

# **ANNEX 1 TECHNICAL SPECIFICATIONS**

## **SUPPLY OF PIPES AND FITTINGS**

### **1.1 Scope of Work**

The Supplier shall furnish all pipes, fittings, adapters, valves, and other materials of the various sizes and diameters complete with jointing materials in accordance with these specifications and Bill of Quantities. All pipes, fittings and valves shall be in every respect suitable for storage, installation, use and operation in the condition of temperature and humidity appertaining in Sudan. The temperature of the water to flow in pipelines will be about 30°C.

Pipes and pipeline components, including their protective coatings and joint materials that will or may come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth, shall not cause taste or odour, cloudiness or discoloration of the water and shall be approved by a recognized certifying authority as being suitable for use in potable water supply schemes.

The materials to be furnished under this Contract shall be the product of a manufacturer who has de-signed and manufactured similar materials having a record of successful operation. The Supplier may be required to submit the evidence to this effect together with a representative list of overseas supply consignments of the manufacturer.

All pipes, fittings, valves, accessories furnished shall be new and from a current manufacturer. A certificate from the manufacturer stating that the materials furnished are new and out of a current manufacture shall be furnished to the Purchaser.

### **1.2 Affidavit of Compliance**

The Supplier shall provide the Employer with an affidavit in quadruplicate from the manufacturer that the pipes, valves, fittings, meters and any other products or materials furnished under the Contract comply with all applicable provisions of these specifications.

The Supplier shall also produce the certificates to the effect that the items supplied comply with the relevant BS/BS EN ISO 9000 series of quality standards or other recognized and acceptable international standards.

### **1.3 Rejection**

Material that fails to conform to the requirements of the specifications will be rejected and the Purchaser will notify the Supplier accordingly.

### **1.4 Shop Coating and Lining**

The Supplier shall supply all labour, material and equipment for the preparation of surfaces and the shop application of protective coatings and linings specified under each section.

The Supplier shall furnish a manufacturer's certificate of compliance for each coating or lining material prior to its use in the work. The certificate shall include material identification, quantity, batch number and date of manufacture. Coating, where not specified will be selected by the Purchaser from manufacturer's samples submitted by the Supplier.

### 1.5 Marking

Each pipe and fitting shall be legibly and durably marked with the following:

- Name of the Recipient as "UNOPS"
- Material of pipe indicated as "DI" / "PE" etc.
- Nominal Diameter or size
- Year of Manufacture
- Class designation
- Reference Standards such as BS, AWWA, DIN or ISO
- Manufacturer's identification mark – Brand Name
- Pressure rating of pipe and flange
- Angle of bends in degrees
- Socket penetration lines of each pipe with push-in joints

All markings shall be of a permanent nature. The manufacturer's name or identification marks shall be engraved embossed/cast on the socket/flanges of all Ductile Iron, Steel and PE pipes, fittings and accessories. In addition to what is specified in Standards, all pipes, specials and fittings shall be marked legibly and indelibly with details as follows.

Item	Diameter (mm)	Details required	Height of Lettering (mm)
Pipe Lengths (at intervals not more than 3 m)	above 350	"PWC"; Pipes standard (BS); Class type; Nominal dia.	50
	150 to 350 (both inclusive)	as above	25
	50 to 150	as above	10
	below 50	as above (except "PWC")	05
Fittings & Specials	above 350	"PWC"; Pipes standard; Class type, Nominal dia.	25
	150 to 350	as above (except "PWC")	10
	50 to 150	as above	10
	below 50	as above (except "PWC")	05
Manhole Covers	All sizes Class type; Size	"PWC - WATER" Standard;	50
Surface Boxes	All sizes	as for manhole covers	20

### 1.6 Packing

All pipes and fittings, valves and specials and all other products shall be packed in such a manner as to prevent damage in ordinary handling and transportation. Each box, bundle or crate shall be legibly marked identifying the contents, and giving the name and address of manufacturer, name of the project "DFID FUNDED - URBAN WATER FOR DARFUR PROJECT ", consignee "UNITED NATIONS OFFICE FOR PROJECT SERVICES - UNOPS", and date of dispatch.

Bolts of the same length and size (and their accompanying nuts and washers) shall be packed together in separate boxes not exceeding 100 Kg. gross weights. Joint rings and gaskets shall be packed in boxes and separate packages shall be provided for each size and description of ring or gasket. Each box and package therein shall be clearly labelled stating the number, size and description of the contents.

### 1.7 Transporting and Handling

The Supplier shall provide protection to the approval of the Purchaser for the ends of all pipes and fittings prior to the pipes and fittings leaving the place of manufacture in order to guard effectively against damage during transit and storage and the ingress of foreign matter inside the pipes and fittings.

In handling pipes and fittings every care shall be taken to avoid distortion, flattening, and denting, scouring or other damage. Pipes and fittings shall not be allowed to drop or strike objects and shall be lifted or lowered from one level to another by means of approved equipment only. When required pipe and fittings shall be lifted by means of a mechanical forklift, or similar equipment, belt slings shall be applied at the correct lifting points along the length of the pipe section, with tackle suitably padded to prevent damage to the coating.

Pipes and fittings that are damaged during transportation, handling or stockpiling shall be satisfactorily repaired. If the extent of damage to any pipe or fitting is serious or beyond repairs in the field, the supplier shall replace it with new one.

### **1.8 Storage and Security**

All pipes, fittings, valves, and appurtenances shall be stored at sites in or around Project Area as approved by the Employer in accordance with the manufacturer's recommendations until they are incorporated in pipe laying work. Pipe shall be stockpiled on timber cradles on level ground in such a manner as will prevent damage to any part of the pipe. During stacking and removal operations, safe access to the top of the stack is essential. Stacking types and the maximum stacking height shall be in accordance with manufacturer's recommendation or complying BS 8010 Section 2.

### **1.9 Submittal**

The Supplier shall submit to the Purchaser and obtain approval before starting the works the manual for handling, storage, installation, maintenance and repair, test report on materials to be used for manufacture and shop drawings giving complete dimensions of all pipes and fittings.

### **1.10 Material Reconciliation Schedule**

Upon completion of the work the Supplier shall submit to the Purchaser a materials reconciliation schedule in respect of the materials supplied under Supply Bills. The schedule shall give the following detailed for each item:

- (a) Quantity ordered – According to each and every supply bill items
- (b) Quantity Delivered - According to each and every supply bill items

The Employer may accept some or all of the surplus materials for maintenance purposes. The Supplier shall load the materials to be taken into stock and transport and off-load them at the Employer's stock-yards.

## SECTION - 2 PIPE MATERIAL

### 2.1 Ductile Iron (DI) Pipes and Fittings

#### General

##### (i) Scope of Work

Where shown on the bill of quantities the Supplier shall supply ductile iron pipes and fittings in accordance with the details shown and specified herein, including all jointing materials. In addition, the Supplier shall include extra quantity of materials for maintenance purposes to the Employer as specified under relevant clauses hereinafter. The cost of these materials shall be absorbed within the unit rate of relevant item.

##### (ii) Standard Specification Reference

The following standards are referred to:

BS/ BSEN

ISO 9000 Series

Quality Assurance Standards

ISO 2531

Ductile Iron Pipes, Fittings, and accessories for Pressure Pipelines

ISO 4179

Ductile Iron Pipes for Pressure and Non-Pressure Pipelines - Centrifugal Cement Mortar Lining General Requirements

ISO 6600

Ductile iron pipes centrifugal cement mortar lining (composition controls for freshly applied mortar)

ISO 7005 (Part 1&2)

Metallic Flanges

ISO 8179

Ductile Iron Pipes - External Zinc Coating

BS EN 545

Ductile Iron Pipes, Fittings, accessories and their joints for water Pipelines. Requirements and test methods.

BS EN 1563

Founding Spheroidal graphite cast iron

BS EN 1564

Founding Austempered ductile cast iron

BS 3063

Specification for Dimensions of Gaskets for Pipe Flanges

BS 4504 (Part 1)

Circular Flanges for Pipes, Valves, and Fittings

BS EN 1092

Flanges and their joints, circular flanges and accessories

BS 2494

Elastomeric seals for joints in pipe work and pipelines.

ISO 4633/BS EN 681-1

Elastomeric seals. Material requirements for pipe joints seals used in water and drainage applications.

BS 3416.1991

Bitumen based coating for cold application.

DIN 30674/BS 4164

Bitumen based hot applied coating materials for protecting iron and steel.

BS 4865

Dimensions of non-metallic gaskets for pressures up to 64 bars.

BS 8010

Part 1 Code of practice for pipelines on land

General Part 2

Design, construction and installation

Part 2 Section 2.1

Ductile Iron.

BS 6076, 1996

Polymeric film for used as a protective sleeving for buried iron pipes and fittings

BS 970

Wrought steel for mechanical and allied engineering purpose.

BS 1706

Method for specifying electroplated coatings of zinc and cadmium on iron and steel

AWWA C151

Ductile Iron Pipe, Centrifugally Cast in Metal Moulds or Sand-Lined Moulds, for Water or Other Liquids

AWWA C110 and Other Liquids

Ductile Iron and Grey Iron Fittings. 3 inch through 48 inch for Water

AWWA C104	Cement Mortar Lining For Ductile Iron Pipe and Fittings for Water
AWWA C213	Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipeline.
BS GN 545	Ductile Iron Pipes, Fittings, accessories and joints for water pipelines.

Note: The above Standard Specification or equivalent DIN Standards are applicable.

**Manufacture**

(i) General

Ductile iron shall conform to the material specification given in one or more of the standards listed in Clause 4.0 (ii) except for the requirements stipulated herein. The pipe and fittings shall be manufactured in accordance with one or more standards listed in Clause 4.0 (ii) or any other national standard, which is equivalent or superior to those quoted above except as, stipulated herein.

(ii) Mechanical Properties

The mechanical properties of pipes and fittings shall be as follows:

Minimum Tensile Strength	420 N/sq. mm
Minimum Bending Strength	590 N/sq. mm
Modulus of Elasticity	14 to 18 x 10 <sup>4</sup> N/sq. mm

(iii) Hydrostatic Pressure Test

Ductile iron pipes and fittings shall have working pressure of 16 bars and shall be in accordance with ISO 2531 or with BS EN 545. The standard classes of pipes and fittings shall be as follows unless otherwise stated.

Socket & Spigot Pipes	K	9
Flanged Pipes & all other fittings except tees	K	12
Tees and Cross	K	14
Flanges	PN	16

Each pipe and fitting shall withstand the working hydrostatic test pressure given below:

Nominal Diameter (mm)	Hydrostatic Test Pressure (bar)	
	Pipe	Fitting
80 to 300	50	25
350 to 600	40	16
700 to 1000	32	10
1100 to 1200	25	10

(iv) Fitting Compatibility

The Supplier shall supply the fittings manufactured by the same manufacturer of pipes, using the same kind of material and compatible standards. The Contractor shall also ensure the dimension compatibility of pipes, fittings and couplings.

(v) Joints

Joint types shall be as shown on the drawings and meet the following requirements.

Flexible Joint (Push-In Joints)

Except where flanged joints are required, standard pipes and fittings for pipelines of ductile iron shall be supplied with push-in socket and spigot joints similar to joint type A.1 illustrated in BS 8010: Part 2 : Section 2. The material of the joint rings use shall be in accordance with the requirement of BS 2494:1990 type W.

Where pipes and fittings are not available with this type of joint, they shall be supplied with mechanical type flexible joints of the bolted gland type. Glands, bolts, and nuts for mechanical joint shall be of ductile iron having the same mechanical properties as the fittings.

#### Flange Joint

PN 16 pressure rated flanges shall be flat faced and shall conform to the requirements of BS 4504 Part 1 (or to ISO 2531 or BS EN 1092 or equivalent DIN standards which are compatible with BS 4504 Part 1 for the same nominal diameters)

The flanges of all fittings including Tees shall be integrally cast with the fitting. The flanges of Flanged pipes may be screwed, welded or integrally cast with the pipe unless otherwise stated.

“Welded” means, that the flanges shall be welded to the pipes at the point of manufacture under factory conditions with inspection agency certification.

All bolts to be supplied with flanges shall be of high tensile steel to the approval of the Purchaser. Flanged joints shall be complete with all nuts, bolts, gaskets and two washers per bolt. Protection of all bolts, nuts, washers etc. and the joint, as a whole shall be covered with Denso or equivalent paste, primer, mastic, tape and PVC or polyethylene outer wrapping.

Gaskets for flanges shall be inside bolt circle type, with dimensions complying with BS 4865 Part I, and be manufactured from material complying with BS EN 1514, BS 2494: 1990 Type W listed in the Directory of the Water Research Centre, UK or equivalent.

The Contractor shall be responsible for checking and ensuring that mating flanges are compatible in all cases, including where connections are required to pipe work and valves associated with pumping plant and inlet/outlet pipe work at service reservoirs or other structures.

#### Restrained Self Anchoring Joints

The design of restrained joints shall comply with BS 8010, ISO 10804-1 or equivalent.

#### Slip-on Coupling and Flange Adapter

Bolted sleeve type couplings, stepped couplings and flange adapters may be used for connecting plain ended steel, ductile iron, grey iron, uPVC and other rigid or semi-rigid pipe materials, subject to approval of each type by the Purchaser. Couplings, etc. shall be designed and manufactured in accordance with AWWA C219 "Bolted, Sleeve-type Couplings for Plain-end Pipe" except that elastomeric gaskets shall comply with BS 2494 Type W and or BS EN 681-1.

Couplings included in this section will effect a connection between two pipes of either the same pipe materials, or of two different pipe materials, at the same nominal bore. Couplings and flange adapters shall be manufactured from one of the following materials:

Carbon steel:	BS EN10025 Grade Fe 430A, or equivalent DIN Standard or ASTM A283 grade C
Malleable Cast Iron:	BSEN 1562: Grade B35-12, or equivalent DIN Standard or ASTM A47 grade 32510 or 35018
Ductile Iron:	BS 2789 Grade 420/12, or equivalent DIN Standard or ASTM A536 65-45-12

Gaskets shall be of elastomeric material conforming to the requirements of BS 2494 Type W. Gasket shall have a hardness rating of 80IRHD to prevent gasket extrusion at the bottom tolerance of the fitting. All gaskets shall have identification to detail size range, mould number compound and year and quarter of manufacture.

Nuts, bolts and tee bolts for fasteners shall be manufactured from alloy or carbon steel conforming to BS 970 Part 1 grade 070 M20.

Bolts shall be restrained against rotation by means of "D" shaped necks, which will locate in similar "D" shaped holes in the end rings to facilitate single spanner operation. Washers shall be provided to prevent damage to the coating of the fittings.

Centre sleeves, end rings and flange adapters bodies shall be coated with Rilsan Nylon 11 coating, to a uniform minimum thickness of 250-300 microns, having been shot blasted and suitably primed prior to application of coating, maintaining the minimum thickness throughout the fitting. Holding points shall be touched in with the appropriate Rilsan repair coating.

Fasteners shall be electroplated to BS 1706 grade Zn10 or equivalent followed by a suitable primer and then with a coating of Rilsan Nylon 11 to a uniform thickness of 60 - 120 microns.

Flange adapters for jointing flanged specials to plain-ended pipes shall conform to the foregoing contents of this clause. Prior to the commencement of the manufacture the Contractor shall submit to the Purchaser for approval detailed drawings of all couplings and flange adapters.

When harness is specified with coupling or flange adapter, the harnessing shall be provided as recommended by the manufacturer of couplings or flange adapters. Harness joint shall be designed and manufactured to withstand for the pullout force caused by the internal pressure of 16 bars at the joint.

- (vi) Length of Straight Pipes  
Length of straight pipes shall conform to the requirements in ISO, BS, or AWWA to be applied. Pipes longer than specified may be used in accordance with the recommendation of the manufacturer. However, it shall be the sole responsibility of the Contractor to examine the difficulties he is likely to face in transporting, storing and handling such longer length pipe. While ordering the pipes the Contractor shall ensure the possibility of negotiating the horizontal and vertical bends.

Three percent of all straight pipes shall have applicable external diameter to the joints for full length of barrel and shall be suitable for usage by cutting at sites. Such pipes shall be clearly marked.

### **Coating and Lining**

- (i) External Coating

Fittings shall be externally coated with metallic zinc and bitumen paint conforming to BS EN 545 or ISO 8179, which shall not contain any constituent soluble in water or any ingredient liable to leach in water after drying. The coating shall have good adherence to the pipe and fittings and not scale off. Thickness of the coating shall not be less than 70 microns.

(ii) Internal Lining

Internal surface protection shall be either of:

- (a) Cement mortar lining, or
- (b) Fusion-bonded epoxy coating

(a) Cement Mortar Lining

Pipes and fittings shall be internally lined with cement mortar using ordinary Portland cement conforming to BS12 or Sulphate resisting cement conforming to BS 4072. The thickness of lining shall be as follows:

Pipe Nominal Diameter (mm)	Thickness of Lining (mm)	
	Nominal	Minimum
80 to 250	4	3
300 to 600	6	5
700 to 900	8	6
1000 to 1200	10	7

Inside of socket shall be free of cement mortar lining and shall be coated with the material used for external coating. Internal lining shall be done in accordance with BS EN 545, ISO4179, AWWA C104, or equivalent.

(b) Fusion-bonded Epoxy Coating

Fusion-bonded epoxy coating for ductile iron pipes/fittings shall conform to AWWA C213 or equivalent. Material shall consist of a one-component powdered fusion-bonded material composing of ep-oxy resin, hardener, and fillers. Composition of epoxy resin hardener shall not be less than 55 percent in weight. The standard film thickness shall not be less than 300 microns except for the socket portion where the minimum film thickness shall be 100 microns.

The physical properties of coating shall satisfy the requirements of ANSI/AWWA C213 or equivalent. ANSI/AWWA requirements are shown below:

Item	Requirement	Test Method
i. Impact	Min. 1.1 kg-m	AWWA C213
ii. Bendability	Pass	AWWA C213
iii. Appearance	Pass	AWWA C213
iv. Shear adhesion	Min. 210 kgf/sq. cm	ASTM D1002
v. Penetration	Less than 10 %	ASTM G17
vi. Abrasion resistance (5000 cycles-gm loos)	Max. 0.3	ASTM D1044
vii. Cathodic disbandment area	Max. 9.7 sq. cm	ASTM G8
viii. Hot water resistance	Pass	AWWA C213
ix. Water extractable	Max.0.078 mg/sq. cm	AWWA C213
x. Taste and odour	Pass	AWWA C213

Should the coating fail to satisfy the requirements of the tests or the coating were damaged, repair the defective or damaged area by using two-component liquid type epoxy paint.



**Special Protections****(i) Polythene Sleeving for Aggressive Soil Conditions**

The Polythene sleeving supplied shall conform to BS EN 545 or BS 6076 specifications by the manufacturer for the particular DI pipe/fitting. The Supplier shall furnish all the relevant technical specifications of the sleeving he intends to use in the works to the Purchaser for approval, before the sleeves are used.

The sleeves supplied shall include necessary adhesive tapes and any other material that may be required for the comprehensive installation purpose.

**2.2 Galvanized Iron pipes****General****(i) Scope of Work**

The Supplier shall supply Galvanized iron pipes/fittings in accordance with the details shown on the specifications and bill of quantities. In addition, the Supplier shall include extra quantity of materials for maintenance purposes to the Employer as specified under relevant clauses hereinafter. The cost of these materials shall be absorbed within the unit rate of relevant item.

**(ii) Standard Specification****Galvanized Steel Pipes/Fittings**

A Galvanized steel pipes and fittings shall conform to BS 1387 or ISO R49. Fittings shall be galvanized malleable cast iron complying with BS 1256 or JIS G3442 "Galvanized Steel Pipes for Water Service".

B Where indicated on the Drawings, or otherwise required, "Denso" tape, or equal, shall be used for corrosion protection of buried galvanized pipe and fittings. Tape shall be applied in accordance with the manufacturer's recommendations. EN 681-1

**Joint**

Joint shall be flange joints and all flanges shall be accordance with BS 4504 Circular Flanges for Pipes and drilling shall be PN 16. The connection between the pipe and the flange shall be treaded joint for the pipes and fittings up to 150mm. Weld flanges are acceptable for pipe for 200mm and above but fabricated fittings must be hot dip galvanized or apply a protective coating acceptable to the Engineer.

**Protection**

, "Denso" tape, or equal, shall be used for corrosion protection of buried galvanized pipe and fittings. Tape shall be applied in accordance with the manufacturer's recommendations. EN 681-1. All flanges also shall be protected with "Denso" paste and tape, or equivalent,

**2.3 Polyethylene (PE) Pipes****General****(i) Scope of Work**

The Supplier shall supply polyethylene pipes and fittings in accordance with the details shown on the specifications and bill of quantities. In addition, the Contractor shall include extra quantity of materials for maintenance purposes to the Employer as specified under relevant clauses hereinafter. The cost of these materials shall be absorbed within the unit rate of relevant item.

(ii) Standard Specification

The following standards are referred to:

BS 6572:1985	Blue pipe up to nominal size 63mm for below ground level use for potable water.
BS 6730:1986	Black pipe up to nominal size 63mm for above ground level use for potable water.
MS1058, ISO4427, DIN8074, prEN1555-1, prEN12201-1 WIS4-32-15:1995	High Density Polyethylene Pipes (HDPE)  PE80 and PE100 spigot fittings and drawn bends for nominal sizes up to and including 1000mm
DIN 16963	HDPE Butt Fusion Fittings
DIN 8076	Compression Fittings
WRC No: 4-32-06, 4-32-14	Electro-fusion Fittings
DIN8075: 1999	High Density Polyethylene Pipes (HDPE) type 2 - Testing
WIS 4-32-08 – Issue 2	Site fusion of PE80 and PE100 pipe and fittings

(iii) Flanged Joints and Mechanical Couplings

Flanged joints such as slim-flange, stub-end with steel backing rings drilled to BS 4504 PN 16 etc. shall be provided in accordance with the requirement included in the bill of quantities. These fittings shall be suitable for providing connection between similar diameter pipes made of dissimilar materials such as PE/DI, PE/PVC, etc. Mechanical fittings and joints including flanges shall be in compliance with specifications in WIS 4-24-01.

### HDPE Pipe Material

The lightweight polyethylene pipes shall be flexible and suitable to fit along the longitudinal and vertical trench contour of physical environment without utilizing additional fittings or joints and to adopt soil movement. The radius of curvature of the pipe shall be in the range of at least 25 to 40 times of its diameter. The polyethylene material shall be free from corrosion and rust, non toxic, high resistance to abrasion, good impact strength, low temperature performance, UV resistant and weld-able by butt fusion typical jointing method or electro fusion. The interior surface of the pipe shall be smooth to promote low liquid flow resistance with minimum “c” value of 150 and “k” value of 0.010 to 0.015 mm as well as to prevent occurrence of deposits on the pipe wall. Pipes shall be furnished in standard laying lengths of 6m or 12m and shall be black in colour.

Pipes shall be manufactured with material classification of PE 80 or PE 100 and designed for a predetermined nominal working pressure and pressure class. All pipefittings shall have the same characteristics and strength as the connecting pipes. Fittings shall confirm to relevant standards specified in the previous section.

(i) Material Properties

The typical properties of polyethylene pipe material for physical, mechanical and thermal characteristics shall be as provided below:

Raw Material	-	PE 80 or PE 100
Density	-	0.950 to 0.96 g/cm <sup>3</sup>
Melt Flow Index	-	0.4 to 0.7 g/10 min.
Coefficient of Friction	-	0.01 to 0.015 mm
Yield Stress	-	18 to 23 N/mm <sup>2</sup>
Elongation at Break	-	> 600 %
Flexural Creep Modulus	-	800 to 1100 N/mm <sup>2</sup>
Shore Hardness	-	60 to 65
Vicat Softening Point	-	127 to 131 °C
Average Coefficient of Thermal Expansion (20°C to 90°C)	-	0.15 to 0.20 mm/m °C
Thermal Conductivity	-	0.3 to 0.4 W/m <sup>0</sup> C
Operating Temperature	-	- 30 to + 50 <sup>0</sup> C

### **Gaskets for Flanged Joints**

Gaskets for flanged pipe joints shall be of the inside bolt circle type and the dimensions shall comply with BSEN 1514-2:2005 – Flanges and their joints. Dimensions of gaskets for PN-designated flanges. Spiral wound gaskets for use with steel flanges.

The physical properties of gaskets shall comply with BS 7874:1998 (Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines for effects on water quality and resistance to microbiological deterioration).

The Gaskets shall also comply with the relevant provisions in BS 7874:1998 for effects on water quality and resistance to microbiological deterioration.

The Gasket material shall be EPDM/SBR and shall be of average hardness of 65-75.

The Gaskets shall be supplied by the manufacturer and shall suit for PN 16 flanges unless otherwise stated.

Each gasket shall be marked clearly and durably in accordance with the following information in a manner that does not interfere with the sealing function of the gasket, in complying with clause 10 of EN 681-1:1996.

- a). The nominal size
- b). Manufacturers identification
- c). THE NUMBER OF THE BS or BSEN with seal type designation.
- c). The number of the BS or BSEN with seal type designation.
- d). Abbreviation for the elastomer Testing

Pressure testing of the pipes and fittings shall be performed in accordance with SFS 3113 and SFS 3115 standard or any other acceptable recognized international standards.

### **Nuts, Bolts and Washers for flange joint**

The nuts, bolts and washers for flanged joints shall be of high tensile steel and shall comply with BS4395: Part 1 and 2: 1969.

The bolting shall comply with the relevant provisions of BS 4504: Section 3.1:1989.

The Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position with two threads showing.

Two washers per each bolt shall be supplied for providing under the head of the bolt and under the nut. The bolts and nuts shall be hexagonal and shall be in accordance with BS 190:2001 ISO metric black hexagon bolts, screws and nuts, Specification, the bolts, studs, nuts and washers used shall be made of stainless steel or hot-dipped galvanized carbon steel coated with fusion bonded epoxy powder or polyamide 11 to the finished thickness of coating between 75 m and 125 m according to WIS 4-52-03-1994. Cold applied high solid epoxy shall be used to repair the damaged coatings on the bolts and nuts after fastening.

## SECTION – 3 VALVES, APPURTENANCE AND EQUIPMENT

### 3.1 Standard Specification References

The following standards are referred to:

ISO 9000 series	Quality Assurance Standards
AWWA C500	Gate Valves -3-Inch through 48-Inch for Water and Other Liquids
AWWA C504	Rubber Seated Butterfly Valves
AWWA C509	Resilient-Seated Gate Valves 3 through 12 NPS, for Water and Sewerage System
ASTM A108	Steel Bars, Carbon, Cold-Finished, Standard, Quality
ASTM A126	Grey Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Hot-Resisting Steel Bars and Shapes
ASTM A307	Carbon Steel Externally Thread Standard Fasteners
ASTM A320	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM B62	Composition Bronze or Ounce Metal Castings
BS 750:1984	Underground Fire Hydrant and surface box frames and covers
BS 5150	Cast Iron Gate valves.
BS 5153	Cast Iron check valves
BS 5155	Butterfly Valves
BS 5163	Pre Dominantly key operated Cast Iron Gate Valves for Water Works Purposes
BS 4504	Circular Flanges for Pipes, Valves, and Fittings
BS 21	Pipe treads for tube and fittings where pressure type joints are made
BS 5728	Measurement of flow of cold portable water in closed conduits
BS 3100:1991	Steel casting for general engineering purpose
BS 970	Wrought steel for mechanical and allied engineering purpose
BS EN 1561	Grey cast iron
BS EN 1563	Founding. Spheroidal graphite cast iron
BS EN 1564	Founding. Austempered ductile cast iron
BS EN 124:1994	Gully tops and manhole tops for vehicular and pedestrian areas

### 3.2 Materials and Manufacture

All valves shall be of size and type as shown on the drawings or in the Bill of Quantities. All valves shall be from one manufacturer, unless approved by the Purchaser in exceptional circumstances.

#### (i) Valves Ends

Valve ends shall be of flanged ends except where otherwise specifically called out on the bill of quantities. Where flanged ends are used, mating dimensions and drilling shall be in accordance with BS4504. Class of flange shall be PN16 unless otherwise specified. Bolts and nuts shall be galvanised mild steel.

- (ii) Valve Marking**  
All valves shall have the direction arrow for opening; the name or mark of the manufacturer; the name of the beneficiary "PWC"; the valve size; year of manufacture; number of turns to open, and the working pressure for which they are designed cast in raised letters upon an appropriate part of the body. In addition, valves designed for one-way flow only shall have a direction arrow cast on the body.
  
- (iii) Interior Parts in Valves**  
All interior parts of valves manufactured of bronze (except valve stems) shall conform to the requirements of ASTM B62 or approved equivalent standards unless otherwise stated.
  
- (iv) Protective Interior Coating for all Valves**  
Ferrous surfaces in the water passages of the valves excluding those surfaces manufactured of corrosion resistant material shall be non-toxic epoxy resin. The minimum coating thickness shall not be less than 100 microns.
  
- (v) Protective Exterior Coating for Buried Valves**  
All buried valves shall be provided with an exterior protective coating against corrosive soil in accordance with AWWA or equivalent DIN standards K115 or BS 5163: 1974 or approved equivalent standards. The minimum coating thickness shall not be less than 200 microns.
  
- (vi) Valve Stem**  
The valve stem shall be stainless steel grade AISI 304.
  
- (vii) Direction to Closure**  
The manufacturer of the valve shall ensure its closure by clockwise turning of the wrench nuts and open by counter clockwise turning by the valve operators.
  
- (viii) Underground Valves**  
All underground valves shall be furnished with surface boxes unless otherwise specified. All underground valves shall be coated completely including flanges, all bolts and nuts except stem with Denso paste and primer, Denso mastic, Denso tape and PVC or Polyethylene outer wrapping.
  
- (ix) Submittals**  
The Contractor shall submit manufacturer's certified drawings showing the principal dimensions, construction details and materials used for all parts of the valve and full details of valve stem extensions, including material, dimensions, fabrication, torque limits, method of connection to the valve and valve box and stem guides when required to avoid buckling.
  
- (x) Maintenance Materials**

The Supplier shall supply the following materials for use of the Employer as replacement parts for the valves furnished under this Contract in quantities of:

- 1) For every five (5) gate valves of the same size and type or fraction thereof:
  - 1 set stem seal
  - 1 pc stuffing box gasket with O-Ring
  - 1 pc bonnet gasket with O-Ring
  - 1 pc stem
  - 1 pc operating nut
  
- 2) For every five (5) butterfly valves of the same size and type or fraction thereof:
  - 1 pc shaft seal
  - 1 pc rubber-sealing ring
  - 1 pc thrust bearing
  - 1 pc operating nut
  
- 3) For every five (5) fire hydrants of the same size and type or fraction thereof:
  - 1 pc shaft seal
  - 1 pc rubber-sealing ring
  - 1 pc thrust bearing
  - 1 pc operating nut
  - 1 pc outlet standpipe (1m high)

When each type of valve to be supplied is less than five (5) sets, each one (1) set of the materials specified above shall be provided. No separate item is incorporated in the Bill of quantity for the maintenance materials. Costs of these maintenance materials shall be deemed to be included in the unit rate of each type of valve in the relevant item.

#### **(xi) Tee-Handle Valve Keys, Extension Spindles and Lifting Keys**

The Supplier shall supply twelve (12) tee-handle valve keys of sufficient length (inclusive extension spindles where required) for the operation of buried/below ground valves. The length of the key shafts shall vary according to the valve depths but shall project approximately one meter (1m) above ground level. Tee-Handle shall be of galvanised mild steel.

The Supplier shall also supply twelve (12) lifting keys suitable for manhole covers and surface boxes. The Supplier shall obtain Purchaser prior approval before ordering these materials.

### **3.3 Gate Valves (Resilient Seat Type)**

#### **(i) General**

Valves 300 mm and smaller in diameter shall be gate valves (sluice valves) unless specified otherwise. Unless otherwise specified or shown on the drawings, gate valve shall conform to AWWA C500, BS5163, AWWA C509 or Equipment DIN Standards. Gate valves shall be cast iron or ductile iron body, non-rising stem with solid wedge designed for a minimum working pressure of 16 kgf/sqcm. Gate valves specified, as PN16 shall conform to BS5163 PN16 designed for a minimum working pressure of 16 bars.

**(ii) Materials and Construction**

In general, the underground type valve and the aboveground type valve shall be of the same construction with the stem collar made integral with the stem and the hand wheel shall be used instead of the wrench nut in case that the valve is the aboveground type. The design of valve shall ensure opening by counter clockwise turning and the arrow marks indicating the open and close directions shall be cast on the hand wheel or operating nut.

Stem sealing shall be in accordance with BS5163.

Resilient seat shall be bonded to either the gate or valve body. If the resilient seat is rubber material, the method used for bonding or vulcanizing shall be proved by ASTM D429 "Tests for Rubber Property-Adhesion to Rigid Substrates-Method A or Method B". For Method A, the minimum strength shall not be less than 11.0 kgf/sq. cm and when Method B is applicable the peel strength shall not be less than 5.3 kgf/sq. cm.

**(iii) Specific Requirements**

The maximum effort required to operating the valve against the maximum unbalanced head, applied at the circumstance of the hand wheel or end of the tee-key shall not exceed 26 kg.

Testing - Each gate valve shall be subjected to operation, hydrostatic and proof-of-design tests at the manufacturer's plant as specified in the standard of BS or AWWA as applied at the appropriate test pressure.

**3.4 Butterfly Valve (Resilient Seated Type)**

Standard butterfly valves shall conform to BS 5155 for PN 16 pressure rating or equivalent DIN Standards and shall give tight closure against unbalanced water pressure in either direction. The unbalanced water pressure shall be the design pressure rating of the valve. The manufacturer's preferred direction of flow for the valve shall be clearly marked on it.

Valve shall be double flange cast iron or ductile iron resilient seated and shall be suitable for maximum velocity of 3 m/sec and for throttling service. Valve body shall be designed to withstand the maximum working pressure specified and the maximum differential pressure of 0.6 Mpa. Minimum thickness of valve body shall be calculated without exceeding a working stress equivalent to 20% of the tensile strength of the material used.

Valves shall be fitted with sleeve type bearings contained in the hub of the valve body and shall be equipped with either one or two trust bearings, which shall hold the valve disc securely in the centre of the valve.



Sleeve and other bearings fitted in to the valve body proper shall be made of self-lubricated material that do not have a harmful effect on potable water or resilient material.

Shaft shall be a one-piece unit extending completely through the valve disc, or of the “stub shaft” type, which comprises two separate shafts inserted into the valve disc hubs. If “stub” construction, each stub shaft shall be inserted in to the valve disc hubs for a distance of at least 1.5 times the shaft diameter. Valve shaft shall be of high yield strength austenitic series stainless steel such as type 403, 420, 431, and others and valve shafts made by precipitation series stainless steel also maybe acceptable. Allow-able torsional shear stress, not exceeding 25% of yield strength of material used shall be applied for de-sign of valve shaft diameter.

A shaft seal shall be provided where shafts project through the valve bodies for actuator connection. Shaft seal shall be designed for the use standard V-Type packing; O-ring seals; O-ring loaded U-cup seals; or a pull-down packing. If O-rings are used, they shall be contained in a stainless steel or bronze removable recesses. If stuffing box and pull-down packing are used, the design of the valve and stuffing box assembly shall permit adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly except packing gland follower. Gland or gland assemblies shall be made of stainless steel or bronze. Packing shall be made of resilient, non-metallic material suitable for potable water service, which shall not contain asbestos material.

The valve seat shall be replaceable and be formed of approved resilient material. Seats shall be of a design that permits removal and replacement at the site of installation. The valve seat shall be securely clamped into a machined groove in the valve body or to the edge of the disc by seat retention members or other equivalent retention device, in such a manner as to prevent leakage of water under the seats and to hold the seat securely in position during opening and closing of the valve disc. The seat retention members shall be of stainless steel and shall be securely fastened to the body or disc with stainless steel fasteners. When all the seat retention members are in place, the finished edges shall fit closely and the surface shall be smooth with all fastenings set flush in the water passage so as to offer the least resistance possible to the flow of water through the valve.

Valve seats which extend over the face of the flanges to secure the seat in place, or which require sur-face grinding and/or hand fittings of the disc; or designs, which require the adjoining pipe flange to retain the seat in place and resist line pressure, shall not be supplied.

Valve disc shall be made of cast iron or ductile iron or stainless steel casting and shall be of design with no external ribs transverse to the flow. The design of disc shall withstand full differential pressure across the closed valve disc without exceeding the working stress, equivalent to 20% of tensile strength of the material used. Disc edges shall be machined with rounded corners and shall be polished to a smooth finish. The

valve disc shall rotate through an angle of 90 degrees from the fully opened to the fully closed position and the seat shall be of such design as to allow the valve disc to seat at an angle normal to the axis of the pipe when the disc is in the fully closed position. Adjustable mechanical stops shall be provided in the valve body to prevent over-travel of the valve disc in both the open and closed positions.

Operating gear for butterfly valves shall be of the fully enclosed type. Valves shall be suitable for operation by one man at all pressure conditions that can apply. A valve position indicator shall be provided for butterfly valves in chambers. Where a hand wheel is used for operating such a valve, the indicator shall be clearly visible from the hand wheel operating position. Where a containing chamber is not shown, butterfly valves shall be specially adapted for buried use. In line valves shall be operated by means of a hand wheel or tee key and be provided with gearing to prevent rapid closure of the valve. Gear ratios shall be at least 20:1. A bitumen coating shall protect the valve bodies and the valve discs by a Nylon Coating or similar.

All butterfly valves shall be tested at the manufacturer's works in accordance with BS 5155 and under 'open-end' conditions. The seat test shall be for tight closure under maximum unbalanced water test pressure in either direction. The maximum permissible leakage for each valve shall be 0.05 litres per hour per 100 mm nominal diameter of the valve.

The word "CLOSE" or its abbreviation and the arrow mark indicating the direction of rotation to close the valve shall also be cast on the cover or the body. The minimum size of letters shall be 25 mm and 3 mm raised from the surface.

### **3.5 Air Valve**

Air valves shall be designed and manufactured in accordance with fitness for purpose requirement and appropriate verification tests EN 1074 Part 4, or equivalent. Air valves shall meet the working pressure of 16kgf/sq. cm respectively. The valves shall be iron bodied, float actuated air valves. Valve bodies, covers, bonnets and stuffing boxes shall be of cast-iron conforming to ASTM A48 Class 35, or BS1452 Class 220, or equivalent DIN standards.

Stainless steel conforming to AISI 304 may be used for stem, stud, bolts and nuts and main valve retaining units and plugs.

Air valves unless otherwise specifically indicated on the bill of quantity shall be of the following type and size depending on the size of pipeline in which they are installed.

Type & Size of Pipe (mm)	Nominal Size of Air Valve (mm)		Type of Air Valve
	Body size	Flange size	
Up to 225 PVC	25	Saddle	Single Orifice with an isolating cock, 1 inch BSP Threaded Male ferrule.
250 - 300 DI	60	80	Double Orifice with flanged inlet and an isolating ball valve.
400 – 600 DI	100	100	Double Orifice with flanged inlet and an isolating ball valve.
800 – 1200	150	150	Double Orifice with flange inlet and an isolating ball valve.

**(i) Single Orifice Type**

Single orifice type air valves shall be designed to automatically operate so that they will exhaust accumulated air under pressure while the pipe is flowing full of water.

**(ii) Double Orifice Air Valve**

Double orifice air valves shall be designed to automatically operate so that they will:

1. Positively open under internal pressure less than atmospheric pressure to admit air in bulk during pipeline draining operation;
2. Exhaust air in bulk and positively close as the water is flowing full of pipe, under low head, fills the body of the valve during filling operation;
3. Not blow shut under high velocity air discharge; and
4. Exhaust accumulated air under pressure while the pipe is flowing full of water.

Air valves are performance tested to ISO 5208 at the shop.

Seat test 1.1 x working pressure

Body test 1.5 x working pressure

No leakage shall be allowed

Coating of air valve shall be same as coating for gate valve

**(iii) High Speed Air Valve (Quick Type)**

Where shown on the drawing, high speed (quick type) air valve conforming to JIS B2063 Class 4 or equivalent DIN standards shall be used. The valve shall have flanged end and to meet the maximum operating pressure of 16 kgf/sq. cm. Dimension of flange shall conform to the requirement of the pipe flange.

The valve shall be a float actuated air valve with their inlets flanged. Valve bodies, covers, bonnets and stuffing boxes shall be of ductile iron conforming to ASTM A536 65-45-12, or BS2789 500/7, or equivalent.

**3.6 Ball Valve**

**(i) General**

The supply shall supply ball valves in accordance with the provisions incorporated in the Bill of Quantities and specification including gaskets and other necessary jointing materials.

**(ii) Material**

The valve shall be shaft-mounted, single seated ball valve. The body and body cap shall be of ASTM A48 Class No. 35 or FC 200 in JIS G5501, the plug of ASTM A296 CF8 or SCS 13 in JIS G5121, the operating shaft of SUS 304 in JIS G4303-G4309 or ASTM473 304 and thrust bearing and body seat of Teflon, respectively.

**(iii) Joint**

The ball valve shall have two flanges confirming to BS 4504. Class of flange shall be PN16 unless specified otherwise. The gasket shall be in accordance with BS2494 and the contractor shall supply two gaskets per valve.

**(iv) Coating**

All internal steel or cast iron surfaces of each valve, except finished or bearing surfaces, shall be shop painted with two coats of non-toxic epoxy resin and exterior steel or cast iron surfaces of each valve with two coats of zinc chromates.

**(v) Testing**

**Performance Test**

The valve shall be opened off its seated position under the shut-off pressure without exceeding the limitations provided below. Each valve shall be shop operated from the fully closed to fully opened position and vice versa under a no flow condition in order to demonstrate that the assembly is workable.

Pressure required to move cylinder

Cylinder Bore Mm	Pressure kgf/cm <sup>2</sup>
D ≤ 50	14.6
50 < D ≤ 125	11.73
D ≥ 125	8.79

Leakage Test

The valve seat shall be shop tested for leaks in the closed position with a pressure difference equal to the design pressure. The length duration of this test shall be at least 5 minutes and the leakage past the closed plug shall be zero.

Hydrostatic Test

With the plug in a slightly open position, internal hydraulic pressure equivalent to two times design pressure shall be applied to the inside the body of each valve at least for thirty (30) minutes. There shall be neither leakage to the exterior of the valve under test pressure nor any part is permanently deformed.

A hydraulic pressure equivalent to 1.5 times design pressure shall be applied to one side of the plug in the closed position at least for two (2) minutes for valves of 600mm and less and for at least fifteen (15) minutes for valves larger than 600mm. No part shall be permanently deformed at this test pressure condition.

### **3.7 Tilting Disc Check Valves**

Tilting disc check valves shall be cast iron or ductile cast iron body and disc, and bronze or stainless steel seating. Valves shall be designed for a working pressure of 14.0 kg/cm<sup>2</sup> and shall be suitable for operation in a horizontal pipeline.

Body shall be two (2) piece construction bolted together. Seat rings shall be mounted on both valve body and disc and shall be made of bronze casting conforming to JIS H5111 Class 6 or equivalent DIN standards or type 304, 403, 420 or equivalent or other stainless steel. Mating surfaces of body seat and disc seats shall be machine finished. Hinge pin shall be of stainless steel specified above. Bushing of hinge pin shall be bronze casting specified above or aluminum bronze casting conforming to JIS H5114, Class 2 or 3 or equivalent DIN standards.

Body shall be provided with suitable holes for cleaning and by-pass pipe with valve. Pivot pin housing shall be fitted with ball check grease fittings.

Dash pots shall be furnished with valves and designed to have valve opening and closing speed control devices. Dash post shall be approved by the Engineer.

### **3.8 Butterfly Float Valve**

#### **General**

Butterfly float valve shall be designed to mechanically and automatically open and close according to the water level in the storage reservoirs.

#### **Design and Materials**

Butterfly float valve shall be made of stainless steel material. The valve shall consist of a rubber sheeted butterfly valve, gear unit, float and a connection rod to support the float. The gear unit shall be designed to operate the butterfly valve between full opening and full closing positions in the range of 45 degree vertical move of the connection rod which shall be operated with float. Gear unit shall be provided with a stopper to prevent the connection rod exceeding the vertical movement limits. The float shall have enough volume and weight for operating the valve gear unit. The operating level of the float shall be adjustable. The float shall be suspended with stainless steel wire from the reservoir roof to protect it from falling down during low level water storage.

The valve shall have flanged ends conforming to the working pressure of 10kgf/cm<sup>2</sup> for reservoirs. Mating dimension of flange and number of bolt holes shall be in accordance with the manufacturer's recommendations. The materials to be used for the construction shall be stainless steel, stainless steel castings or rubber. Materials for major components of the valve are as follows:

Valve Body	:	Stainless steel
Valve Disc	:	Stainless steel
Valve Shaft	:	Stainless steel
Short Pipe	:	Stainless steel
Connection Rod	:	Stainless steel
Float	:	Stainless steel

The design data and other engineering information of the butterfly float valve shall be submitted to the Engineer for approval.

### **3.9 Flap Valves**

Flaps and frames shall be ductile iron conforming to BS 2789. Mating surfaces of flaps and frames shall be of non-ferrous metal (excluding aluminum) accurately machined to ensure a watertight fit in the closed position.

Hinge pins shall be of tamper proof austenitic stainless steel; all flaps shall be double hung and seat off the vertical. Flanges shall be PN 16 conform to BS 4504.

Coated in either fusion bonded epoxy, minimum thickness 150 microns, or cold applied black bitumen.

### **3.10 Fire Hydrants**

Fire hydrants shall be supplied and installed at the locations shown on the Key Plan Drawings of Distribution Pipelines. The exact locations of the fire hydrants shall be identified at site in the presence of the Engineer's Representative and approved by the Engineer.

Fire hydrants shall be wedge gate type in accordance with BS 750:1984. The fire hydrant shall consist of a screwed outlet 60 mm diameter round head.

The fire hydrants shall have a rated working pressure of 16 bars and flanges shall be drilled according to BS 4504 PN16. All the fire hydrants shall be supplied complete with pipes and specials required to connect the tee and the fire hydrants, manhole covers and frames etc. as per details given in the standard drawing, as specified under relevant item.

### **3.11 Mechanical Couplings and Flange Adaptors**

Couplings for jointing plain-ended pieces shall be of the Dresser Viking Johnson or similar type approved by the Purchaser and may be steel or ductile iron at the option of the Contractor. They shall be designed to withstand a maximum working pressure of 16 bars. Flexible couplings shall have a Rilsan Nylon II coating fully bonded to the surface. The thickness of the coating shall be 250-350 microns, applied by the fluidized bed process.

Bolts and nuts shall be carbon steel to BS 970 Part 1 : 1986 Grade 070 M20 or equal and nuts shall be zinc plated to grade Zn 3 primed and electro-statically sprayed with Rilsan Nylon II powder, giving a dry film thickness of 100 microns. Washers shall be hot dipped galvanized in accordance with BS 729 1971. All couplings and flanged adaptors shall be provided with a transit protection coat. Gaskets shall be of EPDM to BS 2494: 1986 types W (potable water).

The flexible couplings shall be designed for a safe allowable angular deflection of 6 degrees without leakage. Flexible couplings for each size of pipe shall also be capable of withstanding a shear force corresponding to the weight of a 4m length of pipe of that diameter full of water applied by the coupled pipes. Prior to the commencement of manufacture, the Contractor shall submit to the Purchaser for approval detailed drawings of all mechanical couplings.

All mechanical couplings and flange adaptors shall comply with the BS/ BSEN ISO 9000 series quality system. Quality Assurance Certification should be from an organization accredited to issue such certification. Documentary evidence regarding accreditation together with the scope of certification shall be provided.

Couplings and flange adaptors installed **in HDPE pipes shall be axial restraint type** and shall be designed to meet the full Type 1 performance requirements of UK Water Industry Standard (WIS) 4-24-01.

### **3.12 Dismantling Joints.**

Dismantling Joints shall be particularly suitable for simplifying the installation and removal of isolation valves, control valves, and flow meters which are connected with flange joints. Dismantling Joints shall be designed and manufactured to BS EN ISO 9001: 2008 and tested to the most exacting requirements of WRAS (Water Regulatory Advisory Scheme) for use with potable water.

### 3.13 Manhole Cover and Frames

Manhole covers shall be Covers shall be manufactured from 6mm steel floor plate to the sizes depicted in drawings, and shall be hot dipped galvanized accordance with BS 729 after the hand holes and openings have been cut and smoothed and all necessary weld joints had been made. Thickness of the plate does not include the height of the raised sections. If any further holes are needed, then these shall be cut and the cut surfaces given two (2) coats of zinc rich paint. Covers shall be true and flat, and not twisted, so as not to be a potential hazard. Locking arrangement also provided for both cover and for the lid to the inspection opening.

The contractor has to submit shop drawings prior to fabrication for approval.

### 3.14 Surface Boxes

Surface boxes shall be of ductile iron, confirm to BS 5834:1983 Grade A or to the Purchaser's approval, with the following minimum clear opening of 120mm, unless otherwise specified. They shall be with captive hinge arrangement to deter vandals and with suitable watertight arrangement to prevent ingress of surface water into the keyhole. Surface boxes shall be painted before installation with two coats of bituminous paint.

The lids or covers of surface boxes shall have letters or words in English to indicate the function of the fitting "FH, WO, SV, in suitable size, cast in raised letters.

### Pictures – Fittings:

