves shall be used throughout, except where throttling is required ball valve or globe valves shall be used. Ball valves or lubricated plug cocks may be used with approval from the SO where water system valves are to be adjusted to fixed setting in order to achieve system balance with minimum pressure drop.

Check valves shall be of spring return dual check wafer or swing check type with stainless steel spring similar to that as manufactured by Toyo or approved equivalent.

Butterfly valves where indicated shall be of approved manufacture. They shall have bubble tight shut-off in the closed position with no leakage at the valve design pressure. The valve shall be of cast

steel flanged body type constructed to meet 150% of system maximum working pressure encountered in the system and have very low pressure loss.

The valve shall be selected with an extended neck construction for insulation in the case of chilled water system. The valve stem and disc shall be of 316 stainless steel and the seat shall be of proven resilient polymer material reinforcement with stainless steel wire winding. All manually operated butterfly valves 75mm in diameter and above shall be of worm gear drive operated type. Where automatic or remote actuated butterfly valves are required or indicated in the drawings, they shall be supplied with electric or pneumatic positioning actuators depending on the type of automatic controls specified. The selection of the actuators for the correct torque characteristics shall be submitted to the SO's approval before order. Automatic actuated butterfly valves installed outdoors or in wet areas shall have their actuators and ancillary equipment of minimum IP55 enclosure. Pneumatic actuators shall be complete with the appropriate air solenoid valves. All valve actuators shall be provided with limit switches for both open and close remote indications. Each limit switch (open or close) shall have a minimum two (2) numbers double pole, double throw normally open (NO) / normally close (NC) switches.

Actuators shall also be provided with clear external valve position indication and to have a manual worm gear override operator.

Constant flow balancing valves where indicated in the drawings shall be complete with measuring ports for flow measurements, on site flow adjustment control and isolating valve. A portable electronic differential manometer for direct flow measurement shall be supplied and provided for balancing control of the valves.

Where copper alloy valves are specified, they shall be of bronze type.

VENTS AND STRAINERS

Air Vents

Automatic air vents shall be installed at the top of each loop in all pipework and all main headers in the plant room. Vents shall be complete with valve at hand height and discharges shall be fitted with copper tundishes and pipework of appropriate size to the nearest drain pipe or floor drain.

Air vents of approved type shall be installed at the top of all chillers, condensers, water-coils and pump casings.

Strainers

Strainers of approved 'Y' type shall be installed upstream of all motorised and solenoid valves and upstream of all chilled water and condenser water pump units and as shown in the drawings:

- All strainers 50mm and smaller shall be screwed bronze or steel body type
- All strainers over 50mm shall be flanged steel body type
- All strainers shall have removable stainless steel mesh screens

All strainers shall be arranged with isolating valves so that the strainers may be cleaned without draining the system. Mesh sizes shall be to recommendation of valve manufacturer and to suit the equipment installed. Strainers shall be of pipe size and equipped with easily removed cover for access to the sediment basket which shall have a net free mesh area of at least four (4) times that of the pipe.

For strainers above 100mm diameter, they shall be provided with a pipe and gate valve for the convenience of drainage during maintenance.

PIPE FITTINGS

All fittings shall be cast or forged steel conforming to pressure service required and of best quality.

All pipes 50mm diameter and smaller may be screwed with an approved sealing compound. All pipe lengths shall be cut with standard pipe cutters or jig fitted pipe saws, thread cut with standard thread dies and ends reamed before assembly. Approved sealing compounds or tapes shall be used for screwed connections.

All pipes and joints over 50mm diameter shall be connected by either welding or welded flanges except at fittings and valves where flanged connection shall be used.

Expansion joints shall be provided for every 30m for chilled water and condenser water pipes and shall be of the stainless steel bellow type and supported and installed complete with control rods. Welded flanges shall be of the 'slip-on' type jacketed with approved gasket material and sealed using lethargy and glycerin and bolted. Welded flanges shall comply with BS 10 or BS 4504 and shall be suitable for the pressure service encountered. Connections of 25mm diameter and smaller to pipes diameter and larger shall be done by butt welding to the walls of the pipes. The larger pipes shall be shaped and bored before welding.

