FITTINGS AND STANDARDS FOR WATER SERVICE

All water fittings such as valves, pipes, pipe fittings, etc. for use in potable water service installations in Singapore shall comply with the standards and requirements stipulated by PUB and conform to the Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.

A water fitting shall be deemed to comply with the stipulated standards if it is certified or tested as complying with such standards by a conformity assessment body (product certification body/testing laboratory) accredited by the Singapore Accreditation Council (SAC) or its Mutual Recognition Arrangement (MRA) partners. Separate approval from PUB for the water fitting is not required. However, fittings must be supported with valid, complete and full test reports and certificates.

If standards and requirements for a water fitting are not stipulated, the installer shall approach PUB to stipulate the necessary standards and requirements for compliance.

1. STEEL PIPES & PIPE FITTINGS

1.1 General

This Specification covers the supply of straight steel pipes of uniform bore and steel specials, with internal concrete lining and external wrapping/painting.

The word ‘pipe’ or ‘pipes’ shall be taken to include ‘bends, butt straps, canted collars, offtakes, tees, Wyes and all pipe specials etc.’, whenever applicable.

1.2 Manufacture

The steel pipes shall be manufactured to SS 142 “Steel Pipes, Fittings and Specials for Water, Gas and Sewage” and to the dimensions given in the tables under Clause 1.2 and 1.7.2 of this Specification. All standards referred in these Specifications shall be their latest edition with any new amendments.

The steel plates used in the pipe manufacture shall be of steel grade 430 with minimum yield strength of 275 N/mm2 and chemical composition as specified in Table 2 of BS 3601:1987 “Steel Pipes and Tubes with specified room temperature properties, for Pressure Purposed”. The manufacturer shall ensure that no rimmed (or non-killed) steel or semi-killed steel plate is used for making pipes. He shall carry out impact test (BS EN 10045-1:1990) or brittleness test if necessary and submit report to ensure only fully killed (or non-rimmed) steel plates are used.

The steel pipe shells shall be electric fusion welded or spiral seam fusion welded by automatic metal-arc process to BS 3601 and BS 2633 “Class I Arc Welding of Ferritic Steel Pipework for Carrying Fluids”. In the case of spiral seam fusion welded pipes, welding of plates at the end of each coil shall also be done by the automatic arc welding process.

All pipes shall be hydraulically tested by manufacturer to 2.0 MN/m2 (300 psi) of pressure. The test procedure shall comply with BS 3601. The Contractor shall produce Test Certificates for all other test carried out to the requirements of BS 3601.

All steel pipe specials shall be fabricated from pipes which have been manufactured and tested to SS 142 and BS 3601 "Steel Pipes and Tubes for Pressure Purposes", unless otherwise specified. Pipe shells shall be butt-welded by metal-arc process in accordance with BS 2633 "Class I Arc Welding of Ferritic Steel Pipework for Carrying Fluids".

The pipe sections shall be manufactured to the details and dimensions shown in the Drawing, and shell thicknesses as tabulated below for the relevant pipe sizes and pipe specials:

Nominal Diameter (mm)	External Diameter (mm)	Thickness of Steel Shell (mm)
100	118.0	6.0
150	170.0	6.0
200	222.0	6.0
300	326.0	6.0
500	506.9	6.0
700	667.2	6.0
800	825.9	8.0
900	933.5	9.5
1200	1244.6	12.7
1400	1422.4	12.7
1600	1549.4	12.7
1800	1746.3	12.7
1900	1911.3	15.9
2200	2216.2	15.9

1.3 Joints

Sockets and spigot pipe ends shall be made so as to allow slip joint for internal as well as external welding. The pipe and plate ends of socket/spigot pipes and plain-ended pipes shall be cut and finished square to the axis of the pipe. The pipe ends shall be gauged to ensure that the cut and finished square to the axis of the pipe. The pipe ends shall be gauged to ensure that the spigot will freely enter the socket end and be a good fit. The ends of the pipes and specials shall be prepared so as to permit an efficient and economical welded joint in the field. All longitudinal welds at the ends of the pipes and specials shall be ground flush with the plate surface.

For pipelines not exceeding 2200 mm dia, the welded pipe joint shall be such as to allow the axis of adjacent pipe to be inclined at an angle of three degrees (3º) without any weakness or sign of leakage. The pipe and lap at joints shall be such that at this degree of inclination the overlap at any point shall not be less than two times the plate thickness of the pipe or 25 mm or whichever is greater

Pipe ends of the spherical type shall be formed by hydraulic pressing using a full circle die or expanding former capable of forming ends consistently to a constant spherical contact surface diameter throughout the pipe production run. The internal surface of the socket and the external surface of the spigot shall be ground smooth along the shop fusion welds for a distance of 150 mm from pipe ends measured along the pipe axis. The external surface of the plain-ended pipes shall be similarly prepared for a distance of 300 mm from pipe ends measured along the pipe axis.

The socket ends of pipes of 800 mm dia and above shall have a 6 mm BSP tapped hole provided with matching plug (about 20 mm from the end of pipe) to permit an air pressure test to be carried out following completion of field welding.

The socket and spigot of the pipe must be formed before the pipe is subjected to hydraulic test.

1.4 Tolerance

Manufacturing tolerances shall be equivalent to that as specified in BS 3601 and SS142 unless otherwise specified below.

All pipes shall be truly straight with walls parallel to the axis of the pipe. Any pipe section with a fault in alignment exceeding 1 mm for each metre length from a line parallel to the axis of the pipe shall be rejected.

Straight pipe sections shall not vary from the specified lengths by more than 50 mm.

The out-of-roundness of pipe ends shall be such that the spigot end can be readily slid into the socket end for a lap welded joint and a butt-strap joint can be made readily in the field without undue jacking and straining of the pipe ends. The ends of plain-ended pipes must be truly round and ridge (welding) free to accommodate fixing of mechanical coupling.

1.5 External Coating And Wrapping

All pipes shall be thoroughly descaled by shot blasting to BS 7079: Part A1:1989 second quality internally and externally immediately prior to priming.

Where bitumen wrapping is to be applied at the place of pipe manufacture, cleaning and priming shall immediately follow hydraulic testing. Where bitumen wrapping is to be applied at another location, then the pipes shall be coated with a suitable corrosion inhibitor before despatch from their place of manufacture.

If the spun concrete lining is to be applied at the place of pipe manufacture, internal priming of the pipe barrel may be omitted. Otherwise, pipes shall be

primed both internally and externally.

The above priming shall stop short of the ends of pipes intended for field welding. The ends of such pipes shall be coated with an approved priming paint and/or rust inhibitor both internally and externally. This shall be suitable for providing a temporary protection to those areas of pipe not given the full factory applied permanent protection and shall not affect the weldability of the metal from rusting prior to field welding.

The pipe shall be coated with bitumen generally in accordance with Clause 5.4 of SS 142 except that the protection shall have a minimum thickness of 6 mm for pipes over 900 mm nominal diameter. The bitumen shall be Type 2 of BS 4147 and there shall be not less than 2 mm of bitumen between the inner and outer wraps, and between the pipe and inner wrap.

The coating shall be stopped short as shown in the Drawing for ends of all spigot and socket pipes and 100 mm from the ends of all plain ended pipes unless otherwise specified. The edge of the coating shall be chamfered at 25 degrees.

The wrapping materials shall be spirally wound onto the pipes and fittings simultaneously with the bitumen coating. Each wrap shall be from 150-250 mm wide and the edges shall overlap by 12-25 mm. Care shall be taken to ensure that the inner wrap does not come into contact with the pipe metal or with the outer wrap.

The inner wrap shall be of a glass fibre resin-bonded tissue reinforced in the longitudinal direction with parallel glass threads spaced 20 mm apart. The nominal thickness shall be 0.5 mm and the minimum weight shall be 46 g/m2.

The outer wrap shall be of glass fibre resin-bonded tissue reinforced in the longitudinal direction with parallel glass threads spaced 20-25 mm apart. It shall be impregnated with a material fully compatible with the bitumen coating to give a finished thickness of 0.075 mm.

All coated pipes and fittings shall be rigidly inspected for defects. Thickness shall be determined by a pit gauge, continuity with a Holiday detector and coating quality by cutting out 75 mm square samples at the rate of one sample per 5 lengths of pipe manufactured. The whole coated surface area of all pipes and fittings shall be tested for pinholes or other invisible defects in the coating using an approved Holiday detector at a potential of 14,000 volts.

Any lengths on which the coating is poorly applied shall be cleared to bare metal and re-coated. Minor defects may be repaired by touching up. All repairs shall be checked for thickness and continuity.

All coated pipes and fittings shall be given two coats of undiluted commercial “Matex” or similar approved vinyl acetate paint to reduce the risk of the coating becoming tacky.

1.6 External Painting

All pipes and specials to be painted shall be thoroughly cleaned by sand blasting or by mechanical wire brushing to remove all mill scale rust, dirt, grease etc. Thereafter, the bare metal surface shall be painted with two coats of approved epoxy based red lead primer complying with SS 6 "Red Lead Based Primers for Iron and Steel Surfaces".

