

SPECIFICATIONS OF HIGH DENSITY POLYETHYLENE

(HDPE) PIPE AND FITTINGS

1- GENERAL

a. THE REQUIREMENT

1. The Supplier shall furnish and install high-density polyethylene pipe (HDPE), tubing and fittings as following reference standards shall apply.
2. DIN EN ISO 178 – Determination of the Flexural Properties of Plastics
3. DIN EN ISO 527-2 – Determination of tensile properties of plastics – Test Conditions for Moulding and Extrusion Plastics
4. DIN 1988-2 - Drinking water supply systems; materials, components, appliances, design and installation (DVGW code of practice)
5. DIN 7728–1 – Plastics – Symbols for Polymers and Their Special Characteristics
6. DIN 8074/ ISO 4427 - Polyethylene (PE) Pipes Dimensions
7. DIN 8075/ ISO 4427 - Polyethylene (PE) Pipes General Quality Requirements and Testing
8. DIN EN ISO 12162 – Thermoplastic Materials for pipes and Fittings for Pressure Applications – Classification, Designation and Overall Service (design) Coefficient
9. DIN 16963 – Pipe Joint Assemblies and Fittings for High – Density Polyethylene (PE-HD) Pressure Pipes
10. DIN 53752 - Determination of Coefficient of Linear Thermal Expansion of Plastics

b. QUALITY ASSURANCE PROGRAM

1. Qualification of Manufacturers

The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. Given reasonable notice, the Manufacturer's production facilities shall be open for inspection by the EMPLOYER or his authorized representative. Qualified manufacturers shall be approved by the ENGINEER

2. **Material**

Material used for the manufacturing of polyethylene pipe and fittings shall be High Density Polyethylene (HDPE) meeting the DIN/ISO material classification.

The material used in the production of potable water pipe shall be meet DIN / DVGW and ISO requirements.

The Manufacturer shall certify that the materials used to manufacture pipe and fittings meet the requirements of this specifications.

3. **Pipe**

Polyethylene pipe shall be manufactured in accordance with ISO 4427 /DIN 8074 / 8075 for PE-100, SDR 11, design stress 8 Mpa. The density of polyethylene pipe (PE 100) should not be less 0.95~0.965 g/cm³.

4. **Fittings**

Polyethylene fittings shall be made from material meeting the same requirements as the pipe. Polyethylene fittings shall be molded or fabricated by the manufacturer of the pipe.

Where applicable, fittings shall meet the requirements of DIN 16963.

Molded fittings shall be manufactured in accordance with DIN requirements for (socket fused) or (butt fused) fittings, and shall be marked.

Mechanical fittings used with polyethylene pipe shall be specifically designed for, or tested and found to be acceptable for use with polyethylene pipe and approved by the Engineer.

5. **Inspection of Materials**

- a. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in DIN Standards.
- b. The Supplier shall inspect all pipe and accessories for shortages, loss, or damage upon receipt of the shipped material at the time of unloading, recording this information directly on the waybill received from the carrier. If later during the Installation, some material is found to have defects that material shall be rejected by the supervising Project Coordinator of his

authorized inspector. Defective material should be removed from the joining site and not used during the installation. With the approval of the supervising. Project Coordinator, pipe may be repaired by cutting out the damaged sections and thermally fusing the remaining acceptable pipe.

Acceptable limits for cuts, gouges or scratches are as followed:

O.D. Surface - Maximum allowable depth of cut, scratch or gouge shall be 10% of wall thickness.

I.D. Surface - Shall be free of all cuts, gouge or scratches.

6. PRODUCTS

a. HDPE PIPE

- The pipe shall be made from polyethylene resin compound qualified for PE 100, SDR 11, design stress 8 Mpa.
- The raw material shall contain a minimum of 2% well dispersed carbon black.
- The pipe shall contain no recycled compound.
- Compliance with the requirements of this section shall be certified in writing by the pipe supplier, upon request.

b. HDPE PIPE DESIGN

- Polyethylene pipe shall be constructed to a minimum wall thickness of SDR 11 dimension. Pressure rating at 73.4° F (23 c⁰) shall be 160-psi (11.2 bar) minimum.
- The Hydrostatic Design Stress shall be for PE 100 materials.

7. MARKING

- Pipe and tubing shall be marked in accordance with DIN requirements. They shall bear permanent identification markings that will remain legible during normal handling, storage, installation, and service life and that have been applied in a manner that will not reduce the strength nor otherwise damage the products. The following shall be continuously marked on the pipe, or spaced at intervals not exceeding 5 feet:
 - Name and/or trademark of the pipe manufacturer.
 - Nominal Pipe Size.
 - Dimension Ratio (e.g., SDR 11).
 - Standard PE code designation (e.g PE100).

- DIN Manufacturing Standard Reference
- A production code from which date of and place of manufacture can be determined.
- Fittings shall be marked on the body or hub. Marking shall be in accordance with DIN Standards. Mechanical fittings shall be marked with size, body material designation code, pressure rating and manufacturer's name or trademark.

SPECIFICATION OF DUCTILE CAST IRON (DI) PIPES AND FITTINGS

- All ductile iron pipes should conform to ISO 2531/ BS EN 545/ DIN EN 545/ DIN 28605
- Wall thickness of pipe should be Class K9, 6M Length.
- PN=16 bar.
- All pipes and fittings are internally lined with sulphate resistance cement mortar according to ISO- 4179 / DIN EN 545/ BS EN 545.
- Externally the pipe should be coated with metallic ZINC (130g/m²), plus bitumen coating (70 µm) according to ISO- 8179.
- Protection against corrosion with Epoxy coating, conforming to DIN EN 14901.

FITTINGS OF DI

- Wall thickness of fittings and accessories of ductile iron for water-pipes, according to ISO 2531/ BS EN 545/DIN EN 545/ DIN 28605.
- Ductile iron fittings for UPVC or PE piping systems according to DIN EN 12842.
- Externally the fitting should be coated with rich metallic ZINC paint (150g/m²) , plus bitumen coating (70 µm) according to ISO- 8179.
- For All Fittings without Branches should be Class K12.
- For Tee and Angle Branches should be Class K14.
- Gaskets rubbers shall be EPDM as per ISO 4633.
- Price include 102% rubber gasket.
- Pipe and fittings should be packed in wooden cases.

MARKING ON PIPES :

It should cast on Pipes:

- Nominal Size (DN-), manufacture Code (), material, class Designation or standard and Year Manufacture

MARKING ON FITTINGS:

It should cast on Fittings:

- Nominal Size (DN-),manufactures Code (),angle of Bends, year Manufacture, ductile Iron Sign () and nominal Pressure (PN).

SPECIFICATIONS OF VALVES

- All valves (gate valves and air release valves) should be (PN = 16 bar).

1- SUPPLIER SUBMITTALS

- a. Any valve shall contain the following information:
1. Valve name, size, pressure rating, identification number (if any), and specification section number.
 2. Cavitation limits for all control valves.
 3. Attaching catalogues showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
 4. Valve Labeling: A schedule of valves to be furnished with stainless steel /non corrosive tags, indicating in each case the valve location and the proposed wording for the label.
- b. **Technical Manual:** The Technical Manual shall contain the required information for each valve.
- c. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.
- d. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

2- PRODUCTS

- a. **General:** Valves shall be new and of current manufacture. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet (213 cm) above working level shall be provided with chain actuators.
- b. **Protective Coating:** The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4 inches (100 mm) and larger shall be coated in accordance with – epoxy coating according DIN EN 14901. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. .

- c. **Valve Labeling:** A label shall be provided on all shut-off valves and control valves except for hose bibs and chlorine cylinder valves. The label shall be of 1/16-inch (1.6 mm) plastic or stainless steel, minimum 2 inches by 4 inches (50 mm and 100 mm) in size, - Piping Identification Systems, and shall be permanently attached to the valve or on the wall adjacent to the valve
- d. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3 inches (75 mm) in diameter and smaller shall be tested in accordance with manufacturer's standard and 4 inches (100 mm) in diameter and larger shall be factory tested as follows:
 - 1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to 1.5 times the water rated pressure of the valve. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
 - 2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to 1.1 times the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.
 - 3. **Performance Testing:** All valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.
- e. **Certification:** Prior to shipment, the supplier shall submit for valves over 6 inches (150 mm) in size, certified copies of the hydrostatic factory tests, showing compliance with the applicable standards of DIN, or ISO.
- f. **Valve Marking:** Valve bodies shall be permanently marked in accordance with DIN EN 19 - Standard Marking Systems.

3- MATERIALS

- a. **General:** Materials shall be suitable for the intended application. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve bodies shall conform to the following requirements:
 - 1. **Cast Iron:** Close-grained gray cast iron, conforming to DIN 1691 - Gray Iron Castings, GG25.

2. **Ductile Iron:** DIN EN-JS 1030 - Ductile Iron Castings, or Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
3. **Steel:** DIN GS-C25 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
4. **Bronze:** DIN 1705, 2.1096.01 - Composition Bronze or Ounce Metal Castings. and valve stems not subject to dezincification shall conform to DIN material 2.1090.01 Copper Alloy Sand Castings for General Applications.
5. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to DIN 17440 - Steel Castings, Austenitic, for High-Temperature Service, stainless steel type 1.4401 or 1.4571.
6. **PVC:** Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
7. **CPVC:** Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
8. **NSF Standard 14:** All materials shall be listed for use in contact with potable water.

4- VALVE PARTS

- a. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature (equal or more than 50 °C) and pressure to which the valve will be subjected.
- b. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- c. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to DIN 1705 and 1725, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 30,000 psi (258 N/mm²), a minimum yield strength of 14,000 psi (120 N/mm²), and an elongation of at least 10 percent in 2 inches (50mm). Where dezincification is not a problem, bronze conforming to

DIN 1705 material 2.1090.01 may be used, with a zinc content not exceeding 16 percent.

- d. **Stem Guides:** Stem guides shall be provided spaced 10-feet (30 cm) on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 1.4301 stainless steel.
- e. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 1.4401 or 1.571 stainless steel or other best suited material.
- f. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be made from brass or steel.

5- VALVE ACCESSORIES

Valves shall be furnished complete with the accessories required to provide a functional system.

6- SPARE PARTS

- a. The supplier shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The supplier shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the EMPLOYER, after expiration of the correction of defects period.

7- MANUFACTURERS

- a. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the valves indicated.
- b. **REFERENCE SPECIFICATIONS, CODES AND STANDARDS**
 - 1. ISO 2531/ BS EN 545/ DIN EN 545/ DIN 28605- Ductile-Iron Pipe and Fittings for Pressure Pipelines – Flanged Joints – Assembly, Flanges, Gasket, Bolts and Nuts.
 - 2. DIN 3230 - Conditions and Terms for Delivery of Valves
 - 3. DIN 1691 - Gray Iron Castings
 - 4. DIN EN 1563 - Spheroidal Graphite Cast Irons
 - 5. DIN EN 558-1 - Face-to-face and center-to face dimensions; flanged valves.
 - 6. DIN EN 1092 – Circular flanges for pipes, valves fittings and accessories

7. DIN EN 1171 - Cast iron gate valves, with metallic and electrometric seating.
8. DIN EN 593 – Industrial Valves – Metallic Butterfly Valves
9. DIN EN 1074 - Valves for Water Supply - Fitness for Purpose Requirements and Appropriate Verification Tests
10. DIN 3202 - Face-to-face and center-to face dimensions; flanged valves.
11. DIN 3352 - Cast iron gate valves, with metallic and electrometric seating.
12. DIN EN 593 – Industrial Valves – Metallic Butterfly Valves
13. DIN EN 1074 - Valves for Water Supply - Fitness for Purpose Requirements and Appropriate Verification Tests
14. BS 750 – Underground Fire Hydrants and Surface Box Frames and Covers

c. SUPPLIER SUBMITTALS

The SUPPLIER shall furnish submittals in accordance specifications and submit the following:

1. Catalogues.
2. Certification of proof-of-design test from the pipes, fittings and valve manufacturers.
3. Manufacturer's Certification that the valve complies with all applicable provisions of ISO/ BS or DIN Standards for – Rubber-Seated Butterfly Valves, Resilient-Seated Gate Valves for Water Supply Service, Air-Release valves.

d. QUALITY ASSURANCE

1. Valves shall be manufactured in accordance with the latest revisions of DIN and EN Standards or equivalent from ISO standards. The manufacturer shall have produced valves for a minimum of five years. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by applicable DIN or equivalent standards.

e. RESILIENT –SEATED GATE VALVES

1. **General:** Gate valves shall be resilient seated, manufactured to meet or exceed the requirements of DIN EN or equivalent latest revision standards
2. Gate valves shall be manufactured with a minimum design working water pressure of 16 bars.

3. The valve ends shall be flanged and joined with brass or steel bolts.
4. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.
5. The valves are to be non-rising stem with the stem made of stainless steel. Two stem seals shall be provided and shall be of the O-ring type. The stem nut, made of bronze, shall be independent of the gate. Provide extension stems to ground level.
6. The sealing mechanism shall consist of a cast iron gate having a vulcanized synthetic rubber coating. Where resilient seated gate valves are applied for drinking installations the rubber coating shall be approved according DVGW Guideline W 270. The resilient sealing mechanism shall provide zero leakage at the design water pressure of PN 16 when installed with the line flow in either direction.
7. The valve body, bonnet cover shall be cast iron. All internal and external surfaces shall be coated with epoxy to a minimum thickness of 250µm.
8. All gate valves are to be tested in strict accordance with DIN EN 1074 and VDE requirements.

F. AIR-RELEASE VALVES

1. **General:** Air vacuum and air release valves shall be in accordance with DIN Standards or equivalent standards.
2. **Air-Release Valves:** Air valves shall have two orifices, while being capable of venting large quantities of air while pipelines are being filled, exhausting accumulated small quantities of air when pipeline is pressurized and allowing air to re-enter while pipelines are being drained.
3. Air-Release Valves shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of ductile cast iron. The float, seat, and all moving parts shall be constructed of Type stainless steel or other non corrosion type.
4. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 16 bar water-working pressure, unless otherwise indicated.
5. Body cover of ductile cast iron EN-JS 1030 (GGG-40), inner parts of plastic material sealing of EPDM, inside and outside epoxy coating 200-300 microns.

g. RUBBER SEATED BUTTERFLY VALVES

1. **Rating:** Butterfly valves shall be manufactured to withstand full working pressure of PN 16 plus 6 bar surge pressure in both directions.
2. The valve shall not leak or fail in anyway at the design pressure and the operators shall be capable of opening and closing the valves with bi-directional flow. .
3. **Valve Bodies:** Valve bodies shall be of short body type, constructed of cast iron for flanged valves. Flanged valves shall be drilled in accordance with DIN standards for a working pressure of PN 16.
4. **Valve Seats:** Rubber seats shall be of one piece construction, simultaneously molded and bonded into a recessed cavity in the valve body. Seats located on the disc or retained by segments and/or screws are not acceptable.
5. **Valve Bearings:** Valve bearings shall be of a self-lubricating, nonmetallic material to effectively isolate the disc-shaft assembly from the valve body. Metal-to-metal thrust bearings in the flow stream are not allowed.
6. **Valve Disc:** The disc shall be a lens-shaped design to afford minimal pressure drop and line turbulence.
7. **Valve Shafts:** Valve shafts shall be of stainless steel.
8. **Painting:** All surfaces of the valve interior shall be clean, dry and free from grease before painting. The valve surfaces except for disc edge, rubber seat and finished portions shall be evenly coated with asphalt varnish. The exterior valve surfaces and actuator shall be evenly coated in accordance with Section 09800 – Protective Coatings.
9. **Testing:** Hydrostatic and seat leakage tests shall be conducted in strict accordance with DIN requirements.
10. **Proof of Design:** The manufacturer furnishing valves under the specification shall be prepared to provide Proof of Design Test reports to illustrate that the valves supplied meet the design requirements.
11. **Manual Actuators:** Manual actuators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Actuators shall be equipped with mechanical stop-limiting devices to prevent overtravel of the disc in the open and closed positions. Actuators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 lb. On the handwheel or chainwheel. Actuator components shall withstand an input of 300 ft-lbs. At extreme operator position without damage.

12. Valves shall turn counterclockwise, or the left to open.

h. SWING CHECK VALVES (75 mm AND LARGER)

1. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and weight type, in accordance with DIN Standards requirements for - Swing-Check Valves for Waterworks Service, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 10 bar. They shall have a flanged cover piece to provide access to the disc.
2. Body: The valve body and cover shall be of cast iron conforming to DIN 1691 - Gray Iron Castings for Valves, Flanges, with flanged ends conforming to DIN 2501 – Flanges Connecting Dimensions, Class PN10.
3. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to DIN 1705 – Cast Tin Bronze and Gunmetal Castings.
4. Seat and Rings: The valve seat and rings shall be of bronze to conforming DIN 1705 – Cast Tin Bronze and Gunmetal Castings, or of Buna-N.
5. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

i. FIRE HYDRANTS

1. Fire hydrants shall be underground in chamber wedge gate (type 1). The fire hydrant shall meet or exceed BS 750, latest revision. Rated working pressure shall be 16 bar, test pressure shall be 24 bar. The hydrants shall include the following specific design criteria.
2. The wedge gate valve shall comply with the requirements of BS 5163 for PN16 valves.
3. Duck foot bend shall be Gray cast Iron according to BS 1452 or Spheroidal graphite cast iron according to BS 2789.
4. Screwed outlets shall be of Gunmetal or Die-cast brass according to BS 1400 with dimensions as per the requirements of BS 750.
5. The spindle shall be provided with a cast iron cap securely fixed to the spindle.
6. The duck foot bend shall be provided with a drain boss on the outlet side. It shall be located at the lowest practicable point, which will permit the fitting of a blank plug.

SPECIFICATION OF PIPE SELF-TAPPING SADDLES SURFACE BOXES AND MANHOLES COVERS

1- PIPE SELF-TAPPING SADDLES

- Self-Tapping Saddles are required to be installed as indicated on the drawings for house connections on the secondary distribution system pipes (DN150 DI). The saddles shall be suitable for a working pressure not less than 10 bars.
- The saddles shall be of single strap design and in two parts, flat top and bottom-bolted at both sides. The inside corners of the saddle strap should be rounded to prevent digging into the pipes. The saddles shall be manufactured from gunmetal to DIN 1705 or BS 1400 to suit the distribution pipes and shall be supplied complete with the following:
 - Bolts and nuts of stainless steel to DIN 601, ISO 3506 or equivalent. Bolt heads shall be clearly marked with the manufacturer's name or his identification mark.
 - Nitrile rubber sealing "O" rings, suitable for service connections to be fixed between the disc and the pipe in groove in accordance with DIN 16963 and DIN EN 681 or equivalent. They shall be suitable for working pressure of 16 bars.
 - The saddles shall be suitable for use with threaded push-fit adopter. Saddles shall be tapped for internal pipe threads in accordance with DIN 2999, ISO 7/1, BS 21 or equivalent.

2- SURFACE BOXES AND MANHOLE COVERS

- Cast iron surface boxes with round lid according to DIN 4056 shall be supplied for operation of gate and butterfly valves. Surface boxes shall be suitable for a 100 kN load.
- Shorter surface boxes for casting into concrete slabs may be used with lockable lid and also suitable for a loading of 100 kN.
- Hexagonal lids shall be supplied for service (house) connection stopcocks (ferrules).
- Surface boxes shall have a cold applied bituminous black paint coating. The hinge of the lid shall be of non-corrosive material.
- Manhole covers for casting into concrete slabs of valve chambers shall be of the heavy-duty class D 400 KN (40 ton) for installation in roads and streets. They shall be of the round type with a clear opening, non-ventilated

JOINING METHODS

1. Wherever possible, plain end polyethylene pipe and fittings should be joined by the method of thermal butt-fusion.
2. Butt-fusion joining of pipe and fittings shall be performed in accordance with the procedures established by the pipe manufacturer. Joining must be conducted by, or under the supervision of a factory trained manufacturer's representative.
3. Butt-fusion joining of pipe and fittings shall be performed on fusion machinery approved by the pipe manufacturer. Fusion pressures, temperatures and cycle times shall be according to pipe manufacturer's recommendations. No pipe or fittings shall be joined by fusion by any Contractor unless he is adequately trained and qualified in the technique involved.
4. The polyethylene pipe, may be adapted to fittings or other pipe elements by means of a suitable flange assembly. Flange assemblies shall consist of the following items:
 - a. A polyethylene stub end made from the same resin material as the pipe. This stub end shall be factory machined from a molded polyethylene blank made at the pipe manufacturer's factory.
 - b. A back-up flange of ductile iron or other suitable material, made to PN 10, DIN dimensional standards. Exceptions to these dimensional standards can be made for systems with exceptionally high operating pressures.
 - c. Flange assemblies are connected by bolts of compatible material with gaskets, of suitable material for the fluid and pressure characteristics, cut to fit the joint in all cases, the bolts shall be drawn up evenly and in-line, using procedures recommended by the pipe manufacturer.
5. Polyethylene pipe, in sizes from 3 inch (75 mm) IPS to 12 inch (300 mm) IPS, may be alternatively joined by way of specially designed mechanical couplings. These couplings shall include a malleable or ductile iron body, an elastomeric gasket (grade E), and cadmium, plated nuts and bolts.
6. Polyethylene pipes of the same outside diameter, but different wall thicknesses, shall only be joined by means of a flange assembly, suitable mechanical couplings or transition spool pieces supplied by the pipe manufacturer.

MITRED FITTINGS

7. Mitred fittings (e.g. elbows, wyes and tees) shall be designed with additional material in areas subject to high stress. The common commercial practice is to increase wall thickness in high-stress areas by using heavy-wall pipe sections. This is similar to molded fittings that are molded with heavier body wall thickness. Reinforced overwraps may be used to increase the pressure rating of a

fitting. All fittings shall be assembled using the but-fusion technique under factory conditions, under the supervision of the pipe manufacturer.

8. Mitred fittings shall be available from the pipe manufacturer with either flanged or plain ends.
9. In all cases where polyethylene pipe is installed, a detectable metallic tape shall be installed in the pipe trench parallel and one foot (300 mm) above the top of the pipe. The metallic tape shall consist of a minimum thickness of 0.35 mils solid aluminum foil core running in a protective, high-visibility, color-coded plastic jacket that is impervious to corrosive soil conditions. The tape shall be a minimum of 6 inches (15 cm) wide with a minimum overall thickness of 5.0 mils. The tape shall meet or exceed the industry standards and DIN requirements. The tape shall be permanently printed with lettering which reads: "Caution – Water Line Buried Below- Sana'a Water and Sanitation Local Corporation-SWSLC Telephone Number" in Arabic and English.

HANDLING OF PIPE OF MATERIALS

- Pipe and fittings shall be handled carefully at all times to avoid damage. Straight lengths of pipe can be safely unloaded using mobile handling equipment capable of lifting the weight of pipe to a height that will allow the complete pipe length to clear truck side racks.
- Wide belly-band slings are commended for handling straight lengths of pipe. Thick nylon rope slings may also be used, either in an inverted "Y" or with a spreader beam to distribute the weight evenly over two lifting points.
- Forklifts or mobile cranes can be used to move straight lengths of pipe, providing that the load is lifted at mid-point. Forks shall be checked for ragged edges or burrs. These shall be removed or the forks wrapped to prevent damage to the pipe.
- Under no circumstances should hooks be inserted into the pipe ends to lift pipe. Dragging the pipe over gravel or rock shall be avoided, as this may cause cutting whereas pulling over reasonably smooth terrain (e.g. sand or topsoil) will not damage the pipe.

STORAGE OF PIPE AND FITTINGS

- Storage of the pipe on the job site shall be done in accordance with the pipe manufacturer's recommendation.
- Recommended ground conditions are leveled gravel, sand, topsoil or grass. The interior of all pipe and fittings shall be kept free of debris and lifting equipment at all times.

- Pipe shall be piled in a free-standing manner with wide-face wooden chocks restraining the bottom layer.

SPECIFICATION OF HOUSE CONNECTIONS WORKS

SERVICE CONNECTIONS

Installation:

- A number of complete service connections between existing or new pipe lines and the customers existing systems shall be made by the Contractor.
- Service connections of OD 63 mm, OD 32 mm or OD 25mm HDPE from new HDPE main lines should be constructed using a self-tapping ferrule and saddle placed on the service line or an equal tee as indicated on drawings.
- Services connections on existing or proposed ductile iron pipelines DN 100 mm or larger shall be made under pressure tapping. A gunmetal saddle is to be provided with stainless steel nuts and bolts and nitride rubber sealing ring/washer suitable for a working pressure of 10 bars. The tapping shall be made of OD 25 mm, OD 32 mm and OD 63 mm. The gunmetal ferrules shall have single outlets suitable for OD 25 mm, OD 32 mm and OD 63 mm pushfit outlets. The Engineer's Representative will issue instructions regarding the size, location and fittings for each service connection.
- Tapping shall be made into saddles affixed to the main lines as shown on the detailed drawings and care shall be taken to avoid breaking away concrete lining.
- The machine manufacturer's recommendations shall be followed in respect of the tapping machine.
- Tapping shall be positioned on the main so that the ferrule is inserted into the main at the crown. The jointing of the threaded ferrule to the main line shall be made using lead free jointing compound or p.t.f.e tape.
- The outlet of the ferrule shall be set to point in the direction in which the service pipe is to be laid. The HDPE service pipe shall be laid with a cover of not less than 600 mm below the ground surface unless otherwise shown on drawings.
- The jointing on the HDPE pipe to the **pushfit joint** shall be in accordance with the instructions of the Manufacturer of the pushfit fittings.

- The service connection pipe shall be carried to the property wall of the customer to a location to be proposed by the Contractor and approved by the Engineer. The service line shall be sleeved from where it passes through the boundary wall, to the connecting point on the GI pipe to facilitate subsequent withdrawal. All GI pipe upstream the meter shall be polyethylene coated GI pipe.
- The transitional point from the HDPE to the GI pipe shall be protected as shown on the standard drawings. Execution is to be as instructed by the ENGINEER.
- In all cases the house-connection line shall terminate in a gunmetal compression adapter manufactured to DIN 1705 or BS 1400, to connect existing or new GI pipe and stop valves before and behind the water meter as shown on the drawings.
- A number of replacement of existing service connections will be required. The work may include the disconnection of the old existing water meter. The same water meter or a new one (supplied by the SWSLC) shall be installed as directed by the Engineer's Representative.
- Where required pressure reducing valves shall be installed as instructed.
- Pipe work on both sides of the meter assembly shall be anchored to prevent movement of any flexible joints within the meter assembly. Such anchorage shall leave sufficient room for connecting and disconnecting the meter making use of the adapters provided.
- A stop valve, conforming to BS 1010 heavy duty pattern for installation above ground with water meters, key operated closing direction clockwise and female threaded to BS 21 shall be installed upstream of the meter on the entry side as indicated on the drawings to work as isolating valves for maintenance purposes and a non return stop cock shall be installed downstream of the meter.
- Where meter assemblies need to be repositioned, the meters shall be fixed horizontally, and with the lowest dial not more than 1.0 m above the floor level and easily visible for reading.
- The work shall also include installation of sufficient lengths of 1/2", 3/4", and 1" exposed galvanized pipe lines as may be required to connect the water meters (in their new locations) to the existing pipe lines inside the properties of the consumers. All galvanized pipes, valves, fittings and adapters required for a complete connection shall be supplied and installed by the Contractor at no additional cost.
- If existing valves are in good condition, they shall be reinstalled by the Contractor at no extra cost.
- All buried fittings including the ferrule should be manufactured from gunmetal or other resisting material and be suitable for underground use.

SIZES OF SERVICE CONNECTION PIPES

The size of the HDPE pipe service connections which terminate in a compression adapter inside the residential areas shall be as follows:

Max. No. of Flats/Plots	Size of HDPE inlet (Size of House Connection)
≤10	OD 25 mm
11 – 12	OD 32 mm
22 – 130	OD 63 mm

For larger consumers and for schools, hospitals, and other large community buildings, the diameter of house connection shall be OD 32 mm or as calculated by the Contractor according to the actual demand and approved by the Engineer.

The size of single ferrules to multi-occupation premises shall be as follows:

MaximumNo of Flats/Plot*	Number of Plots connected	Maximum Number of Flats	Ferrule outlet Diameter (Single Type)
4	1	4	OD 25mm
	2	8	OD 25mm
	3	12	OD 32mm
7	1	7	OD 25mm
	2	14	OD 32mm
	3	21	OD 32mm
15	1	15	OD 32mm
	2	30	OD 63mm
	3	45	OD 63mm
25	1	25	OD 63mm
	2	50	OD 63mm
	3	75	OD 63mm

* The maximum number of Flats/Plots shall be determined according to the municipal regulation

The inlet sizes of the ferrules shall be as follows:

Ferrule Outlet Size	Ferrule Inlet Single
OD 25mm	OD 25mm
OD 32mm	OD 32mm
OD 63mm	OD 40 mm for main ≤ DN 100

OD 63mm	OD 63 for mains \geq DN 150
---------	-------------------------------

The exact number of house connections should be updated at time of construction, if required.

NOTE:

- Under no circumstances should the total time under test exceed eight (8) hours at 1.5 times the pressure rating. If the test is not completed due to leakage, equipment failure or any other reason within this time period, the test section should be permitted to “relax” for an additional eight hour period prior to starting the next testing sequence.

Galvanized Iron Pipes(GI)

The galvanized iron pipes which will be used in the house connections works have to be medium, and the specifications of medium Galvanized Iron Pipes should be manufactured and Conform to IS : 1239 [Part - 1] 1990 or as per BS 1387 .

Dimensions & Nominal Mass of Medium Quality pipes as per IS 1239.

Nominal Bore in mm	Outside Diameter in mm		Thickness in mm	Mass of Screwed & Socketted tube.(kg/m)
	Maximum	Minimum		
15mm	21.8	21.0	2.6	1.22
20mm	27.3	26.5	2.6	1.57
25mm	34.2	33.3	3.2	2.43
32mm	42.9	42.0	3.2	3.13
40mm	48.8	47.90	3.2	3.60
50mm	60.8	59.7	3.6	5.10
65mm	76.6	75.3	3.6	6.54
80mm	89.5	88.0	4.0	8.53
100mm	115.0	113.10	4.5	12.50
125mm	140.8	138.5	4.8	16.40
150mm	166.50	163.90	4.80	19.50

Fittings of (GI)

The supplied fittings should conform the following:

Technical Parameter:

NPT: American Standard

Materials: ANSI/ASME/A197-79 / ISO 5922 / DIN 1692;

Dimensions: ANSI/ASME B16.3-85/ ISO 049/ DIN 2950;

Threads: ANSI/ASME B1.20.1/ ISO7/1 / DIN 2999

Mechanical properties:

Tensile Strength $\geq 33\text{kg/mm}^2$

Elongation $\geq 8\%$

Hardness <HB15

Hydraulic Test:

Test Pressure: 25kg/cm²

Working Pressure: 16kg/cm²

Chemical Properties:

C: 2.4~2.9 %

Si: 1.2~1.7 %

Mn: 0.3~0.55 %

P: 0.12 %

SPECIFICATION OF SERVICE METERS

PART 1 –GENERAL

1.1 THE REQUIREMENT

- A. The supplier shall furnish and install velocity, dry, magnetic drive, multi-jet type, Class B water meters, suitable for metering cold potable water to domestic and industrial premises, and all appurtenant work complete and operable, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Comply with reference specifications of the GENERAL REQUIREMENTS,
- B. Comply with ISO 4064, BS 5728 latest version, or equivalent Standard approved by the Client for dry, multi-jet Cold-Water Meters with magnetic drive and Bronze Main Case.
- C. The meters shall be manufactured and tested according to EEC Council Directive No. 75/33. All meters to be supplied under the Contract shall have EEC Type Approval.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the GENERAL REQUIREMENTS.

PART 2 --PRODUCTS

2.1 SERVICE METERS

- A. **Nominal Capacity (q_n):** The flow meter shall be designed to operate continuously at any flow rate within the rated range. The supplier shall furnish and install the following meters, where the required quantities of each size shall be as per the Bills of Quantities:

Meter Dia. (mm)	Flow Range (m ³ /h)		
	Minimum (q_{min})	Nominal (q_n)	Maximum (q_{max})
15	0.03	1.5	3
20	0.05	2.5	5
25	0.07	3.5	7

- B. **Nominal Pressure (PN):** The nominal pressure of the water meters shall not be less than PN 16.

- C. Pressure Loss:** The pressure loss caused by the presence of the water meter shall not be greater than 1.0 bar at q_{\max} ($q_{\max} = 2 q_n$).
- D. Accuracy at $0.5 q_{\min}$:** The accuracy range of the water meter at the flow-rate of $0.5 q_{\min}$ ($q_{\min} = 0.02 q_n$ for Class B, see Table 5, ISO 4064) shall be between +5% to -20%.
- E. Accuracy at q_{\min} :** The accuracy range of the water meter at the flow-rate of q_{\min} ($q_{\min} = 0.02 q_n$ for Class B, see Table 5, ISO 4064) shall be between +5% to -5%.
- F. Accuracy between q_t to $2 q_n$:** The accuracy range of the water meter at the flow-rates between q_t ($q_t = 0.08 q_n$ for Class B, see Table 5, ISO 4064) and $2 q_n$ shall be between +2% to -2%.
- G. Negative reading:** No negative reading is to be imposed by air passage or suction due to emptying pipe system upstream from meter.
- H. Registers:** Registers/Counter mechanism shall be straight-reading hermetically sealed dry type and shall read in cubic meters and litres. The register that is furnished with the meter shall be the same register that was on the meter when it was tested for accuracy. The totalizer Register shall have the following characteristics:
- It shall be a straight reading type.
 - The totalizer shall register in cubic meter units.
 - The unit symbol (m^3) shall appear immediately adjacent to the numbered display.
 - The totalizer shall be set at 0 (zero).
 - The totalizer shall reset to 0 (zero) at $10,000 m^3$.
 - The totalizer shall consist of a row of four on-line, black coloured, consecutive digits to read $9,999 m^3$.
 - Other registers that will register flows in litres shall be red coloured and shall either be of digital register type consisting of at least 3 digits or analog type consisting of three dials.
 - The totalizer should be able to protect readings against condensation.
- I. Accessories:** The meters shall include the following accessories:
- Internal strainers of at least 18 holes per cm^2 near the inflow inlet of the meter.
 - Two threaded tailpieces, conforming to BS 1387 and BS 21 or equivalent.
 - Internal non-return valve.
- J. Sealing:** the water meter shall be sealed by the manufacturer before delivery and shall be provided with a hole for sealing the meter with the service valve on the inlet side of the meter.
- K. Marking:** The nominal meter size and meter designation, model, direction of flow with an arrow indicating the direction of flow through the meter, the serial number, Nominal pressure, metrological class, year of manufacture and the letters “SWSLC” shall be clearly and indelibly marked (cast or stamped) on the outer cases of all meters.

The name of the manufacturer shall be indelibly marked under the lid of the register box, if not detachable, together with the measuring unit (m³ per hour) plus any of the previous markings, which the manufacturer may consider useful.

L. Detailed Specification and Construction Requirement:

- i. The body shall be of the split-case type.
- ii. The meter connections for tailpiece and back nuts shall be male threaded conforming to ISO 228-1 or equivalent. The meter connections shall be integrally cast with the meter body or they shall be swaged on such that they shall withstand rough handling and tightening and twisting forces transmitted from the tailpiece connections. The meter body shall be locally reinforced and thickened at the connections. Two (2) connecting threaded tailpieces conforming to ISO 228-1 or equivalent, and back nuts and sealing washers shall be supplied with each meter.
- iii. The meters will be fitted to the service valves, which will be supplied under the Contract. Therefore, the sizing of the meter outlets and tailpieces shall be of the same size of the outlets of the service valves.
- iv. Intermediate gear trains or drive mechanism: The intermediate gear trains or drive mechanism shall be located in the register compartment and the piston oscillation or rotor motions shall be transmitted by magnetic coupling for both types of the counter mechanism described in 2.1 H above.
- v. The registration accuracy of the meters should not be affected when exposed to 2 magnets of 2500 gauss each (one on each side of meter).
- vi. The pivot of impeller chamber must be guaranteed against any corrosion or damage for at least three years after first installation.
- vii. Lower cases of meters shall be painted with thermal painting internally and externally. The painting materials should be safe for human uses and should be of the type permissible for use in meters for potable water. The painting colour shall be agreed on later after the Contract award.

2.2 BASIC MATERIALS

A. Meters:

- The water meter and accessories shall be manufactured from materials of adequate strength and durability. The materials, which come in contact with the potable water, shall not create a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or discoloration in the water supply.

- The Supplier shall supply certificates stating that the meters comply with the requirements for use of the meters with potable water in accordance with the specified standards.

- The spindle and bearings, however, shall be made of stainless steel and sapphire. The materials of all those parts which will come in contact with the water, shall safely withstand the effect of at least 2 ppm (parts per million) of residual chlorine in the water supply and shall also be resistant to corrosion.
- Upper cases, lower cases, the cover and any other exposed parts of the meters shall be totally made of basically brass or bronze alloy, other materials shall not be accepted.
- Pistons, rotors, intermediate gear train and counters mechanism shall be of dimensionally stable low friction durable plastic of suitable specific gravity comparable with that of the water. They shall have sufficient dimensional stability to retain operating clearances at working temperature up to 50 °C and not warp or deform when exposed to operating temperatures of 70 °C.
- Meter spindle, bearings shall be of stainless steel, bronze or other durable noncorrosive low friction material.
- Coupling tailpieces and nuts shall be of copper alloy.
- A complete parts diagram and list shall be submitted stating the material used in all the components of the meter.

B. Register Boxes: The transparent counter indicating window or lens shall be of scratch resistant material and shall not craze or discolour under the action of heat or strong light with UV rays. The window shall be fully covered by the lid, which shall be designed to protect the window and exclude dirt and dust. It shall be designed in such a way so that if the counter protective glass is broken for any reason the counter still cannot be removed from its place. The counter protective cover shall be made of sturdy glass and shall have a wall thickness of not less than eight (8) mm.

C. Manufacturers or Equal

The source and the type of Meters should follow up the specifications mentioned above .

2.4 TESTING

A. Meters: meters shall be tested for pressure and accuracy in accordance with BS 5728 or ISO 4064 or their equivalent. All tests shall be done by a Third Party approved by the OWNER, in accordance with the requirements of ISO 4064, or equivalent.

Meters shall meet the following requirement for accuracy with water at temperature between 0 and 30 °C. The meters shall be tested for registration accuracy in accordance with the Metrological Class B of ISO 4064, or equivalent. Tests will be conducted at the following flow-rates and within the specified flow-rate variances.

Test Flow Rate	Flow Variances	Permissible Registration Error
q_{min}	$\pm 2.5\%$	$\pm 5\%$
$q_t^{(1)}$	$\pm 5\%$	$\pm 2\%$
$0.3 q_n$	$\pm 5\%$	$\pm 2\%$
$0.5 q_n$	$\pm 5\%$	$\pm 2\%$
$1.0 q_n$	$\pm 5\%$	$\pm 2\%$
$1.5 q_n$	$\pm 5\%$	$\pm 2\%$
$2.0 q_n (q_{max})$	$\pm 5\%$	$\pm 2\%$
⁽¹⁾ $q_t = 0.08 q_n$ for Class B (see Table 5, ISO 4064)		

Registration accuracy tests shall conform to ISO 4064 , or equivalent. The meters shall meet the requirements of EEC Class B approval when used within and angle $\pm 30^\circ$ from the horizontal.

The meters shall be tested for conformance to the Pressure and Pressure Loss specifications detailed in items 2.1 B and 2.1 C above according to ISO 4064, or equivalent.

The meters shall be tested for accelerated wear, using both continuous flow tests and discontinuous flow tests according to ISO 4064, or equivalent. The accelerated wear test tolerances shall be as follows:

Continuous Flow Test

	Detail	Accepted Tolerance
Flow Rate	Relative variation in flow rate during each test	$\pm 10\%$
Time	Tolerance on specified duration of test	Value is minimum
Volume	Tolerance on volume discharged during test	Value is minimum

Discontinuous Flow Test

	Detail	Accepted Tolerance
Flow Rate	Relative variation in flow rate during constant test flow test	$\pm 10\%$
Time	Tolerance on specified duration of each test phase	$\pm 10\%$

	Tolerance of total test duration	± 5%
Number of Cycles	Number of cycles of test	+ 1% and – 0%
Volume	Tolerance on volume discharged during test	± 5%

Complete Test Result Reports shall be provided in accordance with the requirements of ISO 4064, or equivalent, including Pattern Approval Reports.

B. Counter shield glass: The counter shield glass shall be tested to ensure its sturdiness. For this purpose, sturdiness is defined as the ability of the counter shield glass to withstand, without damage or break, a free fall of a metal ball that weighs 27.2 grams from a vertical distance of not less than 70 cm. Furthermore, the glass shall withstand a pressure of 20 bars in case the meter has to operate under wet conditions and will be tested accordingly.

- PACKAGING

- All products (Valves , fittings, and accessories,etc.) must be packed in transparent protective bags then be packed in wooden or carton boxes and showing the Manufacturer identification, the description of the product, the drawing of the product, the relevant size and the quantity in the boxes.

THERMAL FUSION FABRICATION

- Butt-fusion joining of pipe and fittings shall be performed in accordance with the procedures established by the pipe manufacturer. Joining must be conducted by, or under the supervision of a factory-trained manufacturer’s representative.
- Butt-fusion joining of pipe and fittings shall be performed on fusion machinery approved by the pipe manufacturer. Fusion pressures, temperatures and cycle times shall be according to pipe manufacturer’s recommendations. No pipe or fittings shall be joined by fusion by any Contractor unless he is adequately trained and qualified in the techniques involved.
- Joining sites should be cleared and graded if necessary, to provide enough space for pipe storage and fusion. The site shall be free of rocks, stumps and debris which could cut, scar or gouge the pipe. The fusion machine must be mounted on a level, stable base (e.g. ¾ inch plywood secured on level ground) or on a sled of a design approved by the pipe manufacturer. In order to allow the joining operation to continue in adverse weather conditions, a shelter shall be built for the joining machine.
- Not only **butt-fusion** will be used as applications of fusion techniques but also electro-fusion fittings should be used to connect between pipes as mentioned in Bill of quantity.

- Unplasticised Polyvinyl Chloride (uPVC) Pipes

Polyvinylchloride pipes and fittings shall be in accordance with DIN 2401, DIN 2402, DIN 8063, DIN 16450, DIN 16451, DIN 16929 and DIN 19532.

Schedule of Particulars No. 2 : uPVC Pipes and Fittings

Item	Description	Details
	Pipes	
1	Manufacturer	
2	Country of origin	
3	Type	
4	Applicable Standards	
	Fittings	
5	Manufacturer	
6	Country of origin	
7	Type	
8	Applicable Standards	

Specification of HDPE Pipe Butt Fusion Welding Machine

Technical specifications:

1. Welding range: 2" to 8" diameter of HDPE Pipes.
2. Maximum effective pulling force: 11000N
3. Facer power: 1000W 220V 50Hz
4. Hot Plate Heater power: 3000W 220V 50Hz
5. Hydraulic unit power: 1500W (0-63bar) 220V 50Hz
6. Temp. Deviation in surface: 170-250° C ± 7° C

the whole machine consists of machine body, hydraulic unit, facer, heater, support for heater & facer. The machine should include accessories (Flange stud end holder and Data logger).

PE pipe fittings electro-fusion welding machine

Technical Parameter:

1. Welding range: PE pipe and pipe fitting
2. Pipe diameter: 20~315 mm
3. Input voltage: 220 V
4. Output power: 3.5 KW
5. Input frequency: 40 ~ 65 Hz
6. Ambient temp.: -15 ~ 45 Centidegree
7. Storage temp.: -30 ~ 70 Centidegree

8. Weight: around 20 KG

Universal bar code reader electrofusion machine for HDPE and PP couplings (from 8 to 48 V). The machine is made in compliance with international standards.

- Universal electrofusion machines
- For high pressure conduits from Ø 20 to 315 mm
- Optical scanner, for reading barcodes
- Memory that register 4000 welding cycles
- Data download through USB port

Note : It is highly required that the supplied HDPE Pipe Butt Fusion Welding Machine and PE pipe fittings electro-fusion welding machine should be able to work and read the bar code of pipes and fitting which should be connected.

- **General note:**

- Any specification is not mentioned in this document the supplier should apply the followed rules and specifications of Sana'a Water and Sanitation Local Corporation (SWSLC).