Connections of 25mm diameter and similar to less than 50mm diameter shall be done by reducing tee and bushes where necessary.

All equipment and valve connections shall be arranged with unions up to and including 50mm diameter pipes and shall be arranged with flange for over 50mm diameter pipe for ease of disconnection. All drainage shall be connected to equipment with unions to facilitate cleaning. Where welding is done on galvanised pipe, the weld must be painted with zinc rich paint.

WELDING JOINTS

All welding shall be done only by capable, skilled and experienced welders. Any welder may be asked by the SO to carry out a test weld. Should the weld not meet the required standard, the SO shall have the authority demanding the removal of the welder from the project. Welds in steel pipes shall be 'V' butt welds strictly in accordance with BS 2633 or approved equivalent standard.

All welding carried out shall bear the welder's identification or code. The sub-contractor shall submit a list of names and identification or code of all welders employed and subsequently to revise the list whenever there is a change of welders on the project.

It shall be the sub-contractor's responsibility to supervise the welding such that no unlisted welders shall carry out any welding on the project. Should the SO have evidence to believe that such is taking place, he reserves the right to demand for the removal of the person concerned from the project.

All welds shall be thoroughly wire brushed after each welding. At least 20% joints at main riser randomly selected by SO shall be X-ray inspected, and if more than 5% of selected joint failed the X-ray inspection, additional 20% joint randomly selected by SO shall be X-ray inspected, and if again more than 5% of selected joint fail the test, then all welded joint shall be X-ray inspected.

Welding of galvanised steel pipework shall be undertaken with special precautions. The welds shall be wire brushed and then painted with two coats of approved cold galvanising paint. Butt welding of galvanised steel pipework is not approved.

If the SO is satisfied with the water testing of the pipes, the pipe welds shall be cleaned, dried and thoroughly wire brushed again and a layer of primer coating applied.

STEEL FLANGED JOINTS

Flanged joints shall be provided where welded joints are impractical or where required for connections to fittings on steel pipe over 50mm diameter flanged valves. Jointing flanges shall be installed truly

parallel to each other that bolts are used only to make the joint tight and not to pull up flanges in true alignment. All bolts and nuts shall be of high tensile steel and have approved manufacture. Flanges shall conform to British Standards.

Taylor metallic corrugated joint rings with approved jointing paste or other approved material shall be used between flanges.

UPVC JOINTS

UPVC joints shall conform to manufacturer's recommendation and shall be to the approval of the SO.

COPPER PIPE JOINTS

All joints shall be silver soldered, except where for ease of assembly, pipes 50mm and over shall be flanged and pipes under 50mm shall be jointed with approved compression unions.

All silver soldered joints shall be made with capillary fittings. The depth of the joint shall not exceed 16mm and a suitable expanding tool of approved make shall be used. The clearance shall not contain less than 15% silver. Where flanges are used, bronze flanges shall be used. Flanges shall be silver-soldered to the pipes.

BENDS

Bends in all piping shall have a radius not less than four (4) times the diameter. If this radius is not obtainable, alternative bends of approved type shall be used. Alternatively, bends in steel pipes shall be beveled and bends as supplied approved welded on fittings. Bends for copper pipes shall be cast bronze bends to British Standards. All bends shall be made in an approved manner and no appreciable flattening or corrugation of the pipe will be allowed.

45° bends or long radius bends shall be used whenever space is sufficient to minimize the pressure drop.

TEES

Tees in steel pipes 50mm and over shall be slip on or beveled end. In pipes less than 50mm diameter tees shall be screwed types. All tees shall be of an approved manufacture.

Tees in copper pipes shall be completely brazed, bronze welded or silver soldered. Tees in copper pipes 20mm and 13mm may also be made using approved capillary fittings together with silver soldered.

PIPE SUPPORTS AND HANGERS

All piping shall be supported by approved type pipe supports and hangers.

Hangers and other approved supports shall be placed at intervals of not greater than:

- 1.5m apart for 13mm to 100mm lines
- 2.0m apart for 125mm lines and over

Hangers for horizontal pipe runs shall be split ring adjustable type or other approved design hung on round steel rods. Brackets or clamps may be used where pipelines run along walls, columns or ceilings.

Copper lines of 25mm diameter or more shall be independently supported at each side of valve and in copper lines smaller than 25mm diameter shall be independently supported.

Hangers shall be placed not more than 600mm from each change of direction of pipes.

Hanger rods of the following minimum sizes or equivalent shall be provided:

- ≤ 100mm - 10mm rod
- > 100mm and ≤ 200mm - 13mm rod
- > 200mm and ≤ 250mm - 20mm rod
- > 250mm and ≤ 350mm - 25mm rod
- > 350mm - 28mm rod

The adjustable split ring straps shall be of the following minimum dimensions:

- ≤ 100mm pipe - 40mm x 6mm
- > 100mm and ≤ 200mm - 50mm x 6mm
- > 200mm - 80mm x 9mm

For chilled water lines, rigid high density hard polyurethane sleeper to prevent condensation occurring on the supports shall isolate the clamps. For use with copper pipes, the split rings shall be of PVC sheathed type to prevent electrolysis between the ring and the copper piping.

Where pipes are to be insulated, the insulation shall completely surround split rings. The hangers shall be slung from I-beam, channel iron or proprietary supports such as GKN Unistrut, with channel or angle supports. All fixings of hangers and brackets to concrete slab or beams shall be by means of rawl bolts or concrete anchor bolts of approved manufacture. The size of all anchor bolts shall be suitable for the weight and duty of the pipe to be supported.

Details of all piping support system shall be submitted to the SO for approval prior to installation.

All vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Where possible, vertical runs of pipes shall be grouped on pipe racks. Racks shall consist of shaped steel frame fix to walls and or floors. The pipes shall be carried in saddles, bolted or screwed to the racks. Details of pipe racks shall be submitted for the SO's approval prior to installation.

Where the steel fixing viz. hangers, brackets, bolts, nuts, washers etc. are installed outdoor or exposed to the weather or in wet areas they shall be hot dipped galvanised to BS 729 or equivalent. All anchor bolts, washers and nuts for the fixing of I-beams, channels, brackets etc. to walls, floor or roof exposed to the weather / in wet areas shall be of stainless steel type to approval. All fixing (whether galvanised or not) shall be primed and given the same finish paint as the piping.

PIPE VIBRATION ISOLATION

Pipe hangers or brackets shall be properly isolated to prevent vibration and noise transmission to the building and special care shall be taken in making piping connections to pumps and all other vibrating equipment. Methods and types of isolation shall be in accordance to the section on Noise and Vibration. Sleeves where necessary shall be placed on floors and walls through which pipelines pass and extend 50mm on each side. Isolating medium such as high-density fibreglass or waffle pattern neoprene shall be placed between pipes and pipe sleeves or between pipes and wall / floors. The gaps between the pipe sleeve and the pipe shall be caulked with waterproof resilient type compound similar to Expandite Thioflex 600 or approved equivalent and properly flashed.

Straight pipe runs in any direction in excess of 30m on one side of an anchor points shall have stainless steel type axial expansion bellow or an approved design for every 30m interval.

Connection of piping to all chillers, pumps, cooling towers, air handling units, packaged units etc. shall be by means of stainless steel type flexible connection of appropriate pressure rating.

The flexible connection shall be complete with stainless steel restraining guide rods. For refrigerant piping, rigid connections may be permitted provided the pipework layout is designed to be sufficiently flexible to prevent work hardening of the pipe work. For flexibly mounted compressors with large movements, approved stainless steel flexible type pipe work connections shall be used. The metallic flexible connections shall be metallic braided. Specimen samples of vibration absorbing fittings shall be submitted for approval.

PUMPS CONNECTION

For every pump installation, the following fittings are required as a minimum or as shown in the drawings:

- Isolation valve at suction and discharge
- Check valve at discharge
- Flexible connection at suction and discharge
- Eccentric tapered reducer at suction
- Concentric tapered reducer at discharge
- Strainer at suction
- Pressure gauge at suction and discharge

PIPE INSULATION

Chilled water pipes shall be insulated with performed sectional closed cell phenol foam complying with Class 'O' material with minimum density of 35kg/m^3 , thermal conductivity not higher than 0.025W/m.K at 24°C and minimum compressive strength 84kN/m^2 . Thickness of insulation shall be as recommended by the manufacturer for ambient still air condition of 30°C 90% RH with chilled water of 5°C . The calculation of thickness of the insulation shall be submitted to SO for approval.