1.7 Internal Concrete Lining

All pipes shall be provided with internal concrete lining in accordance with SS 142 in an approved plant by the centrifugal process.

The finished concrete lining shall adhere firmly to the inside of the pipe and shall be smooth and even. Voids, sand and clay pockets, blisters, areas that are drummy or excessively cracked or not in contact with the surface of the pipe or fitting, and cracks into which a metal gauge 0.8 mm (1/32 in) thick can be inserted to a depth of half the thickness of the lining at intervals along the crack exceeding 75 mm (3 in) shall be regarded as defects. Superficial cracks shall not be regarded as defects.

The concrete lining shall be perfectly continuous starting 75 mm from the spigot end of the pipe to the bottom or beginning of the socket in the case of spigot and socket pipes, and shall be perfectly continuous from end to end in the case of plain-ended pipes. The lined pipes must be cured for at least 14 days before delivery.

1.7.1 Materials

(i) SAND

Sand shall be clean, sharp and gritty and composed of hard siliceous grains and shall conform to SS 31 “Coarse and Fine Aggregates from Natural Sources for Concrete”. It shall be free from clay, animal, vegetable or other foreign matter.

(ii) GRANITE DUST

Granite dust shall be fine, clean and free from all organic or other impurities and shall conform to SS31. It shall be obtained by crushing granite of best quality. The maximum grain-size shall not exceed one-third the thickness of the lining.

(iii) WATER

Water shall be fresh, clean and clear and shall be drawn from a supply normally used for drinking purposes and shall be maintained at a normal even temperature.

(iv) CEMENT

Portland Cement shall be fresh and shall conform in all respects to SS 26 “Portland Cement (Ordinary and Rapid Hardening)”.

1.7.2 Composition of Internal Concrete Lining

The Internal Concrete Lining shall consist of roughly equal volumes of Portland Cement, Granite Dust and Sand; each of these materials shall be to the Standard specified above. These ingredients shall be carefully mixed together with water in an approved manner to produce a mortar of maximum strength and a dense concrete. The inside of the steel pipe shell shall be thoroughly cleaned and free from all rust, scale, dirt, oil, grease or other foreign matter before lining.

The thickness of the lining shall not vary beyond the limits of tolerances stipulated below:

Nominal Diameter of Pipe (mm)	Thickness of Portland Cement Concrete Lining (mm)	Tolerances (mm)	
		Minus	Plus
100	6	0.00	3
150	6	0.00	3
200	10	0.00	3
300	10	0.00	3
500	13	0.00	3
700	13	0.00	3
800	19	0.00	3
900	19	0.00	3
1200	19	0.00	3
1400	25	0.00	6
1600	25	0.00	6
1800	25	0.00	6
1900	25	0.00	6
2200	25	0.00	6

1.7.3 Permissible Variations of Thickness Of Lining

The thickness of Lining as given above is the minimum. The Contractor shall exercise great care to ensure concentricity throughout the length of pipes and specials and in no place shall the thickness of the lining vary beyond the limits of tolerances stipulated above.

1.8 Pipe Flanges

All pipe flanges shall be at right angles to the axis of the pipe, and shall be machined right across the full width of the face. The flanges shall be manufactured in accordance with BS 4504 “Circular Flanges for Pipes, Valves and Fittings”. The bolt holes for all flanged specials shall either be drilled or cored in accordance with PN 10 flanges. Blank flanges shall be manufactured to the same details as pipe flanges. All flange surfaces shall be painted with two coats of approved bituminous paint. The overall flange dimensions and bolt holes shall conform to the table below:

Pipe Diameter (Nominal) (mm)	Diameter of Pipe Flange (mm)	Bolt Circle Diameter (mm)	Thickness of Pipe Flange (mm)	No. & Size of Bolt Hole	Diameter of Bolt
100	220	180	20	8 x 18 ϕ	M16
150	285	240	22	8 x 22 ϕ	M20
200	340	295	24	8 x 22 ϕ	M20
300	445	400	28	12 x 22 ϕ	M20
500	670	620	36	20 x 26 ϕ	M24
700	895	840	42	24 x 30 ϕ	M27
800	1015	950	42	24 x 33 ϕ	M30
900	1115	1050	44	28 x 33 ϕ	M30
1200	1455	1380	52	32 x 39 ϕ	M36
1400	1675	1590	58	36 x 42 ϕ	M39
1600	1915	1820	64	40 x 48 ϕ	M45
1800	2115	2020	68	44 x 48 ϕ	M45
1900	2345	2230	70	48 x 57 ϕ	M54
2200	2540	2413	154	48 x 57 ϕ	M54

1.9 Bolts And Nuts

Bolts and nuts shall comply with BS EN ISO 3506-1:2009 ‘Mechanical properties of corrosion-resistant stainless steel fasteners. Bolts, screws and studs.’ Bolts shall be of stainless steel finish and shall have hexagon heads and be provided with stainless steel hexagon nuts.

The bolts and nuts shall be greased and attached to the pipe flanges before delivery. The nominal lengths of bolts for pipe flanges shall be equal to:

(twice the thickness of the pipe flange) plus (2 x the diameter of the bolt);

Unless otherwise shown in the Drawings. The bolts shall be threaded for a length equal to twice the diameter of the bolt from the end of the bolt. The threads on the bolts and nuts shall be of the coarse pitch series specified in S.S. 186 “ISO Metric Screw Threads: Basic Profile, Standard Thread Series and Limits and Tolerances for Coarse Pitch Series and Constant Pitch Series Threads”.

1.10 Rubber Insertion Cloth

The jointing material used between flanges of pipe specials shall be rubber insertion cloth not less than 3 mm thick, and shall conform to the requirements for rubber insertion jointing material reinforced with fabric in BS 6956. The width of the joint shall be such that it completely covers the face of the flanges.

1.11 Engagement At Welded Joints

At pipe joints, the spigot end shall enter the socket end to the full distance permitted by the joint. Where the pipe is deflected (up to a permissible maximum of 3°), the minimum overlap at any point on the socket and spigot joint shall not be less than 2 times the plate thickness of the pipe or 25mm whichever is the greater.

In the case of buttstrap or canted collar welded joints, the pipe ends shall be entered as far in as possible while allowing sufficient room for internal welding at the joint. The minimum overlap for such joints shall not be less than 4 times the plate thickness at any point around the pipe or 40mm whichever is greater.

1.12 Joints To Be Left Ready For Welding

For jointing of pipes, the spigot ends shall enter well into the socket ends so as to be ready for welding. The surfaces of the pipes to be welded shall be cleaned and wire-brushed.

1.13 Welding

All welding shall be performed by the metallic arc process and comply with BS 4515: "Field Welding of Carbon Steel Pipelines". Welding of pipe joints shall proceed closely with the laying of the pipes and must not lag behind the laying operation by more than two pipe lengths.

1.14 Electrodes

All electrodes used shall be suitable for welding of mild steel containing not more than 0.26% carbon and shall comply with the requirements of BS EN 499: 1995 "Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification"; other standards that are equal or superior to the British Standard may be accepted.

1.15 Size Of Welds Etc

Pipe joints shall be of the sleeve and fillet weld type and shall be welded externally and internally. Pipe joints of 700mm dia and below shall be welded externally only. The fusion faces of the parent metal shall be thoroughly cleaned as required before welding operations are commenced.

Fillet welds for the sleeve type joints shall be of such a size that each leg is not less than the thickness of the pipe wall. All welds shall be built up to a full throat thickness.

1.16 Welds On Offtakes

For small offtakes below 100 mm diameter where no compensating plate is used, the fillet weld made externally shall be so formed that each leg of the weld shall not be less than one and a half times the thickness of the steel plate forming the branch pipe.

For offtakes or branches of 100 mm diameter and above fitted with compensating plates, fillet welds shall be formed internally as well as externally. In such a case, each leg of the fillet weld shall be not less than the thickness of the plate forming the branch offtake.

1.17 Flexible Couplings

Mechanical couplings shall be used to connect two steel mains of similar external diameters. The characteristics of the couplings and sealing rings should be equivalent to that of Viking Johnson or Dresser coupling.

Stepped couplings shall be used to connect an existing cast iron main and a new steel main of differing external diameters during link-up. The characteristics of the couplings and sealing rings should be equivalent to that of Viking Johnson or Dresser coupling and they shall be fabricated to suit DIN tolerances. Exact dimensions of the couplings and tolerances shall be confirmed upon determination of the external diameter of the existing cast iron main at site by the Contractor.

1.18 External Protection Of Flexible Couplings

After the newly laid pipeline has been satisfactorily pressure tested, the flexible couplings shall be primed with approved pipe primer and wrapped with one layer of Densopol 80 HT tape or equivalent.

1.19 Installation Of Valves, Fittings And Specials

Where air valves, washouts, sluice valves or connections are required, the Contractor shall do all necessary excavation, make joints, attend to the welding and have the joints coated with bitumen or wrapped.

The Contractor shall lay and install pipe specials and valves, etc and make all joints and provide concrete supports and thrust blocks.

The Contractor shall also install temporary ground hydrants, flushouts, access manholes and other temporary connections, when required.

1.20 Markings

Each pipe and special shall have the mark PUB painted on them and in addition the following information:

(a) The nominal diameter and the plate thickness.

(b) Effective laying length, internal diameter, and for bends the angle of the bend.

The marking shall be in a brightly coloured paint with letters and figures not less than 75 mm high.

1.21 TRANSPORT OF PIPES AND SPECIALS

The pipes shall not be rolled during loading or unloading. The pipes shall be stacked in one layer only and in such a manner that the coating is not damaged. Adequate packing between pipes for this purpose must be supplied by the Contractor. All pipes must be kept clear of the ground and rested on minimum 2 Nos. padded sleepers or supports.

The pipe shall be so handled, stored and transported as to prevent undue distortion and shall not be moved in any manner involving rotation of the pipe about the longitudinal pipe axis.

The pipe shall be lifted by means of two reinforced canvas slings at least 300 mm wide suspended from a lifting beam so that the slings are positioned at a distance of one-fifth of the pipe length from each end of the pipe.

The Contractor shall provide sufficient timber struts of minimum size 100 mm x 50mm to fit the pipe circumference to prevent distortion during handling and delivery. Such struts shall be left in position when the pipes are delivered to the storage areas.

1.22 Testing Programmes for All Pipes

All pipe fabrication shall comply with the following programme in accordance with SS142 and API 1104:

(a) Welding

(i) Bend Test

(ii) Transverse Tensile Test

(iii) Charpy V-Notch Impact Test

Tests shall be carried out before commencement of work and at every 100 lengths of pipe and the last 50 lengths.

Each test shall comprise at least 2 random specimens and in all cases, at least 4 tests shall be performed for every project. Failure in any 2 specimens or extremely poor result in any single test will render the batch of steel plates to be rejected.

(b) Hydraulic Test

Pipes shall be hydraulically tested in the manufacturer's factory. The test pressure shall be 5 MPa for 300 mm dia pipes, and 3.2 MPa for 900/800/700 mm dia pipes for duration of at least 10 minutes. All pressure charts shall be readily accessible for inspection and submission on request.

(c) Pipe Asphalt

All charts for the automatic recording thermometer shall be readily accessible for inspection and submission on request. Adhesion test (BS 534:1990) or holiday detector test shall be carried out as and when requested by pipe inspector.

(d) Joint Test

(i) 1.9 to 3 degree deflection test

(ii) Engagement test

The tests shall be carried out at beginning and towards completion of pipe fabrication.

2. DUCTILE IRON PIPES & PIPE FITTINGS

2.1 Standards

Ductile iron pipes shall be Zinc coated with socket and spigot ends manufactured and tested to the requirements of BS EN 545:2010 "Ductile Iron Pipes, Fittings, Accessories And Their Joints For Water Pipelines. Requirement and Test Methods" for ductile iron pipes and pipe fittings complying with BS EN 545, unless otherwise specified below.

2.2 Ductile Iron Pipe Dimensions

Nominal Dia Dn (mm)	External Dia DE (mm)	Pipe Shell Thickness e (mm)
100	118	6.0
150	170	6.0
200	222	6.3
300	326	7.2

2.3 Coatings

The pipes shall be given an external coating of metallic zinc, and a finishing layer of bituminous material in accordance with the provisions of BS EN 545.

The pipes and fittings shall be coated with bitumen based hot-applied coating material complying with BS EN 545 or SS 83, and executed in accordance with the provisions of BS EN 545.

2.4 Joints

The pipe joints shall be of the push-in “Tyton” type joint.

2.5 Joint Rings

Type and quality of joint rings for pipes and pipe fittings shall be the same as joint ring specified in ISO 4633 "Rubber seals - Joint rings for water supply, drainage and sewerage pipelines - Specification for materials" or SS 270. The physical property requirements shall conform to ISO 4633 for natural rubber, Hardness (IRHD) 56-65.

2.6 Hydraulic Test for Ductile Iron Pipes

Pipes shall be hydraulically tested to a test pressure of 50 bar in accordance with Table 15 of BS EN 545, and shall not show any signs of leakage, sweating or other failure of any kind.

2.7 Dimensions of Flanged Fittings

The dimensions of flanged fittings shall comply with the requirements of BS EN 545. The bolt holes shall be either drilled or cored in accordance with PN 10 flanges as per Table 34 of BS EN 545.

The double flanged bends shall be of short radius and the dimensions shall comply with Table 27 and 28 of BS EN 545 for 90° and 45° bends respectively.

2.8 Dimensions of Double Flanged Duckfoot Bends

The dimensions of double flanged duckfoot bends shall comply with the Table 27 of BS EN 545

2.9 Flanged Sockets & Flanged Spigots

Details of flanged sockets and flanged spigots shall comply with BS EN 545 Table 18 and 19 respectively except as otherwise specified below.

2.10 Hydrostatic Pressure Test for Ductile Iron Fittings

Before being cement-lined and coated, each fitting shall be hydrostatically tested to a test pressure of 16 bar in accordance with Table 15 of BS EN 545.

2.11 Bolts and Nuts

Bolts and nuts used for making flanged joints shall be hexagon headed stainless steel bolts and nuts complying to Grade 304S11 equivalent in BS EN 10250 Part 4 with high strength and high corrosion resistance.

2.12 Rubber Insertion Cloth

The jointing material used between flanges of pipe fittings including valves shall be rubber insertion cloth not less than 3 mm thick, and shall conform to the requirements for Rubber insertion reinforced with fabric in BS 6956. The width of the joint shall be such that it completely covers the face of the flanges.

2.13 Internal Cement Mortar Lining

The internal cement mortar lining of the ductile iron pipes and fittings shall be carried out in accordance with BS EN 545.

2.14 Materials for Cement Mortar Lining

Cement: The cement used shall be ordinary Portland Cement in accordance with BS 12 or SS 26.

Sand: The sand shall comply with the requirements of BS 882 for Grade F fine aggregate when sampled and tested in accordance with BS 812, or SS 31, except that the maximum grain size shall not exceed 1/3 of the minimum lining thickness.

Water: The water shall be obtained from the public water supply used for drinking purposes and shall contain no constituent that adversely affects the quality of the cement.

2.15 Cement Mortar Mix

The cement mortar mix shall comprise cement, sand and water which shall be thoroughly mixed. The cement mortar mix shall contain at least one part by mass of cement to 2.5 parts by mass of sand. The cement mortar mix shall be free of any mud, clay or other foreign matter. Works cube crushing tests shall be carried out in accordance with SS 142.

2.16 Application of Lining

The surface on to which the coating is to be applied shall be free from all loose scale, foreign bodies, or any other material that could be detrimental to good contact between the metal and the coating.

The cement mortar shall be applied to the internal surface by means of an approved process. Any damage caused to the lining by the removal of the end rings shall immediately be made good by hand before the cement mortar lining is set.

2.17 Thickness of Internal Cement Mortar Lining

The thickness of the lining shall comply with Table 9 of BS EN 545.

2.18 Finished Linings

The finished linings shall adhere perfectly to the inside of the pipe or fitting and shall be smooth, even and free from ridges, corrugations, cracks, foreign matter, blemishes or other defects. The lining shall be a continuous layer of cement mortar over the bore of the pipe or fitting. The inside of the sockets and the faces of flanges shall be free from cement mortar.

2.19 Markings

In addition to the requirements of BS EN 545 all pipes and fittings shall have cast on it the following letters:

i) Manufacturer's Name/Trademark

ii) Year of Manufacture

iii) Nominal Diameter of main body

iv) Angle of Bend in degrees

v) BS Number

Alternatively, for ductile iron pipes, the markings may be indelibly imprinted longitudinally in white colour.

2.20 Sealing of Pipe Ends

All pipes shall be cleaned internally and sealed at the ends to prevent ingress of foreign matter before transportation to site. The seals shall only be removed when making pipe joints.

2.21 Manufacturer’s Certificate & Test Reports

All pipes and fittings shall comply in all respects with the provisions of BS EN 545, and shall have the following test certificates/reports:

a. Dimension check
b. Hydrostatic pressure test
c. Tensile test (for pipes)
d. Brinell hardness test
e. Chemical analysis
f. Microstructural test (for ductile iron)
g. Cement mortar cube test

3. FLANGED ADAPTOR, TAPER FLANGE AND PACKING PIECE

3.1 Materials

The material used in the manufacture shall be steel complying with BS EN 10028 (Parts 1 to 3) and BS EN 10029:1991 or cast iron complying with BS EN 1561:1997 or ductile iron complying with BS EN 1563:1997.

3.2 Dimension

The flanges shall generally comply with the requirements of BS 4504 "Flanges and bolting for pipes, valves and fittings" for PN 10 flanges.

