

DUCTILE IRON PIPES AND FITTINGS

DETAILED PRODUCTS SPECIFICATIONS

General

All Materials shall be EN, ISO or equivalent standard and shall be supplied from approved manufacturers. According to the International Standard ISO 9001:2000, the manufacturer must produce according to the latest version of the products Standards ISO and EN.

The Manufacturer or Supplier shall be specific as to the country of origin and the manufacturing firm of the materials he intends to supply under this contract. All pipes, fittings and valves shall be suitable for buried installation.

Coordination

As per EN 545-2010, the Manufacturer or Supplier shall assume full responsibility for the complete compatibility of all elements of each piping system he will provide (this must be certified by an eligible Third Party). The Manufacturer or supplier shall furnish suitable transition pieces and special fittings acceptable to the Engineer where required to ensure compatibility of piping with valves, and other items of equipment he will supply.

APPLICABLE CODES AND STANDARDS

The codes and standards generally applicable to the work under this section are listed below, equivalent standards are acceptable but internationally recognized standards will be preferred. Codes and standards current at the time of bid shall be used.

ISO 2531:2009:	Ductile iron pipes, fittings, accessories and their joints for water or gas applications
EN 545:2010:	Ductile iron pipes, fittings, accessories and their joint for water pipelines. Requirements and tests methods.
ISO 4179:2005:	Ductile iron pipes and fittings for pressure and non-pressure pipelines.- Cement mortar lining.
ISO 8179-1:2004:	Ductile iron pipes-External zinc based coating. Part 1- Metallic zinc with finishing layer.
ISO 4633:2002:	Rubber seals- joint rings for water supply, drainage and sewerage pipeline-specifications for material.
ISO 7005-2:1988:	Metallic Flanges - Flange Dimensions
EN 14910: 2006:	Ductile iron pipes, fittings and accessories-Epoxy coating (heavy duty) of ductile iron fittings and accessories-Requirement and tests methods.
EN 15542:2006:	Ductile iron pipes, cement mortar coating for pipes-Requirement and tests methods.
ISO 8180:	Polyethylene sleeve

Ductile Iron Material Characteristics

The ductile iron materials shall meet the following requirements:

Material Characteristics	Pipes Centrifugally Cast	Pipes not Centrifugally Cast, Fittings, Accessories
Minimum Tensile strength (MPa)	420	420
Minimum elongation at break (%)		
DN 40 to 1000 mm	10	5
DN 1100 to 2000 mm	7	5
Maximum Brinell hardness (HB)	230	250

By agreement between manufacturer and purchaser, the 0.2% proof stress (Rp0.2) may be measured. It shall be not less than:

270 MPa when $A \geq 12\%$ for DN 40 to DN 1000 or $A \geq 10\%$ for DN > 1000.

300 MPa in other cases.

Ductile Iron Pipes

Ductile iron pipes shall be centrifugally cast in accordance with the European Standard EN 545:2010.

Centrifugally cast pipes shall be subjected to a work hydrostatic test for duration of at least 10 seconds at a minimum pressure given in EN 545:2010 Standard, depending on the class of pipes.

Pipes, pipe-fittings and joints class adjusted by the contractor based on the final design for each segment must be able to withstand normal working conditions especially inner pressure, external strains, overloads and reactions from soil or supports taking into consideration the surge and test pressures.

Unless not specified in the specification, the manufacturer has to produce the pipes according to the following requirements:

Useable cutting length:

According to EN 545:2010 Standard, cutting of pipe DN ≤ 300 mm can be made anywhere along 2/3rds of the length of the pipe working from the spigot.

For other diameters the contractor shall clearly mention the number of pipes to be calibrated.

Ductile Iron Fittings

Ductile iron fittings shall be sand cast in accordance with the European Standard EN 545:2010.

The dimensional requirements are indicated in the above mentioned Standards.

The fittings shall be submitted at the works to a leak-tightness test carried out either with air at a pressure of 1 bar or with water in accordance with EN 545:2010.

The fittings shall be designed and manufactured as automatic push-on joint type (Tyton and/or Standard or equivalent), flanged type and self-anchored automatic push-on joint type, mechanical joints shall be used for collars or couplings only.

Each socket joint shall be supplied with its EPDM gasket, (and glands and bolts when mechanical or anchored type).