In general, insulation thickness shall be as follows:

Pipe Size (mm)	Thickness (mm)	
	Air-Conditioned Space	Non-Air-Conditioned Space
Up to 38	30	40
50 to 100	40	50
125 to 250	50	60
300 to 750	65	75

All butt-jointed sections shall be sealed with the manufacturer recommended sealant.

The sectional insulation shall further be vapour-sealed and overwrapped using PARSEC VAPO-BRITE aluminum radiant barrier or approved equivalent. The vapour barrier shall be overlapped for a minimum of 50mm and sealed with the manufacturer recommended 50mm wide aluminum self-adhesive tape.

Vapour condensation stops and chilled water pipe bracket supports shall be of hard, high-density polyurethane sleepers, minimum 100mm wide of thickness equal to the insulation material as specified. For hanger type brackets, they shall be of integral hinged type with brackets of galvanised steel.

For channel mounting, they shall be of split section with base for level mounting. They shall have minimum density of 300kg/m^3 , thermal conductivity of 0.054W/m.K at 24°C , minimum compressive strength of $4,500\text{kN/m}^2$.

Vapour condensation stops shall be installed at every pipe support bracket / hanger and at every 3m apart for straight pipe length. They shall also be installed at all locations where the pipes enter or leave the plant room.

The whole piping insulation and vapour barrier shall be aluminium (24 SWG) jacketed and painted to approval. All jackets shall be held in place by 25mm wide aluminium bands (24 SWG), at intervals of 0.75m.

Insulation of chilled water pipes exposed to the weather or installed in underground trench or direct burial shall be of FOAMGLAS as manufactured by Pittsburgh Corning or approved equivalent. Sealant used shall be in accordance with the manufacturer's recommendation. The thickness of insulation used shall be 50mm for pipes with nominal outer diameter (OD) up to 200mm and 75mm for pipes above 200mm nominal OD.

The insulation shall be sealed overwrapped with proprietary waterproof thermal resistance and anti-corrosion tapping similar to that as manufactured by Denso or RUSTOL or approved equivalent.

Drain pipes discharging condensation from drain pans etc. and collecting from AHU room condensate collection fittings shall be insulated with 38mm thick fiberglass insulation and double sided aluminum foil and sheathed with galvanised sheet metal of 0.7mm thickness and painted.

Insulation shall not be applied until testing and cleaning of pipework and equipment has been completed.

All pipe insulation, aluminum foil and aluminum tape shall pass SPRING's Fire Propagation and Ignitability Test. The material shall have indices of performance that can be classified as not easily ignitable and qualify for a Class 0 flame spread rating.

Refrigerant lines shall be insulated with closed cell elastomeric foam type flexible tubing insulation similar to that as manufactured by Thermaflex, Rubatex, Armaflex or approved equivalent and metal jacketed to approval.

Insulation shall have thermal conductivity at 10°C of 0.035W/m.K or better and density of greater than 40kg/m³. It shall be UV resistant and have a flame spread rating of lower than two (2) to BS 476 Part 7. Insulation thickness shall be a minimum of 25mm and suitable for ambient still air condition.

BALANCING VALVES

The balancing valves shall be capable of performing four (4) functions; measurement of water flow, adjustment of flow, isolation and draining or venting.

The valve shall be capable of tight shut-off when used for isolation with Teflon valve sealant and be provided with two (2) tapping, one on each side of the variable orifice for connection to a measurement device. Measuring device shall be in digital format and an accuracy of $\pm 5\%$ maximum flow shall be achieved.

The balancing valve and the measuring device shall be of the same manufacturer to ensure compatibility and accurate measurement.

To avoid unauthorised tampering after final adjustment, a locking device shall permit closing of the valve for isolation purposes but prevent opening greater than its preset value to allow the valve to be returned to this position after it has been closed temporarily.

Commissioning for the hydraulic system with the above balancing valves shall be performed by the local agent to ensure proper system balancing.