3.3 Bolts and Nuts

Bolts and nuts used for making flanged joints shall be hexagon headed stainless steel bolts and nuts complying to Grade 304S11 equivalent in BS EN 10250 Part 4 with high strength and high corrosion resistance.

3.4 Coating

The flanges, bolts and nuts shall be coated with bitumen based coating material complying with SS 83 "Hot applied bitumen based coatings for protection against corrosion".

3.5 Hydrostatic Pressure Test

Each fitting shall undergo hydrostatic pressure test to 16 bar.

3.6 Markings

Each fitting shall be indelibly marked with the number of the British Standard/Singapore Standard Specifications, nominal size, manufacturer's name/mark and "PUB".

3.7 Manufacturer’s Certificate & Test Reports

All fittings shall comply in all respects with the provisions of standards, and shall have the certificates from manufacturer certifying that the fittings comply with the standards

4. CHAMBERS AND ACCESS MANHOLES

4.1 Air Valve & Washout Chambers

Air valve and washouts shall be housed in RC or precast concrete pipe chambers. Precast concrete chambers supplied shall comply with SS 183: "Concrete Cylinder Pipes and Fittings including Manholes and Street Gullies". Alternatively a brick chamber may be constructed to house the air valve assembly.

4.2 Control Valve Chambers

Sluice valves and other Control Valves shall be housed in RC or precast concrete pipe chambers. When necessary, the alternative of a brick chamber to house the valve spindle and packing may be required. Details of these chambers are shown in the Drawings. Cast iron manhole covers shall be supplied and transported to site by the Contractor, unless otherwise specified.

4.3 Manholes

The access manhole shall consist of a flanged 500mm or 800mm dia offtake with compensating plate welded on to the pipeline. The offtake shall preferably be located at air-valves where the latter can be installed on top of the offtake with a reducer. In the absence of an air-valve assembly the offtake shall be blanked off with a blank flange.

500mm or 800mm dia flanged radial offtakes x 150mm high shall be used as access manholes for 800mm dia or larger pipes. They shall be placed at an angle of 45° either to the left or to the right of the vertical axis of the pipe. If the access manhole coincides with the position for air valve then it shall be placed at 90° to the horizontal axis of the pipe. For 700mm dia pipeline, 700mm dia x 500mm dia flanged tees shall be used as access manholes.

5. BUTTERFLY VALVES

5.1 Standard for Butterfly Valves

The butterfly valves shall conform to BS 5155 or BS EN 593 unless otherwise specified.

5.2 Butterfly Valves of 300mm diameter and below

5.2.1 General

The butterfly valve flanges shall be cast and drilled to BS EN 1092-2:1997 for nominal pressure of at least 10 bar (PN10).

The valve stem and disc shall be coupled together via reliable heavy-duty internal securing mechanism such as spline-shaft, key, etc. No opening (whether plugged or exposed) is allowed to be made on the disc for assessing the aforementioned mechanism from the liquid side of the disc.

Full-lugged for 100 mm and 150 mm diameter and flanged body for 200 mm and 300 mm diameter enabling isolation for upstream and downstream dismantling under maximum pressure at the valve pressure rating shall be provided. Alternatively, semi-lug design for all the above sizes suitable for upstream and downstream dismantling is also acceptable.

The valves shall be of the rubber lined type design with field replaceable liner. The liner must be formulated by the same valve manufacturer. The internal body resilient lining shall isolate the complete body interior surface from the water conveyed by ensuring leak tightness around the pipe flange and at the shaft. The protruding lips of the liner shall be thick and used as gaskets between the valve and the adjoining pipe flanges. Valve connection shall be made without the necessity of flange gaskets.

The shaft and disc shall be on the same axis and all valves shall be opened in a clockwise direction. The sealing between the body liner and the disc at the shaft area will be fully leak tight and no leakage of fluid is allowed. The valve and the shaft shall be constructed without any packing gland. However, the shaft, bearing, internal part of the body shall remain unexposed to the fluid.

The valve shall not only provide a positive tight shut off at the fully closed position (90 degrees) but also at an angular allowance of a minimum ± 4 degrees off the fully closed position.

The disc hub must have a spherically machined convex surface to match that of the spherical concave shape of the liner. To have proper displacement of the liner during flanging, the rubberlined butterfly valve must have clearance on the circumference between the liner and the body on both sides of the valve.

The butterfly valve shall generally be mounted with the spindle in the vertical position with the weights of the disc and the shaft being evenly supported by the two bearings. The butterfly valve shall be quarter turn type operating from fully close to fully open position. The valve cap shall be directly mounted onto the valve vertical spindle with mechanical indicator giving direct read-out of the disc position.

5.2.2 Quality of Materials

Materials used in the manufacture of valve components shall be as follows:

(a) Body and Gear Box - The Ductile Iron used shall be in accordance with BS EN 1563:1997.

(b) Disc - Stainless steel to Grade 316 equivalent in BS EN 10250 Part 4.

(c) Shaft - Stainless steel to a standard equivalent to that specified in BS 970 Grade 420S37.

(d) Body Lining - Replaceable elastomer EPDM to BS6920 (suitable for drinking water).

5.2.3 Hydrostatic Pressure Tests for Butterfly Valves

All butterfly valves shall be hydrostatically tested to the following pressures:

(i)	Body Strength Test (Shell Test)	=	1.5 x PN Rating
(ii)	Leak Tightness Test (Seat Test)	=	1.1 x PN Rating
(iii)	Disc Strength Test	=	1.1 x PN Rating

Duration of maintaining the valve under different test conditions shall be in accordance to BS 5155 or BS EN 593. The above tests shall be performed at the manufacturer's works.

5.2.4 Diameter of Bore

The bore of the valves shall have the dimensions shown in the following table and the manufacturing tolerances shall be plus or minus 1.5 mm.

Nominal Size of Valve (mm)	Diameter of Bore in (mm)
100	100
150	150
200	200
300	300

The disc of the butterfly valve shall not hit the cement lining of the adjoining pipes or fittings when it is fully opened. Cement lining of the adjoining pipes or fittings shall be shaped in such a way that it will not obstruct the opening of the valve disc.

5.2.5 Flanged Ends of Valves

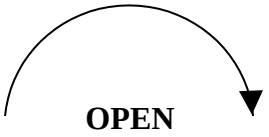
All valves, face to face dimensions shall conform to ISO 5752. Flanged ends of valves shall be at right angles to and concentric with the axes of the bore and shall be machined right across the full width of the face. The "Black" shall be completely machined away, but the casting and flange shall hold up fully to the requisite dimensions.

Flanges shall be drilled and bolt holes shall be "off-centres". The valve flanges shall comply with the general requirements for ductile iron flanges in BS EN 545:1995 and BS EN 1092-2:1997. The dimensions of the valve flanges shall be as given in the table below:

Nominal Size of Valve mm	Thickness of Flange (Ductile) mm	Flange Dia mm	Pitch Circle Dia mm	No. of Bolt Hole	Size of Bolt Hole mm	Dia of Bolt
100	19	220	180	8	19	M16
150	19	285	240	8	23	M20
200	20	340	295	8	23	M20
300	24.5	455	400	12	23	M20

5.2.6 Direction of Rotation for Opening of Valves

The valves shall be OPEN when the valve key or handwheel is rotated in a CLOCKWISE direction. The direction of opening shall be marked on the valve and shall be fitted with a pointer indicating the position of the disc. A stop mechanism shall be provided to prevent overcrossing of the valve disc.



5.2.7 Markings on Valves

The following marks and figures shall be cast or with a reasonable size brass plate tacked on to the bodies of all the valves:

(a) direction of valve opening arrow as shown above.

(b) manufacturer's name or trade mark.

(c) nominal size

(d) nominal pressure designation (PN 10)

(e) WD / year of manufacture e.g. WD / 2013
PUB PUB

5.2.8 Coating of Valves

The valve body shall be internally and externally coated with fusion bonded epoxy complying with SS 375.

5.2.9 Bolts and Nuts for Valve Flanges

Stainless steel hexagon bolts and nuts shall be provided in accordance to Grade 304 S11 equivalent in BS EN10250 Part 4. The bolts and nuts shall comply with BS 3692 or BS 4190 with dimensions appropriate for the purpose. The threads on bolts, stud bolts and nuts shall be of the coarse pitch series in accordance with BS 3643:Part 2:1981.

5.2.10 Manufacturer's Certificate & Test Reports

The valve shall comply in all respects with the provisions of BS 5155 or BS EN 593, and shall have the following test certificates/reports:

(a) Dimension check

(b) Type tests, including pressure, strength and functional tests

(c) Tensile test

(d) Chemical analysis

(e) Brinell hardness test

(f) Production pressure tests

5.3 Butterfly Valves of Above 300mm Diameter

5.3.1 General

Valve rating shall be PN 10. The butterfly valve flanges shall be cast and drilled to suit the dimensions and bolt holes of the adjoining flanges.

All valves with stem and disc connected by shaft-pins will not be accepted.