Each flange joint shall be supplied with gasket and bolts (not less than zinc coated 15-20 microns in accordance to ISO 4014 and ISO 4032) for all sides and flange connection shall be in accordance with ISO 7005-2.

JOINTS

Flexible Joints

Flexible Joint shall be of spigot socket automatic push-on joint type (Tyton and/or Standard or equivalent), mechanical type (for collars or couplings only).

The joint shall be suitable for angular deflection.

Joints may permit angular deflection to accommodate ground movements and negotiate large radius bends. The angle deflection shall be as per the table below:

- 5 ° for DN 80 to 300
- 4° for DN 350 to 400
- 3 ° for DN 500 to 1000
- 1 ° 30 for DN 1200 to 2000

Higher angular deflection shall be accepted.

The material used for the rubber gaskets shall be an EPDM elastomer, in accordance with ISO 4633:2002 and duly certified as suitable for potable water up to 50°C.

Flanged Joints

Flanged ended pipes and fittings shall be used when connecting to valves or other special fittings.

The flanges shall be raised face and integrally cast rotatable flanges may be used for fittings up to DN 600 mm.

The dimensions and the drilling of the flanges shall be in accordance with the International Standard ISO 7005-2 or the European Standard EN 1092 -2. The pressure rating of the flanges shall be as given in the particular specifications. Flanged joints shall be supplied complete with gaskets and bolts.

Rubber gasket shall be EPDM elastomer in accordance with the International Standard ISO 4633: 2002 and duly certified as suitable for potable water up to 50°C. The gasket shall be reinforced and suitable for a minimum pressure rating of 10 bars and higher.

Anchored Joints

Ductile iron pipes and fittings may be anchored to be used where pipelines have to cross through existing ducts, in areas with restricted accessibility, when the use of concrete anchor blocks is prohibited or impossible, or when the pipes must be pulled during the installation and for mains on steep slopes (> 25%).

Anchored joint shall be designed to resist to the axial thrust forces but maintaining flexibility and angular deflection as mentioned in Table below. Anchored joints shall be designed to withstand the greater of the pressure or the service pressure + surge pressure or the site test pressure.

The socket ends of all pipes and fittings shall consist of two chambers: a sealing chamber for the gasket and a locking chamber for the restraining locks. The spigot ends of all pipes and fittings shall induce a factory applied welding bead to fit inside the restrained socket. No bolts, nuts, and glands shall be used as part of the

locking joint. The locking mechanism shall be a resultant of the direct contact between the welding bead and the corresponding number of locking segments as shown in Table below. The locking segments shall be of ductile iron.

DN	Axial Deflection	Component Operating Pressure PFA (Bar)	Permitted Tractive Force (kN)
80	5°	100 / 1101)	115
100	5°	75 / 1001)	150
125	5°	63 / 1001)	225
150	5°	63 / 751)	200
200	4°	42 / 631)	350
250	4°	40 / 441)	375
300	4°	40	380
400	3°	30	650
500	3°	30	860
600	2°	32	1525
700	1.5°	25	1650
800	1.5°	25	1460
900	1.5°	16 / 252)	1845
1 000	1.5°	10 / 252)	1560
*All calculations are made based on K9 wall thickness for all pipes			
1) An additional high - pressure lock is installed in the joint. 2) Wall thickness class K10			

WALL THICKNESS

General

For pipes centrifugally cast, the minimum wall thickness, e_{min} , shall not be less than 3,0 mm. The nominal wall thickness, e_{nom} , is equal to the minimum wall thickness, e_{min} plus $(1,3 + 0,001 DN)$.

The thickness shall be as per Class 50, Class 40, Class 30 and Class 25 for pipes of DN 40 to DN 2000.

For fittings, the thickness is according to EN 545-2010. The nominal thickness corresponding to the main part of the body. The actual thickness at any particular point may be increased to meet localized high stresses depending on the shape of the casting (e.g. at internal radius of bends, at the branch-body junction of tees,...).

Preferred Pressure Classes: Class 40, Class 30, Class 25

Pipes should be manufactured according to the preferred pressure class as per the final design provided by the contractor and approved by the engineer.

Pipes, pipe-fittings and joints class adjusted by the contractor based on the final design for each segment must be able to withstand normal working conditions especially inner pressure, external strains, overloads and reactions from soil or supports taking into consideration the surge and test pressures.

