7.2.4 Leak tightness of flexible push-in joints to positive external pressure

Reference is made to Sub-Clause 7.2.4 of the EN 545:2010.

7.2.5 Leak tightness of flexible joints to dynamic internal pressure

Reference is made to Sub-Clause 7.2.5 of the EN 545:2010.

7.3 Leak tightness and mechanical resistance of flanged joints

Reference is made to Sub-Clause 7.3 of the EN 545:2010.

7.4 Leak tightness and mechanical resistance of pipe saddles

7.4.1 Positive internal pressure

Reference is made to Sub-Clause 7.4.1 of the EN 545:2010.

7.4.2 Negative internal pressure

Reference is made to Sub-Clause 7.4.2 of the EN 545:2010.

8. Tables of dimensions

8.1 Socket and spigot pipes

General Reference is made to Sub-Clause 8.2 of the EN 545:2010.

8.2Flanged pipes

Reference is made to Sub-Clause 8.2 of the EN 545:2010.

8.3 Fittings for socketed joints

Reference is made to Sub-Clause 8.3 of the EN 545:2010.

8.4 Fittings for flanged joints

Reference is made to Sub-Clause 8.4 of the EN 545:2010.

9. Evaluation of Conformity

9.1 General

Reference is made to Sub-Clause 9.1 of the EN 545:2010.

9.2 Initial Performance Testing

Reference is made to Sub-Clause 9.2 of the EN 545:2010.

9.2.1 General

Reference is made to Sub-Clause 9.2.1 of the EN 545:2010.

9.2.2 Characteristics

Reference is made to Sub-Clause 9.2.2 of the EN 545:2010.

9.2.3 Treatment of calculated values and design

Reference is made to Sub-Clause 9.2.3 of the EN 545:2010.

9.2.4 Sampling, testing and conformity criteria

Reference is made to Sub-Clause 9.2.4 of the EN 545:2010.

9.2.4.1 Sampling procedure

Reference is made to Sub-Clause 9.2.4.1 of the EN 545:2010.

9.2.4.2 Testing and compliance criteria

Reference is made to Sub-Clause 9.2.4.2 of the EN 545:2010.

9.3 Factory production control (FPC)

Reference is made to Sub-Clause 9.3 of the EN 545:2010.

3. Tests required according to the Water Authority Standard of the Hashemite Kingdom of Jordan

The manufacturer shall demonstrate the conformity of his products with the standards by submitting the performance tests specified in the standards:

4. Quality Assurance System:

The manufacturer shall control the quality of his products during their manufacture by a system of process control according to EN ISO 9001:2000, in order to comply with the technical requirements of the standards. The tests should confirm that the ductile iron pipes, fittings and accessories are manufactured according to EN 545:2010.

C. Traceability System:

The manufacturer shall clearly mention the method by which he can keep records and trace of the manufactured ductile iron pipes, fittings and accessories to ensure the capability of going back to the records for the manufactured item in case any problems accrues after the installation.

9.3.1 General

Reference is made to Sub-Clause 9.3.1 of the EN 545:2010.

9.3.2 FPC requirements for all manufacturers

Reference is made to Sub-Clause 9.3.2 of the EN 545:2010.

9.3.2.1 General

Reference is made to Sub-Clause 9.3.2.1 of the EN 545:2010.

9.3.2.2 FPC for tensile testing

Reference is made to Sub-Clause 9.3.2.2 of the EN 545:2010.

9.3.3 Manufacturer-specific FPC system requirements

Reference is made to Sub-Clause 9.3.3 of the EN 545:2010.

9.3.3.1 Personnel

Reference is made to Sub-Clause 9.3.3.1 of the EN 545:2010.

9.3.3.2 Equipment

Reference is made to Sub-Clause 9.3.3.2 of the EN 545:2010.

9.3.3.3 Design process

Reference is made to Sub-Clause 9.3.3.3 of the EN 545:2010.

9.3.3.4 Raw materials and components

Reference is made to Sub-Clause 9.3.3.4 of the EN 545:2010.

9.3.3.5 In-process control

Reference is made to Sub-Clause 9.3.3.5 of the EN 545:2010.

9.3.3.6 Non-conforming products

Reference is made to Sub-Clause 9.3.3.6 of the EN 545:2010.

9.3.3.7 Corrective action

Reference is made to Sub-Clause 9.3.3.7 of the EN 545:2010.

4. ANNEX A
(Normative)

10.1 Allowable pressures

10.1.1 A.1 General
Reference is made to Annex A.1 of the EN 545:2010.

10.1.2 A.2 Socket and spigot pipes (see 8.1)
Reference is made to Annex A.2 of the EN 545:2010.

10.1.3 A.3 Fittings for socketed joints (see 8.3)
Reference is made to Annex A.3 of the EN 545:2010.

10.1.4 A.4 Flanged pipes (see 8.2) and fittings for flanged joints (see 8.4)
Reference is made to Annex A.4 of the EN 545:2010.

10.1.5 A.5 Accessories
Reference is made to Annex A.5 of the EN 545:2010.

5. ANNEX B
(Informative)

11.1 Longitudinal bending resistance of pipes
Reference is made to Annex B of the EN 545:2010.

6. ANNEX C
(Informative)

12.1 Diametral stiffness of pipes
Reference is made to Annex C of the EN 545:2010.

13. ANNEX D
(Informative)

13.1 Specific coatings, field of use, characteristics of soils

13.1.1 D.1 Alternative coatings

13.1.1.1 D.1.1 Pipes

Reference is made to Annex D.1.1 of the EN 545:2010.

13.1.1.2 D.1 .2 Fittings and accessories

Reference is made to Annex D.1.2 of the EN 545:2010.

13.2 D.2 Field of use in relation to the characteristics of soils

13.2.1 D.2.1 Standard coating
Reference is made to Annex D.2.1 of the EN 545:2010.

13.2.2 D.2.2 Alloy of zinc and aluminium with or without other metals
Reference is made to Annex D.2.2 of the EN 545:2010.

13.2.3 D.2.3 Reinforced coatings
Reference is made to Annex D.2.3 of the EN 545:2010.

14. ANNEX E
(Informative)

14.1 Field of use, water characteristics
Reference is made to Annex E of the EN 545:2010.

15. ANNEX F
(Informative)

15.1 F.1 Calculation method of burried pipeline, height of cover.
15.1.1 F.1.1 Calculation formula
Reference is made to Annex F.1.1 of the EN 545:2010.
15.1.2 F.1.2 Pressure from earth loading
Reference is made to Annex F.1.2 of the EN 545:2010.
15.1.3 F.1.3 Pressure from traffic loading
Reference is made to Annex F.1.3 of the EN 545:2010.
15.1.4 F.1.4 Bedding factor, K
Reference is made to Annex F.1.4 of the EN 545:2010.
15.1.5 F.1.5 Factor of lateral pressure, f
Reference is made to Annex F.1.5 of the EN 545:2010.
15.1.6 F.1.6 Modulus of soil reaction, E'
Reference is made to Annex F.1.6 of the EN 545:2010.

15.2 F.2 Heights of cover
Reference is made to Annex F.2 of the EN 545:2010.

16. Bibliography
Reference is made to Bibliography of the EN 545:2010.

4. TECHNICAL SPECIFICATIONS FOR WELDED BLACK STEEL PIPES & FITTINGS

I. Specifications for Welded Steel Pipes with Beveled ends For (4", 6" and 8") diameters.

a) The pipes shall be in accordance with { API-5L, Grade of steel X42 } or {DIN. 2441} or approved equivalent standards, high-tensile, longitudinally or spirally welded steel pipes.

The wall thickness and the test pressures shall be as follows :

Nominal dia. (ND) inch.	Outside Diameter (inch)	Thickness (mm)	Test Pressure (kg/cm^2)	standards
4"	4 ½"	4.40	134	API or DIN
6"	6 ⅝"	5.20	133	API or DIN
8"	8 ⅝"	5.60	110	API or DIN

b) Working Pressure :
The maximum nominal pressure of all pipes shall not be less 40 bar.

c) Average Length :
Pipes shall have 6 meters length, equal length must be supplied.

d) Beveld Ends For 4", 6" and 8":
End of pipes must be calibrated and beveled by 30° degrees (plus or minus 5° degrees) for elecric fusion butt welding.

e) Internal Lining and External Coating :
- Preperation of pipes surfaces befor lining and coating:
- The surfaces of pipes shall be clean and free from scale, loose rust, oil …etc. by:
  a. Acid picking.
  b. Abrasive shot blasting.
  All in accordance with BS.4232 first quality as discribed in BS.534.
  Adhesion Test is required for lining and coating as discribed in BS.534.

e.1) Internal Lining:

All steel pipes of 4", 6" and 8" ND. Shall have internal lining either:
a. **Cement lining according to AWWA - C. 205 or BS. 534 or approved equal.**
b. Zinc galvanzation (Hot Dip) according to Din. 2441 or approved equal, which shall be odorless and tasteless suitable for the passage of chlorinated potable water 0-3 p.p.m.cl_2.

c. Non-toxic 100% solids Amine epoxy according to AWWA C210-03 (Liquid epoxy coating systems for the interior and exterior of steel water pipelines) or approved equal.
d. Non-toxic fusion bonded epoxy according to AWWA C213-01 (for the interior and exterior of steel water pipelines) or approved equal.

Lining must be suitable for drinking water. Non Metalic product for use in Contact with water must be in accordance with BS. 6920.

e.2) External Coating:

All steel pipes of 4", 6" and 8" ND. Shall have an external Coating in accordance with (BS. 534), the Coating must be as follows:

- Priming shall be applied to the pipes as specified in (BS. 534), then Bitumen sheathing or Bitumen enamel wrapping (filled Bitumen with / glass tissue) shall be applied as external coating .

-The coating shall have a total thickness of not less than 3 mm.

e.3) Protection of lining and coating:
The lined and coated pipes shall be transported through climate, so the manufacturer must take into account the choice of material.

Protection of lined and coated pipes against damages during storage, transport and handling is required either by using straw or wood wool pads.

The coating shall show no tendency of flow at a temperature of (70) degrees centigrade.

e.4) The internal lining and the external coating for bevelled ends pipes shall stop 6" from each end of the pipe

e.5) All welded and flanged joints of steel pipes, shall be protected and coated with the same coating materials of the steel pipes.

f. Marking:
The material shall be marked with the manufacturer's symbol or mark in addition to the code number, standard specification, and the inspector stamp. The pipes as well shall be stamped with the purchaser symbol, "WAJ"

Insulation Materials for Joints of All Pipes Sizes:

Sufficient quantity of insulating materials shall be included to cover the joints and fittings after welding the pipes and its cost shall be deemed to be included in the respective unit price.

g. The bidder must give full information, details; technical data require in attached sheets and must also give full technical specifications of his bid in addition to manufacturer catalogue and standards, as well as the chemical and physical analysis.

Item	**1**	**2**	**3**
Diameter	4"	6"	8"
Nominal Diameter			
Outside			

Diameter			
Wall Thickness			
Working pressure			
Test pressure			
Wt/meter (bare)			
WT/meter with			
Lining & Coating			
Thick. Of lining			
Thick. Of coating			
Length of pipe			
Standards			
Manufacturer			
Country of origin			
Welding process			
Type of welding			
Type of lining			
Type of coating			

II. Specifications for Welded Steel Pipes with Bevelled Ends

For 10" Diameters & Above:

a. The pipes shall be in accordance with (API - 5L, Grade of steel, x 42), or approved equivalent standards, high-tensile, longitudinally or spirally welded steel pipes .

b. The wall thicknesses and the minimum mill-inspection test pressures shall be as follows:

Nominal dia. (ND) inch	Outside diameter (mm) (inch)	Wall Thickness (mm)	Test Pressure (kg/cm2)
10 ¾"	273.10 10 3/4"	5.6	100
12 ¾"	323.9 12 3/4"	6.4	96
16"	406.40 16"	6.4	77
20"	508.00 20"	7.1	73
24"	610.00 24"	7.1	61
32"	813.00 32"	9.5	61

c. Working Pressures:

The maximum nominal pressure of all pipes shall not be less than the value stated in the scope of works and / or Drawings.

d. Bevelled Ends:

End of pipes must be calibrated and beveled by 30° degrees (plus or minus 5° degrees) for elecric fusion butt welding.

All welded and flanged joints of steel pipes, shall be protected and coated with the same coating materials of the steel pipes.

e. Average Length :

Pipes shall have an average length of 6 and / or 12 meters and as approved by the Engineer .

f. Internal Lining and External Coating :

The internal cement mortar lining shall be of 6.0 mm. and conform to all relevant requirements of BS. 534 / 1990 or AWWA. C.205 - 85.

The unlined and / or uncoated wall of the pipe shall be protected by suitable harmless approved bituminous or epoxy paint.

The internal lining thickness shall not be less than the minimum thicknesses given in the following table :

Nominal Diameter (ND) inch	Minimum thickness (mm)	
	BS.534.1990	AWWA.C.205-85
10	6 (+2 , -0)	6 (+3.2 , -1.6)
12	6 (+2 , -0)	8 (+3.2 , -1.6)
16	7 (+2 , -0)	8 (+3.2 , -1.6)
20	7 (+2 , -0)	8 (+3.2 , -1.6)
24	7 (+2 , -0)	10 (+3.2 , -1.6)
32		10 (+3.2 , -1.6)

External coating of steel pipes and fittings shall be polyethylene sheathing (reinforced type) according to DIN. (30670), designation: Reinforced sheathing (V).

The polyethylene sheathing shall be applied at manufacturer's works (plant) extruded and melted on and homogeneous to steel pipes with API 5L-X42 for buried installation .

Between the polyethylene sheathing and the pipe steel there shall be an adhesive film which is applied electro-statically.

The polyethylene sheathing shall be made continuos extrusion and the adhesive film shall be firmly bonded to the steel surface. The coating shall be spark-free when tested with a Holiday detector at 25000 volts. The minimum coating thickness shall be 3.0 mm for pipes of nominal diameters up to 20", and 3.50 mm for 24" diameter pipes.

In addition to tests to DIN 30670 for coating and coating materials, the coating shall be tested for cathodic disbonding in accordance with ASTM G8. The polyethylene coating shall be capable of operating at a continuous temperature up to 50 C. without any effect on coating and bonding. The polyethylene and adhesive shall stop at a distance of 100mm plus the insert of the pipe for the spigot and 100mm for the end of the socket of the pipe.

g. Marking:

The material shall be marked with the manufacturer's symbol or mark in addition to the code number, standard specification, and the inspector stamp. The pipes as well shall be stamped with the purchaser symbol, "WAJ"

Insulation Materials for Joints of All Pipes Sizes:

Sufficient quantity of insulating materials shall be included to cover the joints and fittings after welding the pipes and its cost shall be deemed to be included in the respective unit price.

g.1) The bidder must give full information, details, technical data require in attached sheets and must also give full technical specifications of his bid in addition to manufacturer catalogue and standards, as well as the chemical and physical analysis.

Item	1	2	3	4	5	6
Diameter	**10 "**	**12"**	**16 "**	**20 "**	**24 "**	**32 "**
Nominal Diameter						
Outside Diameter						
Wall Thickness						
Working pressure						
Test pressure						
Wt/meter (bare)						
WT/meter with						
Length of pipe						
Standards						
Manufacturer						
Country of						

وزارة المياه والري
سلطة المياه
مديرية العطاءات والمشتريات

origin						
Welding process						
Type of welding						
Type of lining						
Thick. Of lining						
Type of coating						
Thick. of coating						

II. SPECIFICATION FOR BLACK STEEL FITTINGS

a.Scope of Use :

The fittings must be made of seamless pipes and shall be in accordance with ANST (B.16.9). The fittings shall be welded to black steel pipes type (API.5L-X42).

b. Fabrication of Fittings:

The fabrications of fittings shall be as follows:

1. Elbows must be fabricated by forging or by hot or cold forming of seamless pipes.
2. Reducers must be fabricated by hot or cold forming and annealing of seamless pipes.
3. Tees must be fabricated by forming of seamless pipe or by cold or hot forming and annealing of seamless pipes.
4. Caps must be fabricated by hot or cold stamping or forging of plates heat treated.

- Fabrication fittings by welding pieces of pipes are not accepted.

c. Materials of Fittings:

Elbows, Tees, Reducers etc. must be made of seamless pipe grade WPB.(ASTM. A 234) or approved equivalent.

d. Fittings Thickness & Pressure:

The minimum thickness of the black steel fittings shall be sufficient to withstand the pressure rating of their respective pipelines.

e. Elbows Bends:

The Elbows must be of long radius type, but short radius elbows can be offered as an alternative.

f.Reducers:

The reducers must be concentric. Thickness of each side shall be equal to thickness of related nominal diameter, if thickness of reduced size equal to the thickness of the bigger size, higher thickness will be accepted.

g. Straight Equal Tees:

The straight equal tees, in which the run and branch (out let) is equal in nominal diameter, thickness must be equal to the thickness of its related nominal diameter.

h. Tees Reducing:

Tees Reducing, in which the Run is bigger than branch (out let) in nominal diameter thickness of the run, must be equal to the thickness of its related diameter, thickness of the branch (out let) must equal to its related nominal diameter.

i. Coating and Lining:

All fittings must be lined by corrosion proof materials and must be suitable for potable water.

The coating must be of the same coating material as the pipes. Coating and lining must stop at the beveled ends for the purpose of welding.

j.Marking:

Every fitting must be marked with:

- Trade mark.
- Nominal Diameter.
- Thickness.
- Standard.

k. Certificate of Compliance :

Certificates of compliance of required standards are required.

5.TECHNICAL SPECIFICATION for HIGH DENSITY POLYETHYLENE PIPES (HDPE)&FITTINGS

POLYETHYLENE PIPES

1. GENERAL

1.1Ambient Conditions

All pipes ,material sand equipments shall be in every respect suitable for storage, installation, use and operation in the conditions of temperature,humidity and The PH and water quality appertaining in Jordan.

Atmospheric temperature in Jordan varies between-10°C and 50°C.

1.2Potable WaterCertification

All pipes and materials shall be certified for potable water use,and all pipes and materials should be certified as safe for transporting potable water by an independent testing laboratory. All material in contact with or likely to come into contact with water for public supply shall be introduced with the requirements of BS6920 (suitability for non metallic products for use in contact with drinking water)or any equivalent standard as well as the Jordanian standard(JS286/2008) and the World Health Organization standard (WHO), and when ever the regulationis changed it is the supplier responsibility to ensure conformity with any new requirements.

Potable water certificate submitted must be for the same batch delivered toWAJ, certificates must be in English

1.3ToxicMaterials

Pipes and pipe line 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 discolouration of the water and shallcontain no ingredientsthat may migrate into water in amounts that are considered to be toxic or otherw is dangerous for health.

Non toxicity certificate should be provided.

1.4Third Party Witness

1.4.1General

The supplier shall furnish an original certificate from accredited thirdparty inspection agency

Showing all test results and analysis required by the applicable standard(ISO 4427/2007) according to which them at erials have been manufactured.The third party inspection agency shall under this contract, have witnessed the manufacture and testing operation to verify compliancewith the technical specifications and the relevant standard. The third party inspection agency shall verify that all materials used are eligible for the relevant standard productions requirements.All certification should be from a certified and approved third party, and thec ertificates must be related to the same batch delivered toWAJ,all certificates must be valid and written in English.

1.4.2Pipes

For pipes third Party shall verify that all pipesare produced in compliance with ISO 4427-2/2007, EN12201or equivalent,all batch release etests shall be witnessed and certified by an approved third party,and No pipe shall be accepted unlessall typeand batch release tests hav ebeen passed. The third party must clearly identify the pipe production date/code marked on the pipes,with each batch test performed.

1.5Testing afterdelivery

All materials supplied to the site in Jordan shall be subjected to acceptance tests carried out by the Royal Scientific Society. Or similar accredited authority.The test should confirm that the materials and pipes are manufacture according to ISO 4427,EN12201 or equivalent;all Tests required for polyethylene pipes must be performed according to the above standards.If any of the tests mentioned in the standards cannot beperformed by the Royal Scientific Society then the supplier should provide a third party certificate for those tests taking into considerations all the statements mentioned in"third party witness"section.

All testingcosts shouldbeborne by the supplierin all cases.

1.6Pipes Packing and Protection

- All pipes shall be bundled o rpackaged in such a manner as to provide adequate support and protection for the endsduringtransportationfromthemanufacturertothePurchaser. All special provisions foroceanshipmentshall beprovided.
- Thepackagingofpipesbythemanufacturerisnormallyconsistentwiththerequirementto prevent damageand tocomplywith safetyconsiderations. Usuallypipesare delivered strapped intoconvenient bundlesorbanded coils.Allendsmustbeclosedwith caps.

1.7 Identification

The supplier shall be responsible to ensure that each separate item,crate, or package has permanently attached to it, in aconspicuous position , an identification plate of weather- resistant materialon which are engraved or stamped;

- **The Manufacturers Name**
- **Contents Descriptionand Quantity**

- **Serial Number or Reference Number Identifiable on the Delivery Note and Cross ReferencedtothePurchaseOrderItemReferences.**
- **Weight**
- **Tender Number–variable**

In addition the container shall be marked with the following information;

- **Total gross weight**
- **Total net weight**
- **Packing list reference number**

1.8Transportand Deliveries

- The supplier shall send to the Purchasers,one-week advance notice of allc onsignments of materials. Every consignment shall be accompanied by a detailed delivery note.

- The supplier shall deliver to and off load the materials on to the storage area as directed by the Purchasers.All materials delivered will be examined and inspected by the Purchaser and taken over by him.

- The Supplier shall provide necessary details to the shipping line on precautions to be taken during loading/unloading,handling & transport of the pipes & fittings and other components.Supplier shall provide to the purchaser a set of recommendations of manufacturer for handling,loading,unloading,transporting and storing of polyethylenepipes and fittings.

- The Purchaser shall arrange reception and storage areas only. The supplier shall be responsible for off-loading all materials.

- The materials shall be delivered to the Purchaser at WAJ stores, Amman or any other place chosen by the Purchaser.

- The supplier shall also be responsible for all handling and transport activities up to WAJ store-yard, Amman or any other place chosen by the Purchaser.

- The (DDP) price shall include all costs relating to above-mentioned requirements.

1.9 Handling

Care shall be taken during loading , transporting , and unloading to prevent damage to the pipes,. Under no circumstances shall pipes or fittings be dropped or rolled against one another. All pipes and fittings shall be examined. Any damaged materials must be rejected by the Purchasers.

1.10 Details to be provided after awarding the contract

1. Manuals and technical catalogues.

2. Dates of batches or consignment deliveries.

3. The supplier shall state which of the sections of the schedule of requirements he proposes to price and supply.
4. Any alternative standards proposed including demonstration of equivalency or superiority to

the standard specified, if allowed.

5. Any alternative materials proposed including demonstration of equivalency or superiority to the standard specified,thesealternative materials should besubjected to the clients approval.

6. Where the supplier offers alternative standards, materials to those specified, the supplier shall provide prices for those specified and the alternatives proposed.

7. The supplier shall include in his price for the training elements related to the materials he proposes to supply and shall list the elements of training offered,if needed or requested.

8. The supplier shall provide prices for the equipment applicable to the sections of the schedule of requirements he intends to price.

9. The supplier shall provide full details of his materials tests and procedures.

10. Any alternative proposed specificationfor combined tracer andmarkertape.

11. ISO or EN certification for management and product.

12. CV's of proposed training staff, if necessary.

13. CostsofTrainers expenses,if requested.

14. Training program, if requested.

1.11ManualsandTechnical Specifications

The supplier shall supply full technical specifications for the items to be supplied at the time of tender .In addition he shall provide full instruction manuals,which describe the correct methods and procedures necessary to construct the pipeline system in accordance with best practice. Conformity to standard certificate must be supplied at time of tender where this certificate must be issued from accredited third party and valid up to date.

1.12Additional Services

The supplier shall provide details of additional services,which he can providee.g.technical adviceand supportand,in particular,shall state his capability for supporting the project in the Amman location at the time of tender.

1.13Conformity to standard certificate from accredited third party

All certificates must be from an accredited third party and the accreditation logo must be stamped on the certificateas per the requirements of IAF. No certificate will be accepted unlessit isfrom an accredited third party.

2. Polyethylene Pipes

2.1Technical specifications

The polyethylene pipes shall conform to the requirements of Polyethylene(PE) pipes for water supply under pressure – Specification (ISO 4427-1/2:2007), (EN12201-1, EN12201-2) or equivalent standard in which a supplier must submit a copy of that standard and a proof of equivalency to the above specifications.

Conformity to standard certificate must be supplied at time of tender where this certificate must be issued

from accredited third party and valid up to date.

The pipes should have the following properties:

- Pressure class:PN16 or PN25(According to contract documents)
- The Standard Dimension Ratio (SDR) :SDR11
- Material Designation:PE100

2.2Length of Pipes

The following table shows the length of the pipes according to the diameter.

Table1.1length of pipe

Diameterofpipe(mm)	Lengthof pipe (m)
Up to 63	50or100
125	(50or100:coils) (upon request),Or(12m:standard pipes) (for maintenance dept.uses) (upo nrequest)
180 and above	1 2or standard pipes

Markings of Pipes

All PE pipesshall be in delibly marked at maximum intervals of one meter. The markingshall show atleast the following information:

- "WAJ"
- Manufacture's name,logo and/or trademark
- Dimensions(nominal diameter)
- Materials,material class(i.e. PE100)andpressureclass (PN16)
- Production period (date and code)
- "Water"to indicate that pipes are intended for potable water
- Serial number
- Batch number
- Standard number
- Standard Dimension Ratio(SDR).

For direct purchase procurements order the marking depends on the value of the procurements order.

POLYETHYLENE FITTINGS

1. GENERAL

1.1Ambient Conditions

All fittings,materials and equipment shall be in every respect suitable for storage, installation,use and operation in the conditions of temperature, humidity and The PHof water appertaininginJordan.

Atmospheric temperature in Jordan varies between -10˚Cand 50˚C.

1.2Potable WaterCertification

All fittings and materials shall be certified for potable water use,and all fittings and materials should be certified as safe for transporting potable water by an independent testing laboratory. All material in contact with or likely to come into contact with water for public supply shall be introduced with the requirements of BS6920(suitability for non metallic products for use in contact withdrinking water) or any equivalent standard as well as the Jordanian standard(JS 286/2008) and the requirements of EN15664 (influence of metallic materials on water intended for human consumption) orany equivalent

standardand theWorld Health Organization standard(WHO),and whenever the regulation is changed it is the supplier responsibility to ensure conformity with any new requirements.

Potable water certificate submitted must be fort hesame batch delivered toWAJ, certificates must be in English

1.3Toxic Materials

Fittings and pipe line components,including their protective coatings and joint materials, that will or may come into contact with potable water shall not constitute at oxichazard, shall not support microbial growth, shall not cause taste or odour,cloudiness or discolouration of the water and shall contain no ingredients that may migrate in to water in amounts that are considered to be toxic or otherwise dangerous for health.

Non toxicity certificate should be provided.

1.4Third Party Witness

1.4.1General

The supplier must submit at least 3 different international third party companies where WAJ or the client willchoose oneof them.

The supplier shall furnish an original certificate from the third party inspection agency showing all test results and analysis required by the applicable standard(ISO 4427 /2007) according to which the materials have been manufactured.The third party inspection agency shall under this contract,have witnessed the manufacture and testing operation to verify compliance with the technical specifications and there levant standard. The third party inspection agency shall verify that all materials used are eligible forthe relevant standard productions requirements. All certification should be from a certified and approved third party,and the certificates must be related to the same batch delivered toWAJ,allc ertificates must be valid and writtenin English.

1.4.2Fittings

For fittings third Party shall verify that fittings are produced in compliance with ISO4427-3/

2003,EN12201 or equivalent,all batch release tests shall be witnessed and certified by an approved third party,and No fitting shall be accepted unless all type and batch release tests have been passed.The third party must clearlyi dentify the fittings production date/code marked on the fittings,with each batch test performed

1.5Testing after delivery

All materials supplied to the site in Jordan shall be subjected to acceptance tests carried out by the Royal Scientific Society. Or similar accredited authority.The test should confirm that the materials and fittings are manufactured according to ISO4427,EN12201or equivalent;all Tests required for polyethylene fittings must be performed according to the above standards. If any of the tests mentioned in the standards cannot be performed by the Royal Scientific Society then the supplier should provide a third party certificate for those tests taking into consideration shall the statements mentioned in"third party witness"section.

All testing costs should be borne by the supplier in all cases.

1.6Fittings Packing and Protection

- All fittings must be packed in such a way to allow instantuseonsite with out additional cleaning.
- All electro-fusion fittings must be packed in transparent protective bags.The electro-fusion fittings

must then be packed in carton boxes.

- All fittings shall be securely packed in crates and boxes to prevent damage during delivery. The cost of packing shall be deemed to be included in the Contract Rates and crates will not be returned.
- Fittings are normally supplied in separate cartons together with any associated small items, such as bolts and gaskets.

1.7 Identification

The supplier shall be responsible to ensure that each separate item,crate, or package has permanently attached to it, in a conspicuous position, an identification plate of weather- resistant materialon which are engraved orstamped;

- **The Manufacturers Name**
- **Contents Description and Quantity**
- **Serial Number or Reference Number Identifiable on the Delivery Note and Cross Referenced to the Purchase Order Item References.**
- **Weight**

Tender Number–variable

In addition the container shall be marked with the following information;

- **Total gross weight**
- **Total net weight**
- **Packing list reference number**

1.8Transport and Deliveries

- The supplier shall send to the Purchasers,one-week advance notice of all consignments of materials. Every consignment shall be accompanied by a detailed delivery note.
- The supplier shall deliver to and off load them at erialson to the storage are as directed by the Purchasers.All materials delivered will be examined and inspected by the Purchaser and taken over by him.
- The Supplier shall provide necessary details to the shipping line on precautions to be taken during loading/unloading,handling & transport of the pipes & fittings and other components.Supplier shall provideto the purchasera set of recommendations of manufacturer for handling,loading,unloading,transporting and storing of polyethylene pipes and fittings
- The Purchaser shall arrange reception and storage are as only.The supplier shall be responsible for off-loading all materials.
- The materials shall be delivered to the Purchaser at WAJ stores, Amman or any other place chosen by the Purchaser.
- The supplier shall also be responsible for all handling and transport activities up to WAJ store-yard, Amman
- The (DDP) price shall include all costs relating to above-mentioned requirements.

1.9 Handling

Care shall be taken during loading,transporting,and unloading to prevent damage to the pipes, or fittings. Under no circumstances shall pipes or fittings be dropped or rolled against one another. All pipes and fittings shall be examined. Any damaged materials must be rejected by the Purchasers.

1.10Details to be provided at the time of tender

All certificates must be from an accredited third party and the accreditation logo must be stamped on the certificate as per the requirements of IAF. No certificate will be accepted unless it is from an accredited third party.

1. Dates of batches or consignment deliveries.
2. The supplier shall state which of the sections of the schedule of requirements he proposes to price and supply.
3. Any alternative standards proposed including demonstration of equivalency or superiority to the standard specified, if allowed.
4. Any alternative materials proposed including demonstration of equivalency or superiority to the standard specified,these alternative materials should be subjected to the clients approval.
5. Where the supplier offers alternative standards, materials to those specified, the suppliershall provideprices forthosespecifiedandthealternativesproposed.
6. The supplier shall include in his price for the training elements related to the materials he proposes to supply and shall its the elements of training offered,if neededor requested.
7. The supplier shall provide prices for the equipment applicable to the sections of the schedule of requirements he intends to price.
8. The supplier shall provide full details of his materials tests and procedures.
9. Any alternative proposed specification for combined tracer and marker tape.
10. ISO or EN certification for management and product.
11. CV's of proposed training staff, if necessary.
12. Costs of Trainers expenses,if requested.
13. Training program, if requested.

1.11Documents to be provided upon delivery

The contractor shall submit at least the following documents:

1. Certificate of origin.
2. Packing list
3. Third Party inspection reports from accredited third party(inspection including allthe tests required in the standard)
4. Any other documents requested by the Engineer and the hand over committee

All above documents mustbe valid and in English.

1.12ManualsandTechnical Specifications

The supplier shall supply full technical specifications for the items to be supplied at the time of tender.In additionhe shall provide full instruction manuals,which describe thec orrect methods and procedures necessary to construct the pipeline system in accordance with best practice.

1.13Additional Services

The supplier shall provide details of additional services,which he can providee.g.technical adviceand supportand,in particular,shall state his capability for supporting the project in the Amman location at the time oftender.

2. Polyethylene Fittings

2.1fittings used forexisting networks

Fittings used for polyethylene pipes must be manufactured and tested according to the standards shown in the following tables. As shown, table 2.1 is standards for fittings for WAJ uses, such asmaintenancepurposesand storingin warehouses.

2.2fittings used fornewinstallations

For the new projects,WAJ recommends that all fittings should be installed using electro- fusion technology,table3.2shows the standards for the fittings used in the new projects.

2.3 Connection Type

Table 2.3Connection Type

Diameterofpipe(mm)	Connection Type	Standard
25-125	MechanicalorElectro-fusion	Accordingtotables: 3.1.a , 3.1.band3.2
125and above	Buttweldingor Electro-fusion	Machine:ISO 12176 ISO 13953,ISO 11414

The Butt welding machine must befully automatic

2.4DesignRequirements:

- The design of fittings mustensurethat the wires which coiled around the innerpart of electrofusion fittings are built in the bodyof fittings not separated from it.
- The cuer of PE EF Tapping shall becertified for potable wate ruse.

Table 2.1Polyethylene fittings onPolyethylene pipes

No.		Description	InstallationType	Standard No	Testing method
	1.	PEConnector	Compression	ISO14236:2000	ISO 3501,ISO 3503,
		(25mm,32mm,63 mm)			ISO 3458,ISO3459
	2.	PEEFCollar	Electro Fusion	ISO4427:2004 or	ISO 13955,ISO13954,

		(125mm, 180mm,250mm,25mm,32		Equivalent:	ISO11413
		mm,63 mm)		EN12201-3 :2003	
	3.	PEReducer	Compression	ISO14236:2000	ISO 3501,ISO3503,
		(32mmX25mm, 63mmX25mm,63X32)			ISO 3458,ISO3459
	4.	PEAdaptor	Compression		
		(2"(63mm)Male,1"(32mm)Male,			
		3/4"(25mm)Male)[a]			
	5.	PEFlangeAdaptor	Electro Fusion	ISO4427:2004 or	ISO 13955,ISO
		(125mm, 180mm,250 mm)		Equivalent:	13954, ISO 11413
				EN12201-3 :2003	
	6.	PETee	Compression	ISO14236:2000	ISO 3501,ISO3503,
		(63X63X63mm,32X32X32mm,			ISO 3458,ISO3459
		25X25X25mm,63X63X32			
		,63X63X25,32X32X25)[b]			
	7.	PEEF Tee180X125(socket)	Electro Fusion	ISO4427:2004 or	ISO 13955,ISO
				Equivalent:	13954, ISO 11413
				EN12201-3 :2003	
	8.	PEEndCap	Compression	ISO14236:2000	ISO 3501,ISO3503,
		(63mm,32mm,25 mm,.....)			ISO 3458,ISO3459
	9.	PEElbow63mm,32mm,25 mm	Compression		
	10.	PEEF Elbow90^0	Electro Fusion	ISO4427:2004 or	ISO 13955,ISO
		(180(socket),125mm,250mm, ...)		Equivalent:	13954, ISO 11413
	11.	Electrofusionendcap	Electro Fusion	EN12201-3 :2003	
		(125mm, 180mm)			
	12.	PEEF Tapping	Electro Fusion		
		(125*25, 180*25, 125*63,			
		125*32,63*32,63*25,)			
	13.	PEEF Elbow45^0	Electro Fusion	ISO4427:2004 or	ISO 13955,ISO
		(180,125mm,250 mm, ...)		Equivalent:	13954, ISO 11413
				EN12201-3 :2003	

Table 2.2: Fittings for new installation Tenders

No.		Description	Installation/ Type	StandardNo	Testingmethod
	1.	PEConnector	ElectroFusion		
		(25mm,32mm,63mm)			
	2.	PEEFCollar (125mm, 180mm,250mm,25mm,32mm,	ElectroFusion		
		63mm)			
	3.	PEReducer	ElectroFusion		
	4.	PEAdaptor	ElectroFusion		
		(2"(63mm),1"(32mm),3/4"(25mm))			
	5.	PEFlangeAdaptor (125mm, 180mm,250 mm)	ElectroFusion		
	6.	PETee[b] PETee	ElectroFusion		
		(63X63X63mm,32X32X32mm,			
		25X25X25mm,63X63X32			
		,63X63X25,32X32X25)[b]			
	7.	PEEFTee(socket)orsaddlebranch(lineto line)	ElectroFusion		
		(180X125,180X180,.....)			
	8.	PEEndCap	ElectroFusion		
		(63mm,32mm,25mm,.....)			
	9.	PEElbow63mm	ElectroFusion		
	10	PEEFElbow(socket)	ElectroFusion		
		(180mm,125 mm,250mm.....)			
	11	Electrofusionendcap	ElectroFusion		
		(125mm, 180mm)			
	12	PEEF Tapping	ElectroFusion		
		(125*25, 180*25, 125*63,			
		125*32,63*32,63*25,)			
	13.	Connector(25 mm,32mm)[c]	Compression	ISO14236:2000	ISO3501,ISO3503,
					ISO3458,ISO3459

a. **Adapter is used to connect Polyethylenepipes to pipe made from another material,and it should be compression from oneside and male threaded from the otherside.**
b. **ItisnotallowedtousetheweldableoutletKit**
c. **When the installation is near to the customer cabinet,whether the connection was straight connection or using elbow, compression fittings shouldbe used**

Fittings and Joints

1. Mechanical Fittings

Mechanical coupling, push fit or compression fitting or electro fusion, may be used. They shall be produced in acetal, gunmetal or polypropylene. The joints should provide the system with strength in tension and water tightness. All fittings shall be designed for a nominal working pressure of PN16 and they shall be compatible to PE pipes.

The mechanical jointing shall consist of lightening the pipe by means of screwed connections with compression push in such away that water tightness is fully secured by means of elastomer "O" ring and PVC grip ring.

Push fit jointing shall consist of a PVC grip and nittrile elastomer "O" ring.

All fittings of any type shall be designed for working pressure of 16 bar.

2. Testing of Pipes and Fittings

HDPE: Pipes and fittings shall be inspected, tested and certified by the Plastic and Rubber Laboratory in the Design and Mechanical technology Centre in the Royal Scientific Society (RSS) or any other specified firm approved by the Engineer.

Pipes :

Tests for determining the resistance of Pipes to constant internal pressure and the bursting time of these pipes are required and should comply with ISO-1167.

Two types of test are required:

1. Acceptance test, carried out at a temperature of 20°C (1 hr test). These allow a fast verification of the conformity of a batch of pipes to a specified type. At least one sample test shall be carried out for each bath of pipes.

2. Quality test (170 hr test) carried out at an elevated temperature as a nature of the pipes tested.

These allow evaluation of the standard of the production and the pipe material used.

The pipelines of transmission and water distribution system and all the joints shall be tested after laying for water tightness in accordance with cp. 312 part 3.

The procedure of test shall be as follows:

Allowable leakage < 3 liter / km / 25mm dia. of pipe / 3 bar/24 hours.

Hydrostatic testing should be carried out at ambient temperature (20°C) otherwise factor should be applied as a correction to the nominal pressure.

Test should be applied on sections of length less than (500-800)m with uncovered joints.

Partially backfill to maintain adequate support and anchoring and to avoid floating of pipes during testing, with joints exposed and valves in the open Position.

Slow fill with water (and not with compressed air to avoid danger of injury or damage).

The filling should be at a rate given a maximum water velocity of (0.5 m/s) in the pipe to ensure no surge and to give air time to be released by the installed permanent air valves or installing corporation cocks.

Leave to reach equilibrium, i.e. the same temperature as the pipe and the surrounding soil and to remove all existing air and for the saturation of pipe material, if any.

Apply test pressure slowly to avoid surge (1.5 × max. nominal working pressure at lowest point) or 16 bars whichever is greater and hold for (one hour). The system should be isolated from the test pump, i.e. no pumping during the one hour test period allowed.

Apply the equation to decide on the success of test.

Finally after completing testing the line should be emptied slowly to prevent shocks or sudden contraction of pipes.

Assembled Joints:

If the pipes and fittings are produced by the same manufacture, the Contractor shall provide documents demonstrating that the assembled joints comply with the following tests:

- **ISO 3458, ISO 3459**:

  Assembled joints between fittings and polyethylene pipes under internal pressure..

- **ISO 3501**

  Polyethylene pressure pipes joints assembled with mechanical fittings test of leak proofness under internal pressure.

- **ISO 3501**

  Assembled joints between fittings and polyethylene pressure pipes test of resistance to pull out.

- **ISO 3503**

  Assembled joints between fittings and polyethylene pressure pipes test of leak proofness under internal pressure when subjected to bending.

The tests of (ISO 3458, ISO 3459, ISO 3501 & ISO 3503) for the assembled joints shall include testing of tees, bends, reducers and caps, self tapping ferrules and any other fittings to be assembled on the P.E. pipes.

Fittings which made of polypropylene shall comply with (WHO – 1984) and the requirement of ECC. Council Directive – 1980.

If the pipes and fittings are not produces by the same manufacturer, the Contractor shall perform the above test at his own expenses by an approved laboratory.

3 . Pipe Tapping Saddles

Saddles are required to be used as indicated on the Drawings for service line connections. One pipe tapping saddle shall be included for each house connection or as indicated on the Drawings. They shall be suitable for a working pressure of 16 bar.

Saddle shall be fixed around the existing and/or proposed main distribution lines of diameters equal or greater than (3"). The saddle shall be of single strap design and in two parts, flat top and bottom-bolted at both sides, pressure through the disc of max. 1.5" in diameter for mains of 100mm diameter or less.

and 2" for mains of diameters greater than 100mm (4"). 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 DI pipes. The saddle shall be supplied complete with the following:

a - Bolts and nuts of stainless steel to ISO 3506 or equivalent. Bolt heads shall be clearlymarked with the manufacturer's name or his identification mark.

b - Nitrile rubber sealing "0" 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. They shall be suitable for working pressure of 16 bar.

c - The saddles shall be suitable for use with screwdown ferrules. Saddles shall be tapped for internal pipe threads in accordance with ISO 7/1 or BS21.

4 . Self Tapping Ferrule Strap

House connections (DN 20mm and DN 25mm) shall be connected directly to the HDPE service lines by one of the following (2) two procedures:

a. Completely self contained integral cutter self tapping ferrule and saddle as indicated on the Drawings, or as directed by the Engineer shall be used. The service saddle should be bolted around the service line and the house connection connected via the ferrule pushfit outlet. The tapping may be dry or under pressure.

b. Suitable (Tee) made of HDPE.
"Using of suitable (tee) is preferred when it is possible" .

The self tapping ferrule and saddle shall be manufacture from:

Gunmetal to BS 1400, and shall be supplied complete with the following:

a. Bolts and nuts of stainless steel to ISO 3506 or equivalent. Bolts should be clearly marked with the manufacturer's name or his identification mark.

b. Nitrile rubber sealing "0" rings, suitable for service connections shall be fixed between the pipe and the saddle in groove in accordance with Din 16963 and DIN EN 681. Self drilling cutters shall be of aluminum bronze in accordance with Din 1725 and DIN EN 601 or approved international standards, Or

2. Polyethylene, Acetal or Polypropylene, and shall be supplied complete with bolts, nuts, "0" rings .. etc. as mentioned above (in a and b).

5. Ferrule

Ferrule cock shall be designed with single outlet of 25, 32 or 63mm suitable for pipes of working pressure 16 bars. They shall be screwdown type that can take the place of a stopcock and designed as a main stem with a swivel outlet control of water flow via a threaded inner plug. The cock shall have inlets with male threads to ISO 7/1 or BS 21 for underground use. The ferrule should be easily "shut off" by means of a spindle attached to the inner plug. The single ferrule should be of push fit outlet.

The design of the ferrule shall permit service line installation via dry/under pressure machines which mount on to the ferrule/saddle assembly.

The machine manufacturer's recommendations shall be followed in respect of the tapping machine.

The screwdown ferrule cock shall be manufactured of gunmetal complying to BS 1400 with minimum percentage of zinc. Complete with nitrile rubber washer in accordance with DIN 16963 and DIN EN 681.

Cast iron surface boxes with hexagonal lid as specified shall be supplied and installed for single ferrule house connections on mains of min. dia. 3". Surface boxes shall be suitable for a 100 KN load.

Extension rod with coupling sleeve and PE-protection tube shall be installed as required, as to operate the ferrule cock from the surface box.

6. Electrofusion Connections

a. General :

Connection design limitations and manufacturer's joining procedures must be observed. Tools and components required to constructed and install joints shall be in accordance with the best installation practices and manufacturers recommendations, all in accordance with ASTM – F 1055-98 Standard Specifications for Electro fusions Type Polyethylene Fittings For Outside Diameter Controlled Polyethylene Pipe and Tubing". However / filed connections shall be controlled by and are the responsibility of the field installer, and shall be performed by, or under the supervision of experienced personnel provided by the pipe manufacturer or distributor (proof of personnel qualifications shall be provided by the Contractor by means of an official certificate from a certified trainer, upon request by the Engineer) with proper equipment in addition the procedures recommended by Plastic Pipe Institute (PPI) shall be taken into consideration.

- Electrofusion Jointing :

Electrofusion fitting, Saddles, Tapping Tees, Tapping Valves, Connectors, Tees and Elbows shall be produced from Polyethylene material (designation PE 100) PN 16 color black and comply with ISO 4427 or equivalent and shall be installed in accordance with the requirements of the manufacturers instructions using appropriate jointing welding equipment.

- Fusion Compatibility

Compound designated PE 80 or PE 100 having MFR (190°/5 kg) within the range 0.2g/10 min. to 1.3g/10 min. shall be considered compatible for fusion to each other.

Polyethylene fittings designed as PE 80 or PE 100 PN 16 can be used to join pipes with different designations.

1. All fittings shall be injection moulded from recognized top quality resin PE 100 or PE 80 complying with ISO 4427/1996.
2. All fittings must be packed in such a way to allow instant use on site without additional cleaning.
3. No heating coil may be exposed and is to be fully imbedded into the body of the fitting for protection purposes during assembly.
4. All fittings must have moulded-in identification and product information.
5. A limited path style fusion indicator as visual recognition of completed fusion cycle should be incorporated into the body of the fitting.
6. Quality control test results regarding "Wire temperature coefficient" and "Heating element and wire resistance" should be provided by manufacturer.
7. All fitting should have barcode.
8. The pipe and fittings shall be of the same material.

9. Contractor should provide certificates from manufacturers on the pressure rating for the electro fusion connection to be at least PN 16.

b. General Procedures:

The component ends to be connected must be clean, dry and free of detrimental surface defects before the connection is made.

c. Cleaning:

Before joining, and before any special surface preparation, surfaces must be clean and dry.

General dust and light soil shall be removed by wiping the surfaces with clean, dry, lint free cloths. Heavier soil shall be washed or scrubbed off with soap and water solutions, followed by through rising with clean water, and drying with dry, clean, lint free cloths.

d. Safety:

Before using chemical cleaning solvents, the potential risks and hazards to persons shall be known by the user, and appropriate safety precautions must be taken. Special handling and personal protective equipment shall be used as necessary.

The manufacturer's instructions for use, and the material safety data sheet (MSDS) for the chemical should be consulted for information on risks to persons and for safe handling and use procedures.

e. Cutting Pipe:

Joining methods shall produce square-cut ends. Pipe cutting shall be accomplished with guillotine shears, run-around cutters, and saws.

Care shall be taken to avoid cutting a spiral groove around the pipe. Guillotine and run-around cutters shall provide a clean cut without chips.

Chain saws shall be operated without chain lubrication. Bucking spikes shall be removed.

Chips shall be removed from the pipe bore and cleared from the job site. Pipes ends shall be deturred It is essential that operators take care to ensure that jointing procedures are rigorously respected and in particular that:

- ☑ The pipe ends are properly scraped.
- ☑ All parts of the joint should be kept clean and dry prior to assembly.
- ☑ Clamps are used correctly to ensure that no movement of the joint can take place during the heating and cooling cycle.
- ☑ Welding shelters are used to ensure that rain does not contaminate the joint.

Only trained and qualified welders should weld fitting on pipes.

f. Dimensions and Tolerances :

HDPE fittings shall be manufacture to the requirements of applicable to ISO 8085/PrEN 12201-3.

2. The minimum wall thickness of any part of a fitting exposed to the full hydrostatic pressure shall not be less than that of a pipe of the same material with the same nominal pressure rating.
3. The minimum bore diameter in any cross-section, (excluding pipe penetration stops) shall be not less than the maximum outside diameter of the pipe or fittings, for which the socket is intended.

g. Tests :

The Contractor shall provide certificates from a third party demonstrating that all tests in accordance with the applicable ISO are performed on electrofusion assemblies. The tests shall include, but not limited to the following test:

- ISO 13954: 1997 Plastics pipes and fittings – Peel decohesion test for (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 900 mm.
- ISO 13955:1995 Plastics pipes and fittings – Crushing decohesion test for (PE) electrofusion assemblies.
- ISO 13956: 1995 Plastics pipes and fittings – Pull out decohesion test for (PE) electrofusion assemblies.
- EN 1716 Plastics piping systems – (PE) tapping tees – Test method for impact resistance of an assembled tapping tee.

Samples of welded fittings shall be taken as instructed by the Engineer from site for the above-mentioned tests, al least once for every 600 joined connections.

The manufacturer shall subject samples of each productions lot of molded fittings to x-ray inspection for voids. Voids shall not be permitted, should voids be found in the samples, the entire production shall be x-ray inspected. If additional voids are found, the production lot shall be rejected. The x-ray testing shall be conducted by an independent laboratory and certified test report made available to the Engineer upon request. Initial sampling shall be limited to not less than 5% of the production lot.

- **Cutting Branch Outlet Holes :**
  Exceeding self tapping saddle tees, hole cutting will be required for filed installed side outlet Fittings. Commercial hole saws for metal shall not be used. Polyethylene pipe hole saws only shall be used.

  When cutting, hole saws shall be withdrawn as frequently as necessary to clear the chips Powered hole saws shall be operated at properly law speeds to avoid overheating and melting Material.

- **Submittals :**
  Contractor should provide certificate from manufacturers on the pressure rating for the Electro fusion connections to be at least 16 bar.

- **Payment :**
  All electro fusion connections works and fittings shall be included in the unit prices of the relevant pipelines.

6. TECHNICAL SPECIFICATIONS FOR Galvanized steel pipes & Fittings

A. Galvanized Steel Pipes :

1. Galvanized steel pipes must be seam-welded, galvanized threaded pipes, **(HevaySeries)** in accordance with **BS. 1387** latest edition or approved equal.
2. The wall thickness and weight for each Size of the pipe should be as follows:

Nominal Size(DN)	Designation of Thread	Outside Dia.		W.Thicknes Mm	Weight Screwed & Socketed
		Max	min.		
20	3/4"	27.2	26.6	3.2	1.88

25	1"	34.2	33.4	4.0	2.96
50	2"	60.8	59.8	4.5	6.26
80	3"	89.5	88.1	5.0	10.5
100	4"	114.9	113.3	5.4	14.8

4. The pipe shall be supplied screwed in accordance to B.S. 21 Pipe Threads, and shall have the screw threads clean well cut and square with the axis of the pipe and be free from excessive burrs. Each pipe shall be supplied with a socket at one end and shall have a protecting ring affixed to the unsocketed end, to prevent damage to the leading thread. The end of each socket shall be chamfered internally.

5. The galvanization shall be done by the hot-dip Zinc Coating process and shall satisfy the copper sulfate test prescribed in Appendix C. of BS. 1387 latest edition.

6. All pipes shall be straight, cleanly finished, free from cracks, surface flaws laminations and other defects and shall have reasonably smooth surface . The overall pipe length when one socket has been fitted to be (6) meters plus or minus 150 mm.

7. The Socket shall in accordance with in BS. 1387 latest edition

8. Galvanization test as In BS. 1387 latest edition.

B . GALVANIZED STEEL PIPE FITTING :

1. Scope of Use:
The fitting shall be used with the heavy series of pipes according to BS. 1387 - 1985 galvanized pipes. These fittings must be suitable for this type of pipes. It must also be suitable for potable water use.

2. Designation:
The fittings shall be Malleable Cast-Iron Screwdown Pipe Fittings in accordance with BS. 143 and BS. 1256/1986 or approved equal.

3. Threading
Threads must be in accordance with BS. 21 .

4. Working Pressure:
Working pressure shall not be less than 16 bar with 24 bar hydrostatic pressure test.

5. Galvanization:
The fittings shall be (EE, GF, CRANE or equivalent in quality) and have an adequate corrosion protection of internal and external surfaces by means of hot-dip galvanization according to BS. 729. Galvanization test is required.

6. Marking:
Each pipe and fitting shall bear the mark of the year of manufacture, nominal diameter, and the letters "GS on the body of the pipe or fitting. The marks may be cast on, painted or cold stamped.

7. HOUSE CONNECTIONS

The Contractor shall make complete house connections in accordance with the requirements of the Typical Drawings and as instructed by the Engineer. Connections may be required for any combination of new and existing lines with new and existing consumers. The following Clause details the required

method of carrying out the house connections. This Clause shall be read in conjunction with other contract clauses (HDPE, GI, ...etc.).

House connections of 3/4", 1" or 2" diameter HDPE pipework shall be made from service lines as indicated on the Drawings or instructed by the Engineer. Sterilization of the service connection shall be carried out at the same time as the main to which it is connected.

Service connections on existing or proposed pipelines shall be made by under pressure tapping. A gun-metal saddle is to be provided with stainless steel nuts and bolts and Nitrile rubber sealing ring/washer suitable for a working pressure of 16 bars. The tappings will be made for 3/4", 1", 1 1/2" and 2". The gunmetal ferrules shall have single outlets suitable for 25, 32, and 63 mm push-fit outlets. The Engineer's Representative will issue instructions regarding the size, location and fittings for each service connection.

Tappings 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. Tappings 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 PTFE tape.

The outlet of the ferrule shall be set to point in the direction in which the service pipe is to be laid. The service pipe (HDPE) shall be laid with a cover of not less than 500 mm below the ground surface unless otherwise shown on Drawings.

The jointing on the HDPE pipe to the push-fit joint shall be in accordance with the instructions of the manufacturer of the push-fit fittings.

The house connection pipe shall be carried to about 1 m inside the property 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.

The transitional point from the HDPE to the GI pipe shall be protected as shown on the Typical Drawings with necessary excavation 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.

The work may include the disconnection of the old existing water meter. The same water meter or a new one (supplied by the Water Authority) 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 firmly fixed 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. To simplify meter maintenance, a stop valve shall be installed on either side of the meter as indicated on the Drawings.

Where meter assemblies need to be repositioned, the meters shall be fixed horizontally as directed and approved by the Engineer's Representative and with the lowest dial not more than 1.0 m above the floor level, 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 adaptors required for a complete connection shall be supplied and installed by the Contractor.

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 dezincification resistant (DZR) material and be suitable for underground use.

The Contractor must prepare house connection sheets for the deteriorated house connections to be rehabilitated in coordination with the Employer.

8-Pressure Switch

The pressure-sensing element may be of the Bourbon tube, spiral, helical, bellows or diaphragm type, depending upon the application requirements. The pressure sensing element shall be of AISI 316 SS.

Pressure switches shall withstand the maximum pressure of the system to which it is connected. In addition, over range protection, (at least 1.5 times the maximum scale reading), shall be included for all instruments. Gauge protectors shall be included wherever required to withstand maximum surge pressure.

Set point for pressure switches shall be adjustable throughout the operating range.

Transistor or relay outputs for On/Off control or alarm function

Pressure switches shall have ½" NPT (M) process connection.

Pressure switches generally be used for ON-OFF applications with an adjustable set point and a differential gap with a reference or calibrated scale.

The switch shall also be hermetically sealed with gold plated contacts. Degree of protection shall be NEMA type 4X, IP67 or better.

Where isolating transformers are not used, the rated fused short-circuit current shall be not less than the short-circuit strength assigned to the control gear.

Flow Switch

GENERAL:

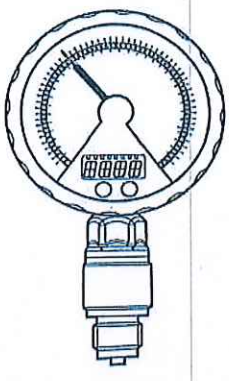
Water Flow Switches are used to monitor and control the flow rate of fluid within an industrial process system (sending trip signals to a pump to protect it in the dry running conditions)

Flow Switch Specifications	
Type	Flapper (Paddle)
Temperature Range	0 C to 50 C
Maximum Fluid Temperature Range	0 C to 50 C
Electrical Micro Switch	SPDT Rating : 220 VAC
Electrical Connections	Screw Terminals
Nominal Pressure	10 Bar
Average Flow Rate	150 m^3/hour
Pipe Diameter	300 mm
Material of Body	Pressure die-casted Brass with plastic top enclosure
Materials of wetted parts	Brass and Stainless Steel
▪ The paddle length should be appropriate to the pipe diameter according to the manufacturer recommendations.	

Digital pressure gauge

GENERAL:

Digital pressure gauges measure the pressure in a system and display the value on an integrated digital display. These gauges are more accurate and easier to read than traditional mechanical gauges and can store and transmit pressure data electronically.



Gauge Pressure Specifications	
Type	Digital, with screen
Voltage	220 VAC
Temperature Range	0 C to 50 C
Nominal Pressure	40 Bar
Average Flow Rate	150 m^3/hour
Pipe Diameter	200 mm
Material	
Pressure port / housing	stainless steel
Display housing	stainless steel
Diaphragm	Teflon or stainless steel or tantalum
Display	graphic LCD display: (resolution 128x64) or higher Measured value display: 4-7 digits.

ELECTROMECHINICAL WORKS SPECIFICATIONS
1-Horizontal Multi-Stage Pump SUBMITTAL

The Contractor/Supplier shall provide complete submittal and include at least the following requirements:

- detailed pump performance curves
- Material of construction for all part of the pump.
- Pump technical data sheet.
- List of required and recommended spareparts.

REFERENCE STANDARDS

The Codes and Standards generally applicable to the work of this section are listed. Codes and updated Standards at the time of bid shall be used.

Table 1: Reference standards for Horizontal Water Pumps

Item	Standard	Description
A	HI – Hydraulic Institute	Centrifugal, Rotary and Reciprocating Pumps, Hydraulic Institute Standards
B	ASTM –	American Society for Testing and Materials
B.11	A48	Gary Iron Castings, Standard Specification
B.2	A108	Steel Bars, Carbon, Cold-Finished, Standard Quality, Standard
B.3	A153	Zinc Coating (Got-Dip) on Iron and Steel Hardware
B.4	A164	Electrodeposited Coatings of Zinc on Steel
B.5	A385	Providing High-Quality Zinc Coatings (Hot-Dip)
B.6	B62	Composition Bronze or Ounce Metal Castings
B.7	B584	Copper Alloy Sand Casting for General Applications
C	EN	European Standard
C1	EN 1563	European Standard defines the grades and the corresponding

Item	Standard	Description
		requirements for spheroidal graphite cast irons.
	EN **10088**	standard used on general purpose stainless steel
D	DIN	German Standard

D1	DIN 1693	Germany standard for stipulating the physical properties of ductile iron
E	ISO	International Organization for Standardization
E.1	ISO 9001	For quality management systems
E.2	ISO 9906	A standard for testing and evaluating the performance
F	IEC	International Electro technical Commission
F.1	IEC 60034	This standard covers the design, manufacturing, and testing of rotating electrical machines, including electric motors used in pumps
J	Others	
J.1	UL Listing	For safety certification

PUMP EFFICIENCY

The minimum accepted efficiency for the pumps will be as mentioned in the below table:

Table 2: Minimum Accepted Efficiency

Pump Capacity (m3/h)	Head (m)	Minimum Efficiency
Q ≤ 100	H≥100	70%
Q < 100	H< 100	75%
250 > Q ≥ 100	All ranges	75%
1000 > Q≥250	All ranges	80%
Q≥1000	All ranges	85%

TESTING OF HORIZONTAL CENTRIFUGAL PUMPING UNITS

- The manufacturer shall conduct all tests required at the factory test bench to ensure that the equipment furnished conforms to the required specification and compliance with the requirement of applicable codes and Standards. Original test certificates and performance curves must be submitted after test and before shipping.
- Hydrostatic Tests: All pressure parts shall be hydraulic tested at 200% of pump rated head or at 150 % of shut off head whichever is higher.

- Performance Tests: All the pumps shall be tested in Manufacture's Works at rated speed for capacity, head, efficiency and break horsepower. Pumps shall be given running test over the entire operating range covering from the shut off head to maximum flow. Testing of pumps shall be in according to DIN EN ISO 9906:2012, the grade of acceptance is according to the below table:

Table 3: Accepted tolerance for pump performance curve & test

Pump Absorbed Power at Duty Point (kW)	Test Acceptance criteria
<20	ISO 9906:2012: Gr 2B
500>P ≥ 20	ISO 9906:2012: Gr 1B
P ≥500	ISO 9906:2012: Gr 1U or 1E

A certified factory performance test should be attached. The bidder shall submit along with his offer or on the date of signing of agreement the original copies in English and the relevant standards used in the material, production test certificates, and original curves shall be provided. The test shall be preferably conducted with actual motor being furnished.

All pump tests must be submitted before shipment for the approval of the purchaser, and any pump that has not passed the test can be rejected

MOTOR TESTS:

- Each motor shall be tested at the manufacturer's plant to determine that it is free from electrical or mechanical defects and to provide assurance that it meets the requirements of these specifications.
- The following tests/inspections are to be performed as part of the Routine Test:
  - Visual inspection
  - Withstand voltage test (High-potential test)
  - Insulation resistance measurement
  - Winding resistance measurement cold
  - Terminal markings and direction of rotation
  - No-load running current and power at 50 Hz
  - Short circuit point at 50 Hz (Locked-rotor test)
  - Vibration level test

- The following tests/inspections are to be performed as part of the Type Test on a single motor from each type/size, in addition to the Routine Test of the individual motors:
  - No load test at rated voltage and frequency
  - Short circuit test at rated current and frequency
  - Temperature rise test
  - Determination of efficiency

- Overload test
- Starting performance test
- Multi-point load test (Partial loads)

➢ Two Certified copies of reports of each test shall be sent prior to shipment of the motor from the manufacturer's plant.

GENERAL REQUIREMENTS

The Contractor/supplier shall refer to the (ANSI), Hydraulic Institute (HI), ISO Standard, and other relevant standards for the design and manufacturing of the horizontal pump. Additionally, the Contractor/supplier shall ensure that the technical data sheet shall fulfill the Compliance Sheet requirements at a minimum. Below table summarizes the required technical specification for pump and motor performance as well as the required material, and the offered pumping units shall be matching all these requirements.

Table 4: General technical requirement for pump & motor for-Split Case/End Suction Pump

Item No.	Description	Specifications
1	Pump Types	Horizontal multistage
2	Flow (m^3/hr)	
3	Head (m)	
4	Fluid type	Raw water, or drinking water
5	PH	
6	Minimum Efficiency (Hydraulic)	Table 2: Minimum Accepted Efficiency
7	Electrical operation parameters at the site	3 phase, 400 v ± 10%, 50 Hz.
8	Acceptable pumps performance curve standard	Table 3: Accepted tolerance for pump performance curve & test
9	Pump stage Casing	EN-GJL-250 (GG-25), EN-GJS-500 (GGG-50), cast steel, or duplex stainless steel for PN<40 bar
	Diffuser material	EN-GJS-500 (GGG-50) cast steel, or duplex stainless steel for PN≥ 40 bar
10	Pump impellers	G-CuSn10 (CC480K), Cast Iron, Austenitic Stainless Steel, or Duplex Stainless Steel
11	Pump shaft	Austenitic St. Steel, or Duplex St. Steel
12	Sleeves Material	EN X20Cr13 (AISI 420), or higher stainless-steel material
13	Renewable wear ring	Austenitic Stainless Steel, Noryl, Bronze, or duplex stainless steel
14	Pump coupling	*Flender Type*
15	Bearing Life	16000 hours at rated load
16	Lubricant type	Grease or Oil
17	Pump test acceptance standard	Table 3: Accepted tolerance for pump performance curve & test
18	Motor type	squirrel cage type, totally enclosed fan cooled (T.E.F.C.)
19	Motor rated power (kW)	Under **Error! Reference source not found.**
20	Motor efficiency	IE4 or better.
21	Power factor	Not less than 0.85
22	IP protection for motor	55
23	Insulation Class	F Temperature rise Class B
24	Motor thermal protection	RTD embedded in motor winding
25	Motor starting methods	DOL, Auto trans, Soft Starter, Variable Speed
26	Speed (RPM)	As per BOQ table
27	No. of starting times	10 per hour
28	Thermal bearing monitoring	PT 100 for each bearing for pumps and motors
29	Vibration Sensor	On each bearing for pump and motor

Note: for high salinity applications the material for casing, shaft, impeller should be duplex stainless steel

OTHER REQUIREMENTS:

- **Duty point must be at BEP or near to BEP by a maximum of -3%.**

- **Flat cure is not accepted, this means that the shutoff head must be higher than the rated head by 10% at least for the pump with a head below 300 m, and 7%.for the pumps having head equal to or larger than 300 m**

- **Pump stage Casing and diffuser**:
  - The pump casing shall be flanged with machine-matching faces. The pump casing shall be designed to collect and run to drain any seal leakages. Where necessary for satisfactory seal operation, provision shall be made for connection to a water supply for seal flushing.
  - Shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or 1.5 times the shut-off head whichever is greater.
  - Casings shall be designed such that the withdrawal of the impeller and drive end cover assembly can be affected without disturbing the pump casings.
  - Hand holes shall be provided, close to the eye of the impeller and near the delivery branch on the volute, to facilitate inspection and the clearance of blockages. The covers to the hand holes are to be bolted and shaped internally to match the internal contours of the casing and to minimize disturbances to the flow.

- **Pump shaft**:
  - The critical shaft speed shall be well away from the operating speed and in no case less than 130% of the rated speed to avoid resonance.

- **Stuffing Box:**
  - Each stuffing box shall contain a replaceable bushing at the inboard end, a split lantern ring at least two packing rings in length, at least five packing rings, and split glands at the outboard end.
  - The gland halves shall be interlocked at assembly and held in position at all pressure by at least two bolts or studs.
  - Each box shall have a flushing connection at the normal lantern ring position.
  - The stuffing box assembly shall be suitable for conversion to a standard size mechanical seal.
  - Each stuffing box shall contain a mechanical seal.
    A flushing connection shall be located at the normal position of the lantern ring. Stuffing boxes shall be suitable for conversion to use standard packing and shall be at least seven packing rings in length.

- Bearings.
  - Bearings may be either grease or oil-lubricated antifriction type or oil lubricated sleeve type.
  - Sleeve bearing unit loads shall not exceed 80 psi and shall be in conformance with the current acceptable practice.
  - The outboard bearing shall carry both radial and axial loads imposed by the pump. The inboard bearing shall carry the radial loads imposed by the pump and driver.
  - Antifriction bearing shall have an AFBMA B-10 rating of 20,000 hours at specified operating conditions.
  - The pump shaft speed shall not exceed the bearing manufacturer's limitations.
  - Bearing housing shall be designed to maintain shaft alignment and optimum life of bearing and lubricant.
  - Housings shall have labyrinth-type running clearances and throwers to retain the lubricant and keep out contaminants.
  - Ample clearance for stuffing box maintenance shall be provided between the bearing housing and the stuffing box glands.
- **Pump-Motor Coupling:**
  - The pump and motor shafts shall be connected with an adequately sized flexible coupling (Flender Type) of proven design with rubber spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided
  - The pump coupling shall be heavy-duty type, sized for continuous operation at full load and at maximum rpm when the misalignment is within the manufacturer's tolerance limit.
  - Couplings for motors with sleeve-type bearings shall have a limited end float feature.
- **Accessories**:
  - Each pump and motor shall be provided with 1 temperature sensor on each bearing housing
  - Each pump and motor shall be provided with 1 vibration sensor on each bearing housing
  - Each pump shall be provided with lifting eye bolts or lugs.
  - Tapped and plugged gage cock connections at the suction and discharge flanges.
  - Tapped and plugged openings for casing and bearing housing vents

and drains, and fittings for properly adding the flushing lubricant.

- Flushing water connections to mechanical seals shall be equipped with 25- micron reusable, ceramic filters.
- The bearing housing shall offer the possibility to install temperature and vibration sensors without modifying the casing or other components.

- **Balance**:
  - All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable.

- **ELECTRIC MOTORS**
  - Each motor shall be a horizontal / Vertical, open drip roof, solid shaft, induction motor.
  - Motor shall be totally enclosed fan cooled (TEFC).
  - shall be protected so as to exclude the ingress of falling dirt or moisture conforming to a degree of protection not less than IP 55.
  - Motors shall be provided with the windings being connected to 6 terminal arrangements in the terminal box.
  - Motors up to 37 kW shall suitable for DOL starting having a starting current not greater than 6 x full load current (FLC).
  - Unless specified elsewhere, motors above 37 kW shall have their starting current restricted to 2.5 x FLC and shall use one of the following starting methods:
    - Solid State Reduced Voltage (Soft Starter).
    - Auto Transformer starter.
    - Variable Frequency Drive.
  - Motors shall be designed for full voltage starting and shall be capable of completing two starting cycles without time lapses or injurious heating to any part of the motor.
  - Stator frame shall be provided with eyebolts, lugs or other suitable means for lifting and handling the completely assembled motor.
  - The motors shall run in ball and/or roller bearings and the weight of the motor shall be carried by thrust bearings incorporated in the motor body.
  - The efficiency and power factor of the motors shall be high over a wide range of load conditions and the motors shall be designed, manufactured and tested in accordance with IEC 34 for continuously rated industrial electric motors with Class F insulation but limited to Class B temperature rise.

- The maximum continuous rating (MCR) of each motor shall be as set out below and shall be rated and designed for operation in ambient temperatures up to 50°C and capable of prolonged operation in sand-laden atmospheres.
- Motor Rating (MCR) **must cover all pump operation curve and not more than 25% of the power absorbed at duty point.**
- Motors shall be capable of starting 10
- The motors shall be commercially silent in operation and run free from vibration and the rotors shall be perfectly balanced both statically and dynamically and shall be tested and adjusted for dynamic balance in an approved manner.
- Terminal boxes shall be provided with glands suitable for XLPE or PVC armored cable.
- The motor stool base where appropriate shall be drilled at works vertically blew the terminal box gland for the passage of the cables and the edges of the hole slightly countersunk or the hole bushed.
- Electric motors shall be fitted with a space heater suitable for the use of voltage and shall be provided and wired to a separate box anti-condensation heater and embedded in the motor windings and the terminal boxes shall be labeled with "Trifoliate" type labels white letters on red background, to read in English:

  WARNING LIVE HEATER TERMINALS - ISOLATE BEFORE REMOVING COVER
- All motor drives shall be labeled to correspond with their respective starters.
- Maximum temperature contact shall be derived either thermostatically or electronically and this thermal contact shall give alarm and or trip its associated motor starter circuit breaker when the motor winding temperature reaches its maximum allowable value

PUMPS EVALUATION CRITERIA

For Pumps item in the BOQ, the financial evaluation will be based on LCC (Life Cycle Costing) after complying with technical specifications.

Below table clarifies the criteria for evaluation and this criterion will apply on pumps price item in the BOQ.

The Supplier/Contractor shall fill out *Pumps Evaluation Criteria / LCC (Life Cycle Costing)* Sheet.

Pumps Evaluation Criteria / LCC (Life Cycle Costing)

Description	Notes	Filled By Bidder
Initial investment (JOD)	Negative value	
Electricity Tariff KWh (JOD)	0.096 JOD	0.096
Average power (kW)	(treated positively)	
Average operating (hours/annum)	24*365	
Annual energy cost	Average power (P1, Absorbed power by motor) (kW) x annual operating hours (h) x cost kWh (cost treated negative)	
Estimated lifetime (years)		10
Discount rate	(Bank Interest Rate)	6%
Inflation		7%
LCC		

وزارة المياه والري
سلطة المياه
مديرية العطاءات والمشتريات

Compliance Sheet

The Supplier/Contractor shall fill out the following Compliance sheet:

Item No.	Description	Required Specification	Bidder data	Deviation
1	Pump Types	Horizontal, multistage		
2	Flow (m^3/hr)			
3	Head (m)			
4	Fluid type	Raw water, drinking water		
5	PH			
6	No. of Stage			
7	Minimum Efficiency (Hydraulic)	Table 2: Minimum Accepted Efficiency**Error! Reference source not found.**		
8	Electrical operation parameters at the site	3 phase, 400 v ± 10%, 50 Hz.		
9	Acceptable pump's performance curve standard	Table 3: Accepted tolerance for pump performance curve & test		
10	Pump stage Casing and Diffuser material	EN-GJL-250 (GG-25), cast steel, or duplex stainless steel for PN<40 bar EN-GJS-400 (GGG-40) cast steel, or duplex stainless steel for PN≥ 40 bar		
11	Pump impellers	G-CuSn10 (CC480K), Austenitic Stainless Steel, or Duplex Stainless Steel		
12	Pump shaft	Austenitic Stainless Steel, or Duplex Stainless Steel		
13	Sleeves Material	EN X20Cr13 (AISI 420), or higher stainless-steel material		
14	Renewable wear ring	Austenitic Stainless Steel, Noryl, Bronze, or duplex stainless steel		
15	Pump coupling	Flender Type		
16	Sleeves Material	EN X20Cr13 (AISI 420), or higher stainless-steel material		

Item No.	Description	Required Specification	Bidder data	Deviation
17	Bearing Life	20000 hours at rated load		
18	Lubricant type	Grease or Oil		
19	Pump test acceptance standard	Table 3: Accepted tolerance for pump performance curve & test		
20	Motor type	squirrel cage type, totally enclosed fan cooled (T.E.F.C.)		
21	Motor rated power (kW)	Under **Error! Reference source not found.**		
22	Motor efficiency	Min. IE4.		
23	Power factor	Not less than 0.85		
24	IP protection for motor	55		
25	Insulation Class	F, Temperature rise Class B		
26	Motor thermal protection	RTD embedded in motor winding		
27	Motor starting methods	DOL, Auto trans, Soft Starter, Variable Speed		
28	Speed (RPM)	As per BOQ**Error! Reference source not found.**		
29	No. of starting times	Under **Error! Reference source not found.**		
30	Thermal bearing monitoring	PT 100 for each bearing for pumps and motors		
31	Vibration Sensor	On each bearing for pump and motor		
32	Pump brand name & country of origin			
33	Motor brand name & country of origin			

Note: **the offered pumping units must comply with the required technical specifications either mentioned in the compliance sheet or not mentioned.**

TECHNICAL SPECIFICATIONS

Variable Speed Drive

General Requirements

a. QUALITY ASSURANCE

- VFD manufacturing facilities shall be ISO 9001 and ISO 14001 certified.
- All printed circuit boards shall be completely tested before being assembled into the complete Drive.
- The Drive shall be subjected to a functional test and load test.
- All printed circuit boards shall have conformal coating.

b. QUALIFICATIONS

The VFD shall meet the following specifications:

- The VFD manufacturing facility shall be ISO 9001 and ISO 14001 certified.
- UL 508A and 508C - Underwriter's Laboratory. The VFD shall be UL listed and carry the UL mark.
- Institute of Electrical and Electronic Engineers (IEEE). Standard 519, IEEE Guide for Harmonic Content and Control.
- The VFD shall carry CE mark.
- The VFD shall be one of well-known brands.

c. SUBMITTALS

The Submittals shall include the following information:

- Outline Dimensions and Weight.
- Customer connection and power wiring diagrams.
- Complete technical description of the proposed system including a complete list of options provided.
- a full compliance sheet according to the required specifications

d. Design.

- The VFD system configuration shall be low Harmonic system that contains an PWM output- IGBTs adjustable Speed AC Drive with all required protections .The proposed system should consider the safe and correct requirements/measures of running the required pumps motors through a VFD .
- Considerations toward motor insulation, common voltage mode / motor bearing currents, resonance phenomena and motor cooling should be taken into account.
- The system shall be properly tuned for ensuring that the overall plant power system quality performance and electrical components would not be affected.

e. HARMONICS

- The Low Harmonic construction of the VFD system configuration shall maintain total harmonic distortion (THDi) levels at the VFD's input terminals to levels at or below 5% of full rated capability at the input terminals of the VFD on power system sized under all motor load conditions. All harmonic management devices must be internal to the VFD enclosure and supplied as a complete solution.
- VFD with active frond end (AFE) with integrated LCL filter technology drives shall be also acceptable(optional) .
- The VFD system configuration must maintain harmonic compliance, at the input terminals of the VFD, without exception, with up to and including a 3% voltage imbalance, phase to phase.
- The VFD system shall operate at fundamental power factor > 0.97 on the supply side under all motor load conditions. The input power factor shall be programmable from 0.8 lagging to 0.8 leading, allowing the VFD to be used as a compensating device for installations that are excessively inductive or excessively capacitive in reactive power.
- VFD panel output current shall approximate actual sinewave current. The output voltage and frequency shall vary proportionally, thus maintaining a constant V/Hz value up to a nominal frequency.
- Drive shall be designed to meet EMC requirements according to IEC 61800-3

f. RATINGS

- The VFD shall be rated to operate from 3-phase power at 380 to 415V ±10%, 50/60 Hz ±5. The overvoltage trip level shall be a minimum of 30% over nominal, and the under-voltage trip level shall be a minimum 35% under the nominal voltage.
- The VFD shall be rated to operate at the following environmental operating conditions: ambient temperature -10 to 40°C continuous. VFDs that can operate at 40° C intermittently (during 24-hour period) are not acceptable and must be oversized. Altitude 0 to 1000 m above sea level without derating, 95% humidity, non-condensing.
- VFD shall be rated 115% of motor nameplate rating

- The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes.
- The heavy-duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes.

1.a.1

g. CONSTRUCTION

- All models shall provide a complete, ready-to-install solution.
- The VFD shall use the same main control board for all ratings.
- Control connections shall remain consistent for all power ratings.
- The VFD can be offered in an IP21 rating or above, however, the overall VFD panel shall be rated at IP54 taking into consideration the ventilation fans IP rating as well.
- VFD shall be expandable when required with communication modules and/or IO modules.

1.a.2

h. OPERATOR INTERFACE

- The VFD shall be equipped with a front mounted operator control panel consisting of a minimum four- (4-) line by 20-character back-lit alphanumeric LCD display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.
- The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
- The display of the control unit shall have the following features:
  1. The LCD display shall have contrast adjustment provisions to optimize viewing at angle.
  2. All parameter names, fault messages, warnings and other information shall be displayed in complete American English words or standard American English abbreviations
  3. During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. The selection shall include at least the following values:
     1. Speed/torque in percent (%), RPM or user-scaled units
     2. Output frequency, voltage, current and torque
     3. Input voltage, power and kilowatt hours
     4. Heat sink temperature and DC bus voltage
     5. Status of discrete inputs and outputs
     6. Values of analog input and output signals
     7. Values of PID controller reference, feedback and error signals

- An intelligent start-up assistant shall be provided as standard. The Start-up routine will guide the user through all necessary adjustments to optimize operation.

1. The Start-Up routine shall include "plug and produce" operation, which automatically recognizes the addition of options and field bus adapters and provides the necessary adjustment assistance.
2. The Start-Up routine shall prompt the user for Motor Nameplate Data including power, speed, voltage, frequency and current.
3. An auto-tune function shall identify the optimal motor tuning parameters for typical applications.
4. An auto-tune function shall also be available to tune the PID speed regulator loop. Manual adjustments shall also be allowed.
5. A selection of at least five (5) preprogrammed application macro parameter sets shall be provided to minimize the number of parameter adjustments required during start-up. Macros offered shall include Hand/Auto, Level Control, PFC (Pump, fan control) traditional, Multi-pump, Anti-Jam, A selection of two (2) user defined macros shall are also be available.

i. PROTECTIVE FEATURES

- For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the VFD's fault history.
- The VFD shall include internal protections for phase to phase and phase to ground line voltage transient protection.
- Output short circuit and ground fault protection rated for 100,000 amps without relying on line fuses shall be provided per UL508C.
- Motor phase loss protection shall be provided.
- The VFD shall provide electronic motor overload protection qualified per UL508C.
- To ensure continuous protection during a low input voltage condition, the Active Front End Drive must maintain UL approved overload protection of the motor, without exception and without nuisance overload trip, continuously, with up to and including a 10% voltage drop.
- Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or under voltage at 65% of min. rated voltage.
- The VFD shall protect itself against input phase loss.
- Stall protection shall be programmable to provide a warning or stop the VFD after the motor has operated above a programmed torque level for a programmed time limit.
- Under load protection shall be programmable to provide a warning or stop the VFD after the motor has operated below a selected under load curve for a programmed time limit.
- Input terminals shall be provided for connecting a motor thermistor (PTC type) to the VFD's protective monitoring circuitry. An input shall also be programmable to monitor

an external relay or switch contact. The existing PTC on the motor is to be connected to the VFD for protection.

j. CONTROL INPUTS AND OUTPUTS

Discrete Inputs

1. A minimum of six (6) discrete inputs shall be provided.
2. A minimum of six (6) of the inputs shall be independently programmable with function selections (run/stop, hand-off-auto, etc.).
3. Inputs shall be designed for use with either the VFD's internal 24 VDC supply or external 24VDC supply.

Discrete outputs

1. Minimum of two (2) form C relay contact outputs shall be provided.
2. All outputs shall be independently programmable to activate with at least 30 function selections including:
1. Operating conditions such as drive ready, drive running, reversed and at set speed
8. General warning and fault conditions
9. Adjustable supervision limit indications based on programmed values of operating speed, speed reference, current, and torque and PID feedback.
10. Relay contacts shall be rated to switch 2 Amps at 24VDC or 115/230VAC.

Analog Inputs

1. Minimum of three (3) analog inputs shall be provided:
3. All inputs shall be independently programmable with input function selections.
4. A differential input isolation amplifier shall be provided for each input.
5. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.
6. If the input reference is lost, the VFD shall give the user the option of the following. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
    1. Stopping and displaying a fault
    11. Running at a programmable preset speed
    12. Hold the VFD speed based on the last good reference received
    13. Cause a warning to be issued, as selected by the user.

7. When inputs are used as speed references, reference signal processing shall include increase/decrease floating point control and control of speed and direction using a "joystick" reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.

Analog Outputs

1. Minimum of two (2) 0 / 4-20 mA analog outputs shall be provided.
8. Outputs shall be independently programmable to provide signals proportional to output function selections including output speed, frequency, voltage, current and power.

1.a.3

k. COMMUNICATION

- Interface modules shall be available for a wide selection of protocols including but not limited to:
  1. Profinet
  2. Profibus-DP
  3. Ethernet IP
  4. Modbus TCP

- Interface modules shall mount directly to the VFD control board to minimize interference and provide maximum throughput.
- The VFD shall have the capability of allowing the overriding controller to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information.
- A connection shall also be provided for personal computer interface. Software shall be available for VFD setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of VFD performance.

l. CONTROL FUNCTIONS AND ADJUSTMENTS

- Output frequency shall be adjustable between 0.1 Hz and 500Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
- The VFD shall be capable of controlling deceleration of a load without generating an overvoltage fault caused by excessive regenerated energy. Overvoltage control on deceleration shall extend the ramp time beyond the programmed value to keep the amount of regenerated energy below the point that causes overvoltage trip.
- The VFD shall be capable of starting into a rotating load (flying start) regardless of motor direction. It should then accelerate or decelerate to the active reference without tripping on fault or causing component damage. The VFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
- The VFD shall have the ability to automatically restart after an over current, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
- Control functions shall include two (2) sets of acceleration and deceleration ramp time adjustments with linear and an s-curve ramp time selection.
- Speed control functions shall include:
    1. Adjustable min/max speed limits.
    2. Selection of up to 15 preset speed settings for external speed control.
    3. Three sets of critical speed lockout adjustments.
    4. A built-in PID controller to control a process variable such as pressure, flow or fluid level.
- Functions shall include flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed operating point.
- The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for VFD acceleration from zero speed without signaling a false under load condition.
- Three (3) programmable critical frequency lockout ranges shall be provided to prevent the VFD from operating the load continuously at an unstable speed.
- The VFD shall have fifteen (15) internal adaptive programming blocks capable of twenty (20) different functions. These blocks shall be connectable to VFD's actual signals and functions allowing the user to tailor the VFD to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of programming software.

5) RTU Enclosures

The enclosure shall be heavy duty; reinforced steel, freestanding cabinet which requires access only from the front (hinged front panels).

A. Index of Protection

Shall be protected to BS EN 60529 as follows:

- IP42 Indoors, clean locations
- IP54 Indoors, dirty locations
- IP67 Outdoors
- IP68 to depth 5 meters where flooding may occur

The degree of protection shall not be degraded during calibration and it shall only be necessary to open the enclosure for the purpose of maintenance, fault finding or repair. The degree of protection for all internal components shall not be less than IP2X.

B. Materials

Equipment housings and enclosures shall be constructed from materials which are resistant to the effects of weather (outdoor applications) and from exposure to process or sample media in solid, fluid or gaseous form.

C. Security

Covers or doors shall be locked (requiring a special tool or key to open) to prevent access to the enclosure and fitted with suitable "Danger Live" labels to be protected against unauthorized intervention which may affect the performance of system.

D. Electrical Termination

Incoming and outgoing cables shall be identified and shall pass through glands fitted to a properly designed gland plate and spaced so as to allow access to both sides of the glands, without the use of special tools. All connections shall be properly identified both on the terminal and conductor by indelible means. Sleeve type ferrules shall be used; open type clip-on ferrules are not acceptable. Where possible, separate terminal rails shall be provided for incoming and outgoing terminals

E. Terminations for PLCs

These requirements are applicable to Programmable Logic Controller (PLC) or other housings containing various instruments, relays, lamps, switches, pushbuttons or other control and indication components, to marshalling cubicles also to control or data acquisition equipment forming part of the system. Such Local Control Panels may be wall mounted or free standing cabinets

- Terminal blocks shall be arranged such that both terminals and wiring ends are readily accessible and have separate terminals provided for incoming and outgoing wires.
- Each terminal shall be labeled to correspond with the diagram of connections and the terminal identification label shall be attached to the fixed portion of the terminal blocks only.
- Terminals which may be "live" when the equipment is isolated from the main

supply shall be adequately shielded from accidental contact and be clearly identified and inscribed accordingly.

- Terminal blocks shall have separate terminals for internal and external connections. External connections shall always be connected to the same side of the terminal blocks.
- Control terminals shall be Phoenix Contact DIN rail mounting of spring-cage connection Clip line ST 2.5 as minimum or similar manufacture and rated for continuous current operation. Control terminal rails shall be provided with 5 spare terminals for future use, within each starter cubicle, and 20% spare terminals within marshalling sections.
- Terminals connected to remote alarms, indication, electrodes and instruments shall be spring cage Knife disconnect terminal for testing (e.g. Clipline ST2.5-MT or similar).
- PLC shall be provided with a panel mounted lighting fixture operated through a dedicated door-limit-switch.]
- An anti condensation heater shall be installed in each vertical section, the heater shall be operated by a common panel-thermostat.

6) Earthing and Bonding

General

This section covers furnishing and installing earthing cable, earthing rods, and earthing materials as indicated on the Drawings and as specified herein for the electrical system and equipment grounding.

The earthing installations shall provide that all extraneous conducting materials in the buildings are equi-potential bonded, so that in the event of an electrical fault potential differences are not present.

Earthing arrangements and protective conductors shall be in accordance with the "Regulations for Electrical Installations" issued by the institute of Electrical Engineers, London, Sixteenth Edition Parts 4 and 5 and subsequent revisions.

The installations shall have separate neutral and protective conductors.

The system will also ensure that the conductors carrying earth fault currents are of adequate cross sectional area to enable the protective device to operate in timed period so that damage is not caused to any installation equipment and that discrimination between protective devices is maintained.

The complete earthing system shall be protected against damage by corrosion.

Local air and soil conditions are aggressive and saline; neither steel nor copper shall therefore be protractedly exposed to the environment. Steel parts shall be hot dipped galvanized; copper shall be tinning plated.

Earthing System

Earthing system shall be installed as indicated in the Jordanian General Technical Specifications for Buildings "Chapter 4'.

The earthing system shall comply with the standards of BS7430,IEC-364-5-54,IEEE-81 regulations.

Main earthing conductors shall consist of tin copper bar of hard drawn, high conductivity copper strip (or equivalent tinned or lead coated bare copper, hard drawn wire).

Earthing conductors shall be adequately sized for maximum fault current.

Each connection shall be identified using engraved laminated plastic labels which may be fixed to the conductor using nylon cable ties.

Bolted connections shall be made using brass bolts, washers, nuts and locknuts. Alternatively electrically plated steel components may be used.

Earthing Rods

Earth rods shall be of 20 mm in diameter by 3 meters long power driven vertically into the ground apart with heads located at a depth to suit the position of the disconnecting chamber.

Earth rods shall be copper plated steel cored with a metallic bonded outer surface, rods shall be provided with special hardened tips and caps, to avoid distortion when driven into the ground. Approved non-ferrous clamps for connecting the rod to the copper strip (or the bare wire), between rod and final earth lead test link shall be provided.

The head of each rod shall be brought to a concrete chamber to enable each electrode to be disconnected for testing purposes.

Concrete disconnecting chambers with removable cover and disconnecting link, for location and test purposes, shall be provided over each rod. The top of the chamber shall be at finished ground level.

The earth rod interconnections shall be an electrically unbroken ring and interconnections shall be tinned or lead coated copper tapes of hard drawn high conductivity copper strips (or equivalent tinned or lead coated bare copper hard drawn wire) sweated to the test links. The conductor shall be adequately sized and sufficient low resistance to carry the maximum fault current for a period equivalent to the clearing time of the protective equipment without undue temperature rise.

Joints at the head of the earth rods shall be easily accessible for periodic inspection.

Where armoured cables are installed above ground level for the purpose of running sub-main or final distribution circuits, then the armouring may be used as the earth conductor provided that the following requirements of the next paragraph are complied with.

Where armoured cables are installed directly in the ground then the armouring must be bonded to earth using suitable glands. The armouring must not be used as the sole earthing conductor. Additional earthing shall be provided by means of a separate insulated PVC-copper cable whose insulation is green/yellow. This cable shall follow the same route as the supply cable and shall be taped to it at regular intervals. Alternatively an integral earth conductor shall be provided where Multicore-armoured cables are provided.

The test link shall be of tinned copper and not be less than the connecting cables cross sectional areas and have a generous contact area.

Disconnecting bolts, nuts, locknuts and washers shall be made from phosphor bronze.

The copper PVC insulated wires connecting the earth rods to the test link shall be exothermically welded at the test link and sweated to the top of the earth rod.

Mains Distributions

Where the armour of cable is used as the earth conductor for remote switchboards and equipments, the Contractor shall ensure that the earth resistance taking account of the cross sectional area of the armour and the lengths of cable is satisfactory. Where necessary steel conductors shall be replaced by copper in the armour cables or separate earth conductors shall be installed.

Particular care shall be taken to ensure earth continuity across items of equipment situated within a cable run, and should the design of such equipment not give adequate and lasting continuity through its structural body then additional earthing clamps and conductors shall be provided to bond the cable sheaths together independently.

Earth electrodes shall be of high carbon steel with a copper bonded finish installed below concrete inspection covers marked "EARTH".

Mains Connections

Connections between the earth bar and principle items of equipment shall be made using copper tape or stranded cable of appropriate size cross sectional area with an overall green or green/yellow PVC sheath.

Electrical Installations

Cubicle switchboards shall include a continuous copper conductor connected to each section of the cubicle and extended to the incoming outgoing cable gland plate and armour clamping rings.

Site assembled panels and boards shall have items of equipment, the frame and cable armour rings bonded with copper tape.

Conduit or trunking shall not be used for earth continuity but all conduit or trunking shall be connected to earth. Flexible conduits shall have an additional external earth connection adequately bonded at both ends. Where conduits and/or trunking is used to connect equipment not separately bonded to the earthing system a separate internal earth conductor shall be run, which shall be securely bonded directly to the respective equipment by means of a separate recognized earth terminal.

Earthing System Resistance

The earthing resistance shall not exceed 2.0 ohms at each structure. All earthing resistance measurements shall be made with a three terminal "Megger" type earthling tester which applies alternating current to the electrodes and which gives a reading in direct current ohms. Two reference earth probes shall be used, and all tests shall be made in accordance with the instrument manufacturer's instructions for ground resistance testing.

The earthing resistance measurement data may indicate that additional earthing rods are required. The Contractor shall install and connect additional earthing rods to achieve the required ohms needed.

Testing

During the progress of the work and particularly for those installations to be buried or concealed, continuity test shall be performed. These tests shall not replace any tests required at the end of the Project.

The procedures shall include a visual inspection by senior personnel followed by testing using appropriate test instruments. Test instruments shall be regularity and recently calibrated before

7)Cables

Power Cables

Scope

This specification defines the requirements for supply of electrical cables 600/1000V XLPE/SWA/PVC type for the system voltage of 415/240 V, 3 phase and neutral and Frequency 50 Hz.

Applicable Codes and Standards

The following codes and/or standards (latest editions inclusive of all amendments) are applicable.

- IEC 60502-1 Power cables with extruded insulation and their accessories for rated voltages of 1 kV (Um = 1.2 kV) and 3 kV (Um = 3.6 kV).
- IEC 60332-1 Tests on electric cables under fire conditions- Part 1: Test on a single vertical insulated wire or cable.
- IEC 60228 Conductors of insulated cables.
- IEC 60230 Impulse tests on cables and their accessories.
- IEC 60724 Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1.0 kV.
- IEC 60811 Common test methods for insulating and sheathing materials of electric cables.
- IEC 60287-1 Calculation of continuous current rating of cables - current rating equations.
- IEC 60287-2 Calculation of continuous current rating of cables - thermal resistance.
- IEC 60287-3 Calculation of continuous current rating of cables - operating conditions.

The Contractor shall also note that it is not the intent of this specification to deviate from good engineering practices. The absence of specifications shall imply that the best engineering practices shall prevail, utilizing first quality materials and workmanship.

The Contractor shall seek clarification from the Engineer of any confusing or conflicting information contained in this specification and the accompanying documents.

Any deviation from this specification shall be indicated by the Contractor along with his bid. Otherwise the Engineer shall assume full compliance with this specification while accepting the bid.

Design and Construction

The design and construction of electrical power and control cables shall be in accordance with the codes and standards as specified.

All electrical power and control cables shall have coloured cores as shown in table 5 and as specified in IEC 60173.

Cable Type	Power Cables	Control Cables
Single core	red or black	red or black
Two cores	red and black	red and black

Cable Type	Power Cables	Control Cables
Three cores	red, yellow, blue	red, yellow, blue
Four cores	red, yellow, blue, black	red, yellow, blue, black
Five cores	red, yellow, blue, black, green	white numericals printed on black insulation

The black sheath is for the neutral and the other colours are for the phase conductors.

For multicore cables (i.e. above 4 cores) for control applications, the core numbers shall be printed on each cable core for identification (i.e. nos. 1,2,3,4,5,6,7 upwards).

All cables shall be suitable for operation under the following conditions:

- Directly buried in ground.
- Run in buried P.V.C., concrete or all steel ducts.
- Runs fastened to cable rack or tray in open air.
-

The cables shall be capable of continuous operation at highest system voltage as specified with maximum conductor operating temperature of 90 C and maximum temperature under fault conditions of not more than 250 C.

Materials

Conductors

The cable conductors shall be of stranded, annealed high conductivity copper conductors laid up and rendered smooth and free from defects likely to injure the insulation.

Conductors shall be of high conductivity copper and meet the requirements of IEC 60228.

Smaller sizes shall be circular in formation and comprise several strands.

Larger conductors to be stranded and shaped to produce a compact, less costly design. For cables having two or more than two core, shall have all cores of uniform cross section.

Insulation

Power and control cables shall be insulated with cross-linked polyethylene (XLPE) compound and insulation thickness complying with the requirements of IEC 60502-1

Laying and Bedding

The laying of cores of cables and bedding shall be as per IEC 60502-1.

Armour

The power cables having two or more cores shall comprise a single layer of spirally applied galvanised steel wire.

The electrical conductivity of the armour shall be such that it is capable of carrying the earth fault current specified in data schedule.

Wire armour for single core cables shall consist of a single layer of aluminium wires.

Outer Sheath

The outer sheath of cables shall be an extruded layer of black PVC, intrinsically flame retardant and anti termite protected. The cables shall meet the requirements of IEC60502-1 and IEC 60332-1.

Marking

The external surface of the cover-sheath shall be embossed along two or more lines with electrical cable 600/1000V according to IEC 60502-1. Also manufacturer's name and year of manufacture shall be provided through out the cable length.

Sealing and Drumming

Both ends of every length of cable shall be sealed properly immediately after tests at manufacturer's premises.

The cables shall be rolled on suitable wooden or steel drums. The drum shall be marked to indicate the direction of rolling, type of cable, voltage and cable length. For all cut lengths of cables which are to be delivered to the Engineer, approved sealing caps of correct size shall be supplied and properly mounted immediately after the respective cable length is cut.

Inspection and Testing

Performance and acceptance tests for electrical power and control cables shall be carried out at manufacturer's works which shall be witnessed by the Engineer or alternatively subject to the Engineer's prior approval, factory test certificates shall be accepted.

Copies of type test certificates as per IEC-60502 shall be furnished by the cable manufacture along with the bid.

The required tests, test conditions and acceptance criteria for the cables shall be in accordance with the latest edition of IEC-60502-1 .

The required tests on the cables shall include but not limited to the following:

- High Voltage Test.
- Conductor Resistance Test.
- Armour Resistance Test.
- Thickness of Insulation.
- Test for Flame Retardant.
- Insulation Resistance Test.

Documentation

The contractor shall provide the following documents as minimum:

Detailed technical particulars for the cables including current carrying capacity, short circuit current ratings, de-rating factors, thickness of each material and composition, weighting, etc. Test certificates for all type tests and materials if specified on data sheets. Installation data.

Control and Instrumentation Cables

Control and instrumentation site cables shall be manufactured in accordance with BS 6346 with steel wire armouring and polyethylene or PVC with 0.38mm thickness insulation. The cable shall be twisted pair, shielded with (1) mm2 cross sectional area per core.

Each cable shall have its individual cores identified along their entire length by permanently printed numerals or letters. At every point of termination, core identification shall be carried out using an approved system of ferrule markers. At any point of interconnection of wiring at which a change of numbering is unavoidable, double ferrules shall be provided on each wire.

Any change of numbering shall be recorded on the wiring diagrams of the equipment at which the change is made.

Where it is proposed to use junction boxes for the marshalling of control and instrumentation cables to a common item of equipment, etc., any such junction box shall be of the wall mounted type, purpose made, complete with double terminal blocks of the pressure plate pattern.

Cabling Method

Each cable shall be installed in accordance with the relevant codes of practice and shall be neatly run in all situations. Cables which are to run on walls, ceilings or other structures shall be supported on cable trays.

Where cables are surface run on the external faces of structures or above ground level, suitable protection from the radiation of the sun shall be provided by means of covers or canopies.

Where cables enter or leave structures or panel plinths, the ducts shall be sealed at the point of entry or exit. Caulking shall be carried out with an approved compound and followed by not less than 40 mm of epoxy resin, two mix-cold waterproof compounds or a weak sand/cement mixture as directed by the Engineer. This shall include any spare ducts. The Contractor shall be responsible for temporarily sealing all cable ducts into structures during the installation stage to prevent accidental flooding of the structures.

Cables shall be delivered on robust cable drums which shall bear details of manufacturer, size, length and insulation and shall be offered to the Engineer for inspection prior to installation.

When a cable is cut from a length on a drum, the drum length shall be immediately sealed. All cables once cut and laid shall be terminated in their final position or effectively sealed.

The general routing of cables shall be as generally indicated on the contract drawings but the final routes shall be those agreed with the Engineer before any cable installation work is carried out. All cables shall be installed strictly in accordance with the requirements of this specification.

The laying of all cables shall satisfy the following requirements: Cable depths shall be assessed from the finished ground level unless otherwise directed by the Engineer. Cables hall be laid at a depth of
0.7 meters, less bedding. A layer of soft sand, 10 cm thick shall be laid under and over the cable, and a 7cm thickness of solid blocks and warning tape shall be placed above the sand along the cable trench.

Cable Installation

Care shall be taken to protect the cable and avoid kinking of conductor cutting or puncturing the jacket, contamination by oil or grease, or damaging in any manner. Cable installation shall conform to the following requirements:

1. Stranded conductor cable shall be terminated by lugs, cup washer, or pressure connectors. Stranded cables shall not be wrapped around screw type terminal.

2. Stranded conductor cable shall be spliced by pressure type connectors. Wire screw type connectors shall not be used on stranded cable.

3. Cables may be spliced only at readily accessible locations.

4. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

5. Cable shall not be pulled tight against bushings not pressed heavily against enclosures.

6. Cable pulling lubricants shall be as recommended by the cable manufacturer for that particular type cable.

7. Buried cables shall have molded warning marker on posts every 20 m and at points of direction change along the route.

12) Main Distribution Board and Control Panels (MDB & CPs)

8) MDB and CPs Description

General

The main distribution board and control panels shall be form 4a type and of a standard well tested and proven design which ensures maximum safety to personnel, maximum service reliability and economic operation for an operational lifetime of at least 30 years. Design and construction shall be simple and well laid-out and shall provide good accessibility to components and parts.

Even under extreme conditions of major short circuit or maloperation, there shall be no danger to persons in the vicinity of the assembly.

The electrical system for all main distribution board and control panels shall be 5- wire system, 3 Phase, Neutral and Earth.

Unless otherwise specified the neutral conductor, size shall be the same size as the phase conductors.

All incomers and bus-coupler shall be mutually interlocked mechanically and electrically.

A. Ratings

i. Main Distribution Board and Control Panels shall be rated based on voltage, current, frequency and the symmetrical breaking

ii. The capacity of incorporated LV automatic switching devices as defined in appropriate IEC publication.

   a. Low voltage, current-carrying components shall furthermore be capable of carrying their rated current continuously at rated voltage and under specified service conditions without exceeding the permissible temperature limits when mounted in the completely assembled boards.

   b. Moulded Case and Miniature Circuit Breakers shall have ampere ratings and current breaking (interrupting) capacities according to IEC 947-2 and IEC 157-2. The circuit breakers shall be 3 pole or single, fixed mounted and manually operated.

iii. All circuit breakers are to be equipped with release and blocking devices for 24 VDC and with an adequate number of signalling contacts. The rated short circuit capacity of all circuit breakers according to the necessary requirements is at least 25 KA.

B. Enclosure

i. The main distribution board and control panels shall be of the floor mounting cubicle type, having a complete metal enclosure of sufficient mechanical strength and high ingress protection grade, heavy duty, high protection against dust and water

penetration. The materials of construction shall be properly prepared and treated against rust or corrosion.

ii. The main distribution board and control panels shall be self-supporting and suitable for front entry and operation and shall be equipped with adequate removal eye bolts for lifting purposes.

iii. Doors, covers and sides shall be made from galvanized sheet metal at least 2 mm thick, painted with two primary coats and two finishing coats of grey oil paint. The cabinets are to be designed for placing against the wall. Doors should be provided with locks for double bit keys and central locking system. To avoid earthing problems, internal parts may not be varnished.

iv. All bolts, nuts, screw, hinges, handles, etc. shall be galvanized, stainless steel or chromate- plated steel.

v. Each vertical section and each functional compartment shall be segregated from the neighbouring sections.

vi. In case of cable cellar, adequate bottom plates shall be provided which at least prevent access by rodents.

vii. The degree of protection shall be IP 54, form 4a Type 1 totally in accordance with IEC publication 60529.

viii. All components requiring periodical maintenance shall be easily accessible.

ix. Effective precautions shall be taken to prevent the formation of harmful condensation inside the enclosure, under either operating or non-operating conditions or service conditions.

x. 230V - 1 phase anti-condensation heater shall be installed in each vertical section: the heater shall be controlled by a common panel-thermostat.

xi. Each vertical section shall be provided with a panel mounted lighting fixture operated through a dedicated door-limit-switch.

xii. The hinges of the (MDB and CPs) doors shall allow the doors to swing through approximately 120 degrees from the closed position.

xiii. The door of each main incoming breaker's compartment shall be interlocked with the respective circuit breaker so that the door cannot be opened unless the breaker is in the OFF position.

xiv. All cables shall enter through glands in plate covering the base of the panels.

xv. All the wiring, instruments, devices and all parts of the panel shall be facing the front of the panels, i.e: it shall not be needed to go to the rear of the panels to do anything to it anytime (for dismantling, maintenance, reinstallation, etc.).

xvi. Unless otherwise specified the panels shall be natural air cooled.

c. <u>The following are to be included with the Main Distribution Board (MDB) and Control Panels (CP).</u>

Cable ducts.

- Mounting materials.
- Connecting materials.
- Installation materials.
- Connecting terminals.

Control circuit breakers with signalling contact for 24 VDC and 230 VAC in adequate number for each panel.

Installation

The MDB and CP shall be divided into compartments with separate doors and installed side by side. The compartments should be as follows:

a. The electricity company Kilowatt hour meter compartment.

b. Main incomer compartment.

c. Power distribution compartments.

d. UPS unit, 24 DC power supply and control feeders circuit breakers compartment.

e. Motors starters and Control Panels compartments.

Each compartment shall include a confined functional unit to enable diagnosis, maintenance, or repair of the respective functional unit without affecting the operation of other unrelated functional units.

To ensure a suitable arrangement for easy installation and operation, taking into consideration the local conditions, the following dimensions shall be used for each compartment:

a. Height 2200 mm

b. Width 800 mm

c. Depth 600 mm

Prior to installation of control panels, all applicable shop drawings and data shall have been submitted for review by Contractor and accepted by the Engineer.

Each floor channel shall be levelled before grouting and shall be securely anchored to the concrete equipment base. Each control panel shall be securely anchored to the channels either by bolting or welding at a minimum of two points for each vertical section.

Installation Check

After the main distribution board and the control panels have been installed and connected, the manufacturer's representative shall thoroughly inspect the installation and make all required adjustments.

Foundation

Bolt holes shall be provided in the base of each section and the control panel anchored to the floor channels.

Main, Neutral and Earthing Busbar Systems

Busbar system which is provided shall comprise main 3 phases + Neutral + Earth. Busbars shall be of tinplated high conductivity electrolytic copper flat bars with round edges, joints by means of noncorrosive high tensile steel bolts, nuts and washers, and secured against loosening. Insulated coloured busbars shall be used. Busbars shall be suitable for extension to the left or

to the right as required. Busbars shall be accessible for maintenance purposes ...etc. Compound or oil insulated busbar systems are not acceptable.

The busbars shall be supported to withstand the thermal and magnetic forces resulting from the highest expected short circuit currents inside any panel.

All parts of the busbar system and the feeders that are under tension are to be covered and must be safe from accidental touching.

Wiring/Cabling

a. Control wiring shall be minimum 1.5 sq mm, stranded, 750 V AC grade, and colour grey.

b. All power wiring/cabling shall be minimum 2.5 sq mm, stranded, and 1000 VAC grade