The valve stem and disc shall be coupled together via reliable heavy duty internal securing mechanism such as spline-shaft, key, etc. No opening (whether plugged or exposed) is allowed to be made on the disc for assessing the aforementioned mechanism from the liquid side of the disc.

U-section body with flat-face flanges enabling isolation for upstream and downstream dismantling under maximum pressure at the valve pressure rating shall be provided.

The valves shall be of the rubber lined type design with field replaceable liner. The liner must be formulated and manufactured by the same valve manufacturer. The internal body resilient lining shall isolate the complete body interior surface from the water conveyed by ensuring leak tightness around the pipe flange and at the shaft. The protruding lips of the liner shall be thick and used as gaskets between the valve and the adjoining pipe flanges. Valve connection shall be made without the necessity of flange gaskets.

The shaft and disc shall be on the same axis and the valve shall be fully bi-directional, i.e. capable of complete tight shut off under the full differential pressure (valve rating) in both directions. The sealing between the body liner and the disc at the shaft area will be fully leak tight and no leakage of fluid is allowed. The valve and the shaft shall be constructed without any packing gland. However, the shaft, bearing, internal part of the body shall remain unexposed to the fluid.

The valve shall not only provide a positive tight shut off at the fully closed position (90 degrees) but also at an angular allowance of a minimum ±4 degrees off the fully closed position.

The disc hub must have a spherically machined convex surface to match that of the spherical concave shape of the liner.

To have proper displacement of the liner during flanging, the rubberlined butterfly valve must have clearance on the circumference between the liner and the body on both sides of the valve.

The butterfly valve shall generally be mounted with the spindle in the horizontal position with the weights of the disc and the shaft being evenly supported by the two bearings. The valve gear box shall be directly mounted onto the valve horizontal spindle. The gear box shall be grease lubricated and suitable for continuous submergence. A mechanical position indicator shall be incorporated at the valve gear box. The above indicator shall give a direct read-out of the spindle position.

Another position indicator shall be provided on the electric actuator.

Lifting lugs on the body shall be provided for ease of installation and removal.

The electrical actuator shall be installed on top of a deck stand mounted on the top of the existing valve chamber. The deck stand's base plate shall be properly supported by adequately sized c-channels spanning across the top of the valve pit. The valve and the electrical actuator mounted outside the pit shall be offset with respect to each other so that future valve removal will not necessitate the removal of the valve actuator. The offset between the actuator and the valve gear box shaft shall be taken up by 2 stainless steel cardan-joints. One joint shall be situated below the deck stand and the other shall be coupled to the gear box input shaft. An intermediate shaft fabricated from stainless steel conforming to BS970 Gr 304 shall be installed between the above cardan-joints. The shaft shall be properly sized with adequate rigidity for transmission of the maximum actuator torque.

Calculations on sizing of the intermediate shaft and cardan-joint shall be submitted for the approval of the Board. A safety margin of at least 20% shall be used in the shaft and cardan-joint sizing.

5.3.2 Butterfly Valve Material

Material used in the manufacture of the valve components shall be as follows:

a) Body : Ductile iron to BS 2789 "specification for spheroidal graphite or modular graphite cast iron".

b) Disc : 316L Stainless Steel

c) Shaft : Stainless steel BS 970 420S37 "general inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steel".

d) Body Lining : Replaceable elastomer EPDM

5.3.3 Valve Tests

All butterfly valves shall be hydrostatically tested to the following pressures:

(i) Body Strength Test (Shell Test) = 1.5 x PN Rating

(ii) Leak Tightness Test (Seat Test) = 1.1 x PN Rating

(iii) Disc Strength Test = 1.5 x PN Rating

(a) Body Strength Test

Test shall be carried out with water, the valve being mounted between 2 unrestrained flanges.

The valve shall be fully assembled with the disc in the opened position. The hydrostatic test shall be applied at 1.5 times the rated pressure of the valve. The sealing between the disc and the liner at the shaft area shall be designed to withstand this pressure. No visible leakage from inside to outside shall be allowed.

(b) Seat Test

Test shall be carried out with water, the valve shall be blanked on one side; the upper part being visible in order to see any eventual leak. This test is done at 1.1 times the rated pressure of the valve and conducted in 4 phases:

(i) The valve is fully closed and the test pressure is applied behind the disc: no visible leakage allowed.

(ii) In order to demonstrate the positive sealing of the valves, the operator will re-open the disc to the minimum 4 degrees and keep the valve in this position: no visible leakage allowed.

(iii) To demonstrate the valve is fully bi-direction, the valve shall be refitted and tested on the opposite side in the fully closed position: no visible leakage allowed.

(iv) Similar to phase (ii), the operator shall re-open the disc to a minimum 4 degrees and keep the valve in this position: no visible leakage allowed.

(c) Disc Strength Test

Test shall be carried out with water, the valve shall be blanked on one side with the disc fully closed in the normal manner. The hydrostatic test pressure shall be applied between the disc and the blanked end at 1.5 times the rated pressure of the valve. The test shall be done on both sides of the disc. No structural damage is allowed. Leakage through the disc edge is not a course of rejection. The testing pressure shall be continuously topped up to compensate for the leakage loss.

Duration of maintaining the valve under different test conditions shall be in accordance to BS 5155 or BS EN 593.

The above tests shall be performed at the manufacturer's works. Two copies of test certificates shall be submitted to the Board. for approval before the valves are despatched. Should the valves fail the above tests, the Contractor shall either replace or rectify the defective valves at their own expense.

The Contractor shall also carry out hydrostatic tests on the valves at site before installation and in the presence of the Board. Test procedures b(ii) & b(iv) can be omitted at the site test. If the valves fail in the site test, the Contractor shall either replace or rectify the defective valves at his own expense.

The Contractor shall supply all necessary labour, material and equipment to carry out the valve tests. Equipment to be used shall include but not limited to accurate gauges, blank flanges, pumps, bolts and nuts, etc. The cost of such tests and blank flanges shall be deemed to be included in the tendered percentage.

5.3.4 Flange Dimensions

Dimensions of flanges and number and size of bolts shall conform to the table below:

Nominal Size of Valve Dia mm	Flange Dia mm	Bolt Circle Dia mm	No. of Bolt Hole	Size of Bolt Hole mm	Dia of Bolt mm	Clear Bore of Pipe With Concrete Lining Mm
2200	2540	2415	48	62	M54	2134.4
1900	2345	2230	48	62	M54	1829.5
1800	2115	2020	44	48	M45	1670.9
1600	1915	1820	40	48	M45	1474.0
1400	1675	1590	36	42	M39	1347.0
1200	1455	1380	32	39	M36	1181.3
900	1115	1050	28	33	M30	876.5
800	1015	950	24	33	M30	771.9
700	895	840	24	30	M27	629.2
500	670	620	20	26	M24	468.9

5.3.5 Identification Plate

Each valve shall bear a stainless steel name plate with the following information engraved:

(i) Name of Manufacturer
(ii) Date of Manufacture
(iii) Manufacturing Standard e.g. BS No...
(iv) Valve diameter
(v) Body Test Pressure
(vi) Seat Test Pressure
(vii) Disc Strength Test Pressure
(viii) Number of turns for full opening of the valve
(ix) Direction of valve opening arrow as shown

OPEN (TURN SPINDLE CLOCKWISE)

Moreover, the pressure rating and flow direction shall be casted onto the valve body. Direction of opening shall be engraved on hand wheel.

5.3.6 Factory Test Certificates

Two copies of the factory test certificates shall be submitted to the Board for acceptance. The Contractor shall be responsible for repeating all the hydrostatic tests of the valves at site before installation (for installation job) or being taken over by the Board (for valve supply job). The Contractor shall provide all necessary labor, equipment and fittings for carrying out the test. If the valves fail the site test, the Contractor shall either replace or rectify the defective valves at his own expense.

6. CONCRETE STOPCOCK BOX WITH COVER AND CONCRETE PIPE

6.1 Concrete Mix

Concrete for stopcock boxes and covers shall be of 1:1½:3 mix by volume with maximum size of coarse aggregate 20 mm and shall comply with the requirements of SS 289.

(i) Cement shall be ordinary Portland cement of approved manufacture and shall comply with SS 26.

(ii) Fine aggregate shall be natural sand or sand derived by crushing stone and shall be perfectly clean, free from coagulated lumps, organic and other impurities and shall comply with SS 31.

(iii) Coarse aggregate shall be crushed granite. It shall be cubical rather that flaky in shape and shall comply with SS 31.

(iv) Water for concrete must be clean, fresh and free from organic or inorganic matter in solution or suspension in such amounts that may impair the strength or durability of the concrete.

Concrete mix for concrete pipes shall comprise one third (1/3) cement and two thirds (2/3) washed sand.

6.2 Test Cube

One test cube (150 mm) shall be made from every batch of concrete mix used for making the stopcock boxes and covers. The 28-day compressive strength of the test cube shall be not less than 25 N/mm^2.