The nominal iron wall thickness of pipes DN 60 to DN 2000 is given as a function of the nominal size DN in the below table. Minimum preferred wall thicknesses shall be according to EN545:2010 as follows:

DN	External Diameter DE mm	Minimum Wall thickness (mm)		
		Class 40	Class 30	Class 25
60	77	3.0		
80	98	3.0		
100	118	3.0		
125	144	3.0		
150	170	3.0		
200	222	3.1		
250	274	3.9		
300	326	4.6		
350	378		4.7	
400	429		4.8	
450	480		5.1	
500	532		5.6	
600	635		6.7	
700	738			6.8
800	842			7.5
900	945			8.4
1000	1048			9.3
1100	1152			10.2
1200	1255			11.1
1400	1462			12.9
1500	1565			13.9
1600	1668			14.8
1800	1875			16.6
2000	2082			18.4

LINING AND COATINGS

Socket and Spigot Pipes (Including Welded Flanged Pipes)

1. Internal Protection

Pipes will be internally lined with a sulphate resistant blast furnace slag cement mortar applied by a centrifugal process, in accordance with the International Standard ISO 4179:2005 and the European Standard EN 545:2010, with the following thicknesses:

DN	Thicknesses (mm)	
	Nominal	Tolerance
60-300	4	-1.5
350-600	5	-2
700-1200	6	-2.5

1400-2000	9	-3
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2. External Protection

Pipes will be externally protected with suitable coating with an Alloy of zinc and aluminium with or without other metals (85%Zn-15%Al) coating followed by a finishing layer in accordance with EN 545-2010.

The alloy of zinc and aluminium shall contain zinc at minimum 85% and aluminium at 15% and the mean mass of alloy zinc and aluminium coating shall not be less than 400 g/m² applied on the bare metal of the external surface of the pipe.

The finishing layer shall uniformly cover the whole surface of the metallic zinc aluminium alloy layer and be free from such defects as bare patches or lack of adhesion. The uniformity of the finishing layer shall be checked by visual inspection. When measured in accordance with EN545:2010 paragraph 6.7, the mean thickness of the finishing layer shall be not less than 70 µm and the local minimum thickness not less than 50 µm.

Fittings

Internal and External Protection

Fittings will be internally and externally protected depending on the corrosiveness of soils, with:

The fittings laid in non corrosive soils shall be internally and externally protected with a **fusion bonded epoxy coating** with a minimum dry film thickness of **250 microns**, according to the European Standard EN 14901:2006, for corrosive soil the thickness will be **300 microns**.

MARKING

All pipes and fittings shall be legibly and durably marked and shall bear at least the following information:

1. The Manufacturing Unit.
2. The identification of the year of manufacture.
3. The identification as ductile iron.
4. The DN.
5. The PN rating of flanges when applicable.
6. The reference to the standard.
7. The C class designation of centrifugally cast pipes.

The first **five markings given above shall be cast-on or cold stamped**; the other markings can be applied by any method, e.g. painted on the casting or attached to the packaging.

GASKETS AND SEALS

The material used for the rubber gaskets shall be an EPDM elastomer, in accordance with ISO 4633:2002 and duly certified as suitable for potable water up to 50°C, by one of the national regulations.

Sufficient lubricant as recommended by the pipe manufacturer shall be provided for pipe installation plus ten percent as surplus material. Lubricant containers shall be adequate for extended storage and the pipe manufacturer shall supply instructions for storage limitations and environment.

FACTORY TESTING

Inspection for external appearance, shape and dimensions shall be carried out on each pipe and fitting. All pipes and fittings shall be sound and free from surface defects.

Each pipe centrifugally cast shall be subjected to the hydrostatic pressure test as specified in EN 545-2010. Hydrostatic pressure tests shall be performed before the pipes are coated or lined. Each fittings and accessory not centrifugally cast shall be subjected to a leak tightness carried out with water or air as specified in EN 545-2010.

Any pipe or fitting that leaks or does not withstand the test pressure shall be rejected.

Mechanical tests for hardness, tensile strength, and elongation shall be performed on pipes selected at random out of castings grouped in lots. Each lot shall comprise 200 pipes successively cast.

STORAGE OF THE MATERIALS

The contractor shall be responsible for the handling, storage and well-being of all materials purchased under this contract, until the delivery defined as per the sales condition of the contract.

The Manufacturer or Supplier will provide to the Tenderer and the Engineer the best practices and advice to be followed regarding the transport, handling and storage of the offered products.

Product Handling

Pipe, fittings, and appurtenances shall be transported, stored, and handled in a manner which prevents damages (protected hooks, textile straps...). As per the Manufacturer or supplier provided handling recommendations and best practices.

PVC PLASTIC PIPE AND FITTINGS

A. PVC, AWWA Pipe: AWWA C900, Class 200, or equivalent PN 16 pressure class ISO 4422/EN1452 UPVC Water Main, with bell end with gasket, and with spigot end.

B. Comply with UL 1285 for fire-service mains if indicated.

C. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

D. Gaskets: AWWA C111, rubber.

E. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

F. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts

Commented [o1]: Pls indicate applicable pressure rate.

SUPPLY OF VALVES

1.1 General for Material of Valves

Unless otherwise specified, materials should comply with the following requirements.

1. Valves body and measuring devices shall be ductile iron.
2. The material shall conform to EN GJS 400-18 according to EN 1563 and ISO 1083 and EN GJS 400-15, 500-7 or ASTM A216-WCB for pressures mentioned above and in the BOQ.
3. Valve stems shall be 410 or stainless steel according to EN 10088-1 and shall be non- rising for gate valves.
4. Stem nuts shall be made of high tensile brass, or gunmetal.
5. Hand wheels and hand wheel nuts shall be malleable iron or steel
6. All name plates and tags shall be stainless steel or plastic.
7. Stainless steel should be 13% chromium minimum conforming to EN10088-1 or DIN 17440 or ASTM A276 or other equivalent standards.
8. Brass should be high tensile brass conforming to EN 1982 or DIN 17660 or ASTM B62 or other equivalent standards.
9. All coatings and materials in contact with water should be certified as suitable for use in potable water.
10. All the valves with their fittings, joints and accessories shall designed and produced to withstand without any failure or leakage due to all the forces resulted from the minimum working pressure as shown in the drawings plus 8 bars as surge pressure and appropriate for the hydraulic test pressure.
11. Each valve shall be factory tested individually under pressure of 1.5 P max when it is full open and 1.1 P max when it is closed in accordance with ISO 5208 based on the pressures mentioned above.
12. Valves shall close clockwise, and all valves shall be flanged. Flanges shall comply with ISO 7005-2 or EN 1092-2 or equivalent from other Standards.
13. All valves shall be have integrated standard flanged
14. All valves except the Air Valve and Flap valve shall be with standard face to face flanged.
15. All valve flanges dimensions shall comply with those given in ISO 7005-2 or EN 1092-2 and shall tight with the flanged pipes, fittings and all coupling joints mentioned other parts.
16. The flanged shall drill in accordance with ISO 2531-1998(E), EN 545:2002(E).

All type of valves, strainers, and measuring devices shall be cleaned and shot-blasted in accordance with ISO 8501-1 Grade SA 2.5, and protected internally (lining) and externally (coating) with fusion bonded powder epoxy to minimum thickness of 300 microns. In addition to manufacturer's standard exterior finish

1.2 Gate Valves

Gate valves for nominal diameter of DN 80 mm, DN100 mm, DN 150 mm, DN 200 mm and DN 250 mm according ISO 5996, ISO 7259, EN 1171 and EN 1074-1-2.

Short type valves shall be used where necessary to gain space, for example in concrete chambers. The valves shall be of the double flange type, utilizing the same differential pressure across the gate, of PN 16, PN 25 with screw less bonnet connection, pressure loaded and pressure sealed with easy assembly and dismantling of functional parts or otherwise with stainless steel connected bonnet.

Gate Valves must be but not limited to:

1. Un- capsulated valve for easy and fast maintenance.
2. The body, the bonnet, the yoke, the bush nut and the gate shall be made of ductile iron in accordance with standards mentioned in 2.2.
3. Removable EPDM sealing & stainless steel seat to avoid cavitations ware.
4. The gate shall be and completely (fully) covered with EPDM elastomer.
5. The gate sealing in the body shall be ensured by the rubber compression.
6. Gate valves shall be of the resilient seal type.
7. The spindle should be cold stamped including the collar and the thread.
8. The dimension as per ISO 5752 – EN 558 basic series 15 (long) for DN 150 mm and above.
9. The dimension as per ISO 5752 – EN 558 basic series 14 (short) for DN 80 mm and DN 100 mm.
10. Shutter of the valves should be guided from the two ends to avoid vibration.
11. The stem sealing shall be provided by two "O" rings. Seals shall be capable of being replaced with the valve under pressure and in the fully open position.
12. Body and the cover must be fully protected with 250 micron\min, fusion bond high temperature Epoxy coating.
13. Valves shall close clockwise.
14. Marking the valves shall indicate the name of the factory and the relevant standard.

All connecting material and rubber ring gaskets or adaptors shall be provided by the Contractor as necessary to connect the valve with the adjoining pipe material.

Valves with diameter < 200 mm shall be installed in the ground in accordance with the Standard Drawings also shall be buried and shall be supplied with stem nuts coupling, sleeves and extension spindles of 0.5 m and 1.00 m length according to the requirements on site.

Valve spindle shall be of stainless steel. Extension spindles shall be made of hot dip galvanized iron, coupling sleeves of galvanized ductile iron connection pins of C & Ni steel.

Spindles may have to be shortened to suit the particular site requirements. The top of the extension spindle shall be fitted with ductile iron surface box according to DIN 4056 with pre-cast concrete support. The spindle itself shall be protected by a suitable PE guard tube including tube cover. Valves to be installed above

ground or in valve boxes shall be provided with hand wheels of mehanite ductile iron. All valves shall be supported by concrete blocks.

Valves with diameter

200 shall be installed in concrete valve chambers according to the Standard Drawings. These valves shall be complete with hand wheels so as to be operable inside the valve chamber. These valves shall additionally be equipped with extension spindles, where needed, and surface boxes, as described above and as shown as a general detail on the standard Drawings, to allow operation without entering the chamber. The extension spindles are to be connected to the hand wheels by stem unit couplings. The surface box shall be casted into the concrete cover above the spindle.

Diameter of hand wheels	DN 250: 500 mm (minimum)
	DN 200: 400mm
	DN 100-150: 315 mm

One operating key shall be provided for every 10 valves delivered. One extra hand wheel shall be provided for every 100 valves of 100, 150 and 250 mm dia delivered.

1.3 Combination Air Relief and Vacuum Valve

These automatic air valves shall include a small orifice and a large orifice, consisting of: One resilient seated large orifice for release and admission of air when filling and emptying One small nipple orifice for release of air accumulated under normal working conditions. It shall be designed to operate under the pressures shown in the BOQ.

1. The triple function air valves shall not have incorporated isolated valve. However, the single air valves shall have incorporated isolated valve.
2. All air valves shall have integrated flanged inlet drilled according to ISO 7005-2 and EN 1092-2 complying with the pressures mentioned above and shall be fitted with lifting eyes for handling
3. The dimensions of the flanges shall be suit to tight with the flanges of the gate valves flanges mentioned above.
4. Air valves should have orifice(s) sized for the operating conditions.
5. Air Valves should comply with EN 1074-4.
6. Valves should be suitable for water service and where required should combine the operating features of air release and air re-entry into the system to prevent vacuum and allow system drainage. The air release portion should automatically exhaust entrained air that accumulates in system.
7. Ductile iron body, cover and flange
8. Stainless steel ball floats for large and small orifice and trim should be provided to meet the operating conditions.
9. Valve body should be coated with Epoxy powder Coating of minimum thickness 300 micron.
10. The valve should automatically operate in order to: a) Positively open under internal pressure lower than the atmospheric pressure, to admit air in bulk during pipeline draining, b) Exhaust air in bulk during pipeline filling and positively close when water fills the body of the valve, c) Exhaust accumulated air under pressure when the pipeline is in operation
11. The valve body and bonnet should be made of ductile iron.
12. The ball floats should be made of stainless steel or rubber coated steel.

13. The nozzle (small orifice of the valve) should be made of brass.

14. The valve should be flanged. The flange should comply with ISO 7005-2, EN 1092-2 or equivalent from other standards. 15. The single air valve shall have a built-in stop valve for maintenance

For pipes 150 mm and larger, automatic air vacuum and air release valves shall be supplied with double orifice air valves with both, small and large orifices. Valves shall be of the flanged type and of pressure class PN 16, PN 25.

The following types and minimum sizes of air valves (nominal diameter) shall be used:

Pipeline = 150-300 mm - double air valve DN 50

Pipeline = 400-500 mm - double air valve DN 80

Air valves shall be designed to limit water hammer effects.

1.4 Valve Indicator Plate

Modify clause 1.42 of the General Technical Specifications for valve detectors and substitute with the following:

Valve indicator plates shall be installed for all types of valves installed in mains with diameter DN 100 and larger. This applies also for existing valves which are to be retained in the restructured pipe systems. The Contractor shall liaise with the Employer (WSSD) for respective information about the location of valves and the numbering code to be shown on the plates. The size of the plate shall be 110 mm x 70 mm with 18 exchangeable number or letter fields

The plate shall be scratch and corrosion resistant, made of non-ageing UV-resistant material. The Contractor shall submit samples for approval by the Engineer prior to delivery.

The valve indicator plate shall be mounted on a plate of non-corrosive material and shall be fixed against walls or concrete pillars as may be required at a particular location. The Contractor shall allow for the supply of pillars and fixing of approximately 50 % of the indicator plates to it

1.5 Dismantling Joints

Dismantling joints shall be installed where indicated on the drawings for convenient installation or re-installation of valves or similar items.

To prevent any movement of the pipe joints adjacent to closed valves, dismantling pieces shall be in general be of the 'restrained' (short version) according to DIN 2541 or DIN 2547 or flanged adaptors as indicated on drawings or as directed by the Engineer.

The body and glands of steel welded dismantling pieces shall be of pressure class PN 16, PN 25 with nuts and bolts of stainless steel. Surface protection shall be by epoxy resin coating or equivalent. Rubber sealing rings shall be of Perbunan material, nitrile rubber or equivalent.

1.6 Flexible Couplings and Flange Adapters

Flexible couplings and flange adaptors shall be of mild steel and of an approved type suitable for making a watertight flexible connection between plain-ended pipes, or between a plain-ended pipe and a flanged fitting (flange adaptor)

Unless otherwise specified, the external and internal surfaces of couplings and adaptors shall be cleaned down to a metallic finish, then primed and painted with epoxy resin paint, applied by an electrostatic process.

All mechanical couplings shall be of appropriate internal diameter and shall be capable of adapting to different pipe materials. They shall be capable of withstanding the maximum working test pressure specified for the pipes to which they connect, including the accommodation of a joint deflection of up to 3° in any direction.

Wedge joint rings shall comply with DIN EN 681 or equivalent, and shall be made of nitrile rubber, ethylene propylene rubber (EPDM) or styrene butadiene rubber (SBR) or other approved materials.

All mechanical couplings and flange adaptors shall be supplied complete with all necessary coupling rings, nuts, bolts, washers and rubber rings. Bolts and nuts of galvanized steel shall be hexagonal with dimensions to DIN 601/555 or BS 4190.

In order to ensure compatibility with the associated flanged pipe work the bolt circles on all the flanges of the flange adaptors shall comply with DIN 2501, DIN 28605 or BS 4504 PN 16, PN 25.

Where a Harnessed Steel Flange Adaptor is shown on the drawings, the bolts connecting the flange of the Flexible Flange Adaptor to the Flange of the adjacent fitting shall be replaced by tie- bars threaded at both ends. One threaded end of each tie bar shall pass through holes in the abutting flanges and be anchored by two nuts to make the flanged joints in the normal way. The other threaded end shall be anchored by two further nuts in a corresponding bolt-hole on the flange, soundly welded integrally onto the fitting which it is intended to harness to the adaptor.

The integrally-cast flange on the flange-spigot shall be located such that, after the joint has been made and fully tightened, the flange is about 400 mm axially from the abutting flanges.

The threaded tie bars shall be machined from steel at least equal to that specified for flange bolts of corresponding duty and threaded in the same way. The threaded length shall allow the nuts to be run forward sufficiently to permit complete withdrawal of the tie bars from the flange of the abutting fitting without requiring any other joint to be dismantled.

The strength of the threaded tie-bars in both tension and compression shall be appropriate to the pressure rating of the flanged joints.

1.7 Surface Boxes and Manhole Cover

Ductile Iron surface boxes with round lid which lock automatically, under the own weight with quarter turn, and with built in extension operating process and shall be supplied for operation of gate valves. Surface boxes shall be suitable for a 400 KN load.

Shorter surface boxes for casting into concrete slabs may be used with lockable lid and also suitable for a loading of 400 KN.

Hexagonal lids shall be supplied for service (house) connection stop-cocks (ferrules).

Surface boxes shall have a cold applied bituminous black paint coating. The hinge of the lid shall be of non-corrosive material.

Manhole cover will be in Ductile Cast Iron, according to ISO 1083, and will be complying with EN124 Standard, class D400 (40 tons of resistance minimum).

This compliance will be certified by an Authorized and Independent Third Party, and the cover will be so badge with the logo of the Third Party (such as "NF", granted by AFAQ/AFNOR

It will have to be cast by a manufacture complying to the ISO 9001: 2000 Standard

Frame will have to be molded with wide anchoring holes, at least 16, to allow effective and durable bedding.

Frame will have at least 18 strong ribs, to provide mastered frame profile capable to withstand traffic stresses.

The frame height will be of 100 mm minimum, square shape, with outside dimension of at least 850 mm for a good settlement of the manhole and a right behavior under traffic stresses.

The clear opening of the frame will be of minimum 600 mm

A sound-proofing gasket in composite material (such as PE+PP) will be installed on the frame to support abrasion and crushing when in function. It will be clamped on the frame, with a specific shape to avoid it moves out from the frame

For an ergonomic opening and lifting once unlocked, the cover will be hinged, with an integrally ductile cast hinge. This hinge will be integral part of the cover, so it resists as well as the cover to corrosion, vandalism and traffic impact

The cover when opened will have to stay in 130 ° position to avoid any accidental self closure on workers.

The cover will be round shape, and none ventilated

An elastic spring bar, cast integrally with the cover, will be active that is to say designed to bring a permanent tension between that spring bar, and the cover positioning lugs. It so will provide a remarkable dynamic stability of the cover thanks to 3 points of contact.

Furthermore, the spring bar keeps the cover held against the gasket, preventing from rocking.

The elastic spring bar will be such that it will be automatically closed by any load (traffic or pedestrian) when coming over the cover

This spring bar will nevertheless be flexible enough to open by itself when over pressure in the network, and will so avoid any damage in the network (shaft and pipes)

The unlocking of the cover will be allowed by lever effect in the opening box, located on the side of the frame, and will be permitted with usual tools such as pickaxe or bar. It will be potentially opened via a single operation.

An optional locking mechanism to prevent from any intrusion in the network will be foreseen on the cast cover, thanks to a punch able recessed area

An anti-theft device, such as a specific sp line, cast in ductile iron, will be installed in the frame hinge box, to avoid releasing the cover out of the frame.

1.8 Pressure Gauges, Pressure Sensors

Pressure gauges shall be installed at all pressure reducing valves upstream and downstream of the valve and at selected strategical points in the distribution system for monitoring pressure fluctuations. They shall be of the bourdon tube type with sensor (for positive and negative pressures) and transmitter for connection to a data logger specified hereunder. All moving parts shall be of stainless steel. The dial face diameter shall be 160 mm and the accuracy class 1.6. The gauge must be suitable for a pressure range up to 20 bar.

The installation of the gauge shall be complete and shall include the connecting fittings to the main pipe the gauge inlet pipe with 3 way cock and screwed joints.

The output of the pressure sensor-transmitter equipment shall be analogue 4 - 20 mA, electrically insulated

1.9 Data Logger

Data logger to be supplied under this Contract is for recording flows and pressure in conjunction with the water meters and pressure sensing equipment specified above. It shall be a mobile system with integrated power supply and equipped with the following features:

at least two inputs to be used simultaneously and settable to analogue or digital input signals

positive or negative data logging

independent memories for recording data (e.g. day, hour, events)

LC display (2 rows, 16 characters each)

recording interval 0.1 sec to 1 day

battery power supply for standard cells

the encasing of the data logger shall be watertight according to IP 69 standard

The respective software to be used with MS Windows 95 complete with manual (in English) for programming readouts and evaluation of data recorded by the data logger shall be included in the supply.

Data logger must be suitable and compatible with the signal transmitting equipment of water meters and pressure gauges.