6.3 Mesh Reinforcement

Galvanised steel wire mesh of 25 mm square and wire thickness of 1 mm shall be placed in the stopcock box and cover.

6.4 Marking

The cover for the stopcock box shall be clearly marked with the letters “PUB” and “WD”.

6.5 Finished Product

The surfaces and edges of the finished product shall be clean, smooth and free from blemish. Products which fail to meet the Specifications or of inferior quality shall be rejected.

7. DUCTILE IRON SADDLES

7.1 Material

The saddles shall be made of ductile iron of a quality conforming in all respects to the requirements specified in BS EN 1563:1997. The material used shall be corrosion resisting, free from toxic substances and shall not foster microbiological growth or give rise to taste, odour, cloudiness or discoloration of the water with which they are or could be in contact.

7.2 Coating

Coating shall be executed in accordance with the provisions of BS EN 545:2006.

7.3 Bolts and Nuts

Bolts and nuts shall be hexagon headed stainless steel bolts and nuts complying to Grade 304S11 equivalent in BS EN 10250 Part 4 with high strength and high corrosion resistance.

7.4 Markings

Each saddle shall be legibly marked with the number of the British Standard, nominal size and manufacturer's name/mark.

7.5 Manufacturer’s Certificate

All fittings shall comply in all respects with the provisions of standards, and shall have the certificates from manufacturer certifying that the fittings comply with the standards.

8. STAINLESS STEEL/COPPER PIPES AND BRASS FITTINGS

8.1 Stainless Steel Tubes

Stainless steel tubes shall comply with the requirements of BS 4l27:1994 "Light gauge stainless steel tubes, primarily for water applications". The chemical composition of the tube shall comply with the requirements of material designated 304S11 in BS EN 10250 Part 4. The tube shall be capable of withstanding a hydrostatic test pressure of 35 bar without any sign of weeping, leakage or permanent increase in diameter at any point.

8.2 Copper Tubes

Copper tubes shall conform in all respects to BS EN 1057:1996 “Specification for Copper and Copper Alloys – Seamless, Round Copper Tubes for Water and Gas in Sanitary and Heating Applications”. The tubes shall be supplied in straight lengths in the half-hard condition. The tubes shall be round, clean, smooth and free from harmful defects and from deleterious films in the bore.

The nominal outside diameters and nominal wall thicknesses of tubes complying with BS EN 1057:1996 shall have the dimensions as shown in the following table and tolerances shall comply with Table 4 and 5 of BS EN 1057:1996.

Nominal Outside Diameter d (mm)	Nominal Wall Thickness e (mm)
15	1.0
22	1.2
28	1.2
35	1.5
42	1.5
54	2.0

8.3 Tube Fittings

All fittings used in conjunction with stainless steel and copper pipes shall satisfy the requirements of BS EN 1254 Part 1 & Part 2: 1998 "Copper and copper alloys – Plumbing fittings". The fittings shall be in accordance with the dimensions given in the tables in BS EN 1254 Part 1 & Part 2: 1998. The fittings supplied shall be suitable for use with stainless steel tubes conforming to BS 4127:1994 and with copper tubes conforming to BS EN 1057:1996.

Metals and alloys used shall be of dezincification immune or resistant brass complying with BS EN 12163:1998 or BS EN 12165:1998 and BS EN 12420:1999. The thickness of the fittings shall comply with Table 3 of BS 1254 Part 2:1998.

Union nuts shall be either hexagonal or shall have ribs for tightening. Provision for tightening shall be made on all straight fittings with screwed ends.

The minimum wall thicknesses specified shall not apply to the thickness of the loose ring or sleeve where such a ring or sleeve must be deformed to form a seal.

The screwed ends of fittings shall be BSP threads to BS 21.

8.4 Swivel Type Ferrules

Brass screwed ferrules for insertion into watermains under pressure shall be DZR (dezincification resistant brass). The ferrules shall be screwed to the watermain under pressure. Each ferrule shall be capable of shutting off the water from the main during installation and on subsequent occasions.

The ferrule shall be of the swiveling type. The branch part shall be capable of being rotated 360° with full pressure on and permit horizontal and vertical deflection without leaking. The deflection shall be in place at right angles to the axis of the ferrule.

The ferrules shall pass a test pressure of 20 bar. Every ferrule shall be tested to this pressure and it shall neither leak nor sweat during the test.

Unless otherwise stated the component parts of the ferrules shall be of DZR brass, gunmetal or an equally suitable corrosion-resisting alloy. The composition of the various alloys shall not be less suitable than the quality laid down in BS EN 1982:1999.

Metals and alloys used shall be of dezincification immune or resistant brass complying with BS EN 12163:1998 or BS EN 12165:1998 and BS EN 12420:1999.

Screw threads shall conform to BS 21:Pipe Threads.

The material used for the washers shall have a high tensile strength and resilience. The washers shall be capable of withstanding high compressive forces with negligible permanent set and without disintegration. The material shall not deteriorate on storage. It shall have a high resistance to tearing. It shall be homogeneous. It shall be odourless and tasteless and shall not cause any staining after a compression test in accordance with BS 903, it shall return to its normal thickness. It shall not deteriorate in chlorinated water.

8.5 Markings

Each pipe and fitting shall be legibly marked with the number of the British Standard, nominal size and manufacturer's name/mark.

8.6 Manufacturer’s Certificate

All fittings shall comply in all respects with the provisions of standards, and shall have the certificates from manufacturer certifying that the fittings comply with the standards

9. AIR VALVES

9.1 Size, Material and Type of Air Valves

All air valves of 20mm, 25mm, 80mm and 150mm inlets shall be made of ductile iron, lined with approved material or of stainless steel 316 with/without lining suitable for water application. The air valves shall conform generally to the relevant British Standards or their equivalent.

The 20mm, 25mm & 80mm air valve is to be used on 300mm diameter water pipeline, while 150mm air valves are for 500 mm to below 1400mm diameter water pipeline. For 1400mm and above diameter water pipeline, twin 150mm air valves are to be used. They shall be of DOUBLE BALL / ORIFICE type. The small ball shall operate when the pipeline is under normal operating conditions, and the large ball shall operate when the pipeline is being filled or emptied. The balls shall not close the valve when air is being drawn in or discharged out even when air is flowing at a critical velocity of 304.8 m/s.

9.2 80mm and 150mm Air Valves

9.2.1 Flanges

All air valves of 80 mm and 150 mm shall have flanged connections. The flanges shall comply with BS EN 545 for PN10 flanges even though the air valves are required to operate at 16 bar working pressure.

9.2.2 Double Orifice

Both the 80mm and 150mm air valves shall be of double orifice 'Aerokinetic' type incorporating hydrodynamic principles. The ball-sealed orifice shall always remain open while air is discharged and shall be immediately closed when the water rises in the valve to lift the ball and seal the orifice. The escaping turbulent air or a mixture of air and water spray (even at the critical velocity of 304.8 m/s) shall not cause the ball to be thrown into the discharge air stream and be blown shut prematurely during the filling of the pipeline at high rate.

Under no circumstances shall the large orifice ball blow shut prematurely.

The neoprene seat ring of the large orifice shall be held securely in place under the top cover by a joint supporting ring to prevent it from sagging when the ball is not sealing the orifice.

The function of the ball of a large orifice shall follow a calculated mathematical relation with the inlet diameter of the valve (i.e. the average cross-sectional area of escaping air stream) so that the ball will be blown shut by a stream of water but held down by a stream of air. The buoyancy of the ball shall be such that it will ensure effective sealing of the large orifice even at low pressure. The weights of each ball of the same size and type shall not differ by more than 2%.

The material of the small orifice for both the 80mm and 150mm air valves shall be made of either gunmetal or stainless steel 316 or other metal with non-corrodible coating and lining suitable for water application. The profile of the orifice shall be of a good design that will avoid damage to the ball surface. The small orifice shall be protected with a suitable plug of stainless steel 316 where appropriate.

9.2.3 Hydraulic Tests for Air Valves

The valve shall be mounted on a test bench and subjected to the hydraulic pressure of 25 bars for a period of l0 minutes and there shall also be no leakage through the valve body nor shall any part be permanently deformed. Subsequently the hydraulic pressure shall be reduced to 0.3 bars and during this low pressure there shall be no water leakage through any of the orifices.

9.2.4 Pressure

The working pressure shall be 16 bars. The test pressure shall be 25 bar. This means the valve shall not permit any water to leak at a pressure of 25 bar.

9.2.5 Balls

The balls shall be made of stainless steel 316 and coated with rubber which is suitable for water application, or other materials suitable for the same application. The sizes and materials of which the balls are made of must be stated clearly by the tenderer.

9.2.6 Insect Proofing

All air valves shall be made insect-proof by providing stainless steel 316 wire screens at the vents leading to the atmosphere.

9.2.7 Materials and Finishes

All the working parts of the air valves shall be machined and finished with the greatest care.

All materials used shall be corrosion resistance, free from toxic substances, and shall not foster microbiological growth or give rise to taste, odour, cloudiness or discoloration of water.

9.2.8 Coating

The inside and outside surfaces of the air valves shall be protected with corrosion resistance coating/lining. All metal parts of the air valve except the balls, which will be in contact with water shall be made of stainless steel 316 or lined with any of the approved materials listed below:

(i) 100% rigid solid polyurethane
(ii) Medium density fusion-bonded polyethylene
(iii) Fusion-bonded epoxy
(iv) Cement-lined (applicable only for cement lined pipes and fittings)

9.2.9 Bolts and Nuts

Bolts shall be made of stainless steel 316 and shall have hexagon heads and be provided with hexagon nuts. The threads on bolts, stud bolts and nuts shall be of the coarse pitch series similar to that specified in BS 3643: Part 2: 2007 'ISO metric screw threads. Specification for selected limits of size'.

9.2.10 Markings

The following marks and figures shall be cast on to the bodies of the air valves:

(i) Manufacturer's name or trade mark
(ii) Nominal size
(iii) Nominal pressure designation (PN16)
(iv) WD /Year of manufacture, e.g. WD / 2013
PUB PUB

10. STAINLESS STEEL SPLIT TEES

10.1 Dimension of Stainless Steel Split Tees

The stainless steel split tees will be used for underpressure connection of DI pipes manufactured in accordance with BS 4772 or BS EN 545 and CI pipes manufactured in accordance with BS 4622. The split tees shall be suitable for use on pipes with external diameters given in the table below:

Nominal Pipe Size	**External Diameter of Pipes**	
	Max (mm)	**Min (mm)**
100 mm (4")	119.0 mm(4.88")	115.0 mm (4.72")
150 mm (6")	171.0 mm (7.06")	167.0 mm (6.90")
200 mm (9")	223.0 mm (10.28")	218.5 mm (10.12")
300 mm (12")	327.0 mm (13.68")	322.5 mm (13.52")

The split tees shall be designed to withstand a hydraulic pressure of 15 bar and an operating pressure of 10 bar. The flange outlet shall have diameters of 100 mm, 150 mm, 200 mm and 300 mm. The bolt holes shall be either drilled or cored in accordance with PN 10 flanges.

10.2 Materials

The body and neck of split tees shall be of stainless steel to Grade 304S11 equivalent in BS EN 10250 Part 4. The stainless steel shall be passivated. The flange shall be of stainless steel in Grade 304S11 equivalent in BS EN 10250 Part 4.

The lugs shall be of stainless steel; bolts and nuts shall be of stainless steel or heavy duty mild steel with zinc coating.

The rubber compound gaskets shall be designed with grids on the sealing surface and with tapered ends to provide for positive seal. The rubber gaskets should have a high resistance to tearing and shall not be affected by weather or storage. The gasket shall have a high tensile strength and resilience and also shall be capable of withstanding high compressive forces with negligible permanent set and without disintegration.

Materials used shall be corrosion resisting and non-porous, free from toxic substances and shall not foster microbiological growth or give rise to taste, odour, cloudiness or discoloration of the water with which they are, or could be, in contact.

10.3 Ductile Iron Split Tees

Ductile iron split tees may be used instead of stainless steel split tees. Ductile iron material shall comply with BS EN 545:2006 Specification for Ductile Iron Pipes and Fittings. Other details, including dimensions and materials used for gaskets, shall follow those stipulated in the foregoing paragraphs for stainless steel split tees.

10.4 Markings

Each split tee shall be legibly marked with the number of the British Standard, nominal size and manufacturer's name/mark.

10.5 Manufacturer’s Certificate

All fittings shall comply in all respects with the standards, and shall have the certificates from manufacturer certifying that the fittings comply with the standards.

11. DUCTILE IRON FLANGED SLUICE VALVE WITH RUBBER BONDED WEDGE GATE

11.1 Standard for Sluice Valves

All flanged sluice valves shall conform to British Standard Specification 5163-1:2004 and 5163-2:2004 “Part 1: Predominantly key-operated cast iron gate valves – Code of practice” and “Part 2: Stem caps for use on isolating valves and associated water control apparatus – Specification”, unless otherwise specified. The sluice valves testing standards shall conform to BS EN 1074-1 and BS EN 1074-2 “Valves for water supply – Fitness for purpose requirements and appropriate verification tests – Part 1: General requirements” and “Valves for water supply – Fitness for purpose requirements and appropriate verification tests – Part 2: Isolating valves”, unless otherwise specified

11.2 Description of Flanged Sluice Valves

The sluice valves shall be double flanged ductile iron sluice valves with rubber bonded wedge gate and shall conform to BS 5163 for nominal pressure of 10 bar (PN 10). The valves shall be manufactured for manual operation and installation on buried horizontal pipelines unless otherwise specified.

The design of the valves shall be such that it is possible to remove the gates without removing the bodies from the connecting pipework. The gate guides shall be cast integrally with the valve bodies. These shall be of adequate strength and of sufficient length to guide the gates throughout their full travel. In the full open position, the gates shall be fully withdrawn well clear of the stream and the spindles shall not protrude into the bores of the valves.

11.3 Quality of Materials

Materials used in the manufacture of valve components shall comply with BS 5163-1 & 2:2004 & BS EN 1074-1 & 2: 2000.

(i) The Ductile Iron used shall be in accordance with BS EN 545:2006.

(ii) The valve spindle shall be made of stainless steel complying to Grade 431S29 in BS 970:Part 1. At the time of manufacture of the actual spindle a portion of the spindle material shall be set aside for tensile test.

(iii) Gunmetal of composition not less suitable than the quality laid down in BS 1400:1985 or BS EN 1982:1999 shall be used for wedge rings, body rings and spindle nuts. Test for Brinell Hardness shall be in accordance with ISO 6506-1.

(iv) Other materials used in the manufacture of Sluice Valves shall be of the

best description of their various kinds, homogeneous in composition, free from all flaws and defects, and of uniform maximum strength.

(v) All materials that are likely to come into contact with water intended for human consumption should comply with BS EN 1074-1 and, for non-metallic materials including lubricants, the requirements of BS 6920-1.

(vi) Materials used shall comply strictly with Appendix B in BS 5163.

11.4 Wedge

The wedge shall be double faced, made in one piece and bonded with synthetic rubber on the upstream and downstream faces of the ductile iron gate to form an axial and butt seal against the ductile iron valve body. The material used for the resilient element shall be of nitrile rubber or EPDM complying with BS EN 681-1:1996. The Nut-Box shall be cast on the top of the wedge for the reception of the gunmetal spindle nut. The recess for the spindle nut shall be smooth and even so that on opening or closing the valve, stresses are evenly distributed over the bearing areas.

11.5 Spindle

The spindle stem shall be of the inside screw non-rising type. The stem threading shall be sufficiently long to give a full flow passage through the valve. The stem and nut threads shall be fully engaged at all times, from fully open to fully closed position. All threads shall be rolled form and shall have square, right-handed, round bottom threads which shall be of 12.7 mm pitch (single thread). The seal for the spindle shall be by toroidal sealing ring (0-ring) in accordance with BS 5163.

11.6 Thrust Collar

The spindle shall have a thrust collar, must be (forged as an integral portion of the spindle) which shall work against gunmetal bushes inserted in the valve cover, and shall be designed for the specified test pressure. The thrust collar and gunmetal bush in each valve shall be ground together so as to form a water-tight joint, to enable the valve to be packed while under pressure. The thrust collar of the spindle shall rest upon a gunmetal washer recessed in the top flange of the dome piece.

11.7 Spindle Nut

The spindle nut shall be of gunmetal, screwed with a square thread to suit the spindle, and the nut shall be properly fitted to the corresponding recess in the wedge. The thickness and bearing areas of the shoulders of the nut shall be adequate to resist the operating thrust.

11.8 Diameter of Bore

The bore of the valves shall have the dimensions shown in the following table and the manufacturing tolerances shall be plus or minus 1.5 mm.

Nominal Size of Valve (mm)	Diameter of Bore (mm)
100 150 200 300	100 150 200 300

It shall be possible to insert a cylinder of the appropriate (outside) diameter through the valve with the axis of the cylinder perpendicular to the flange.

11.9 Flanged Ends of Valves

Flanged ends of valves shall be at right angles to and concentric with the axes of the bore and shall be machined right across the full width of the face. The "Black" shall be completely machined away, but the casting and flange shall hold up fully to the requisite dimensions. Flanges shall be drilled and bolt holes shall be "off-centres". The valve flanges shall comply with the general requirements for ductile iron flanges in BS EN 545:2006 for PN 10 flanges. The dimensions of the valve flanges shall be as given in the table below:

Nominal Size of Valve mm	Thickness of Flange (Ductile) mm	Flange Dia mm	Pitch Circle Dia mm	No. of Bolt Hole	Size of Bolt Hole mm	Dia of Bolt
100	19	220	180	8	19	M16
150	19	285	240	8	23	M20
200	20	340	295	8	23	M20
300	24.5	455	400	12	23	M20

11.10 Hydrostatic Pressure Tests for Sluice Valves

All sluice valves shall be subjected to both closed end and open end hydrostatic pressure tests for PN 10 valves in accordance with BS 5l63 and BS EN 1074. Pressure for the valve seat test in the closed end position shall be 11 bar, and for the test in the open end position shall be 15 bar for all the valves.

While under the test pressure, each valve shall be smartly struck with a suitable hand hammer weighing not less than 0.7 kg. All valves shall be tested under cover.

All sluice valves shall be subjected to type testing as specified in BS 5163 & BS EN 1074. Type testing shall consist of the following tests in the sequence specified:-

(i) Pressure testing
(ii) Strength testing
(iii) Functional testing

11.11 Direction of Rotation for Opening of Valves

The spindles of all valves shall be screwed so as to **OPEN** the valves when the valve key or handwheel is rotated in a **CLOCKWISE** direction.

11.12 Markings on Valves

The following marks and figures shall be cast on to the bodies of all the valves:

(i) Direction of valve opening arrow as shown above.
(ii) Manufacturer's name or trade mark.
(iii) Nominal size
(iv) Nominal pressure designation (PN 10)
(v) Year of manufacture

Valve manufacturing serial number shall be clearly indicated on each valve for traceability.

A reasonable size brass plate shall be tacked to the top cover of valve to indicate number of turns for full opening of the valve.

11.13 Coating of Valves

The valve body shall be internally and externally coated with fusion bonded epoxy and complying with SS 375 or BS 6920.

11.14 Flanged Faces of Component Parts of Valves

All flanged faces shall be machined right across the full width of the face and the "Black" shall be completely machined away, but the casting and flange shall hold up fully to the requisite dimensions. All flanges shall be cast to ensure fair bedding of the nuts and bolt heads and holes shall be accurately centred and drilled to give a clearance of l.5 mm for the bolts. The bonnet bolts shall be cap screw and sealed with hot melt wax. Thus there is no risk of corrosion as the bolts are not exposed to the medium or soil.

11.15 Flange Jointing Material

The jointing material used between the flanges of component parts of the valve shall be rubber insertion cloth not less than 3 mm thick, and shall conform to the requirements for Rubber insertion jointing material reinforced with fabric in BS 6956. The width of the jointing material shall be such that it completely covers the machined face of the flanges.

11.16 Bolts and Nuts for Valve Flanges

Stainless steel hexagon bolts and nuts shall be provided in accordance to Grade 304S11 equivalent in BS EN 10250 Part 4. The bolts and nuts shall comply with BS 3692 or BS 4l90 with dimensions appropriate for the purpose. The threads on bolts, stud bolts and nuts shall be of the coarse pitch series in accordance with BS 3643:Part 2:1981. Exposed portions of bolts and nuts shall be coated with bitumen based coating material.

11.17 Manufacturer's Certificate and Test Reports

The valve shall comply in all respects with the provisions of BS 5163, and shall have the following test certificates/reports:

a Dimension check
b Type tests, including pressure, strength and functional tests
c Tensile test
d Chemical analysis
e Brinell hardness test
f Production pressure tests

12. DUCTILE IRON VALVE BOXES

12.1 General

All carriageway ductile iron valve boxes installed at the site must:

(i) have non-rocking movement from vehicular movement.

(ii) not generate any audible noise from vehicular movement.

(iii) restrict ingression of debris into the chamber.

(iv) prevent mosquito breeding.

(v) have an opening that enable valve spindle to be operated easily.

(vi) have cover that incorporate a wedge seating or alternate proposal to ensure silence operation. Any such design must be capable of being opened by means of a prising bar or usual tools as keyhole. The latter shall also prevent mosquito breeding.

(vii) have safety chain/ hinge or alternate proposal between inner cover and frame to prevent the cover from being accidentally dislodged.

12.2 Standards

All carriageway ductile iron valve boxes shall conform to all the requirements of SS 30:1999 Grade A1 unless otherwise specified. (If these ductile iron valve boxes are installed at site **without** vehicular loading, for eg turf area or sidetable, Grade A2 may be used).

12.3 Materials

The material shall be of suitable quality ductile iron complying with SS 30:1999.

12.4 Testing

Sampling for loading test and method of load testing shall be in accordance with SS 30:1999 Grade A1.

12.5 Rubber Seating

Rubber seatings shall be made of vulcanized natural rubber. The quality of the rubber shall be that of hardness range from 56 to 65 in Table l of BS 2494:1990 "Elastomeric Seals for Joints in pipework and pipelines", or SS 270:1996.

12.6 Protective Coating

All valve boxes shall be supplied coated with a bitumen based composition to BS 3416 or SS 83. The coating shall be smooth and tenacious, shall not flow or chip when exposed to temperature of between 0°C and 63°C.

12.7 Marking

All valve boxes shall have markings cast on the top surface.

12.8 Manufacturer's Certificate and Test Reports

The carriageway ductile iron valve boxes shall comply in all respects with the provisions of SS 30:1999, and shall have the following test certificates/reports:

(i) Dimension check
(ii) Loading test for Grade A1
(iii) Tensile test for ductile iron material
(iv) Chemical analysis
(v) Brinell hardness test for ductile iron material
(vi) Brinell hardness test for rubber seating
(vii) Porosity check (the sizes and distribution of the voids present, if any, shall not affect the performance and function of the valve box)

13. FIRE HYDRANTS

13.1 Materials

The body of the hydrant shall be made of grey cast iron of a quality conforming in all respects to the requirements specified in BS EN 1561:1997, or ductile iron to BS EN 1563:1997. The arms of the hydrant shall be of brass or gunmetal of a quality not less than that specified in BS EN 1982:1999.

All materials used shall be corrosion resisting, free from toxic substances and shall not foster microbiological growth or give rise to taste, odour, cloudiness or discoloration of the water with which they are or could be in contact.

13.2 Marking

The following shall be cast on the body of the hydrant:-

(i) PUB /year of manufacture: eg PUB/2013
WD WD
(ii) Manufacturer's identification mark.

13.3 Workmanship

The hydrants shall be of first class construction, workmanship and finish and shall have machined joint faces throughout. The fitting of adjoining parts shall be such as to make a sound joint. Corresponding parts of hydrants of the same design and manufacture shall be interchangeable.

13.4 Coating

All external surfaces of the fire hydrants shall be painted. The fire hydrants shall be thoroughly cleaned to remove all rust, dirt, grease, etc. Immediately thereafter the bare metal surface shall be painted with two coats of approved epoxy based red lead primer of a grade suitable for prolonged storage. A third and final coating of red enamel paint shall then be applied to give the hydrant a glossy surface. The final coating shall be in Safety Red (B.S. Code 04 E 53). The internal surfaces of the fire hydrants shall be coated with epoxy.

13.5 Hydrostatic Pressure Test

Each fire hydrant shall undergo hydrostatic pressure test to 16 bar in accordance with the procedures outlined in BS 750:1984.

13.6 Manufacturer's Certificate and Test Reports

All hydrants shall comply in all respects with the standards, together with the following test reports:

(i) Dimension check.
(ii) Hydrostatic pressure test.
(iii) Tensile test for cast iron material.
(iv) Chemical analysis.
(v) Brinell hardness test for cast iron material.

14. GROUND HYDRANT FLANGED SCREW NOZZLE, FIRE HYDRANT ARM CAP WITH CHAIN AND INDICATOR PLATE AND POST

14.1 Materials

The ground hydrant flanged screw nozzle, fire hydrant arm cap and the indicator plate shall be made of grey cast iron of a quality conforming in all respects to the requirements specified in BS EN 1561:1997, or ductile iron to BS EN 1563:1997.

The chain shall be made of mild steel conforming to BS EN 10155 or BS EN 10113. The rubber gasket for hydrant arm cap shall be made of natural rubber conforming to BS 903. The post shall be made of galvanised steel tubes to SS 17 medium grade or JIS G 3442 or BS 1387.

All materials used shall be corrosion resisting, free from toxic substances and shall not foster microbiological growth or give rise to taste, odour, cloudiness or discoloration of the water with which they are or could be in contact.

14.2 Coating

The external surface of the ground hydrant flanged screw nozzle, hydrant arm cap and indicator plate and post shall be painted with two coats of approved epoxy based red lead primer of a grade suitable for prolonged storage. The final coating shall be in Safety Red complying with BS Code 04 E 53.

14.3 Hydrostatic Pressure Test

Each ground hydrant flanged screw nozzle and fire hydrant arm cap shall undergo hydrostatic pressure test to 16 bar.

14.4 Markings

Each fitting shall be indelibly marked with the number of the British Standard/Singapore Standard Specifications, nominal size, manufacturer's name/mark and "PUB".

14.5 Manufacturer’s Certificate and Test Reports

All hydrants shall comply in all respects with the standards, together with the following test reports:

(i) Dimension check.
(ii) Hydrostatic pressure test.
(iii) Tensile test for cast iron material.
(iv) Chemical analysis.
(iv) Brinell hardness test for cast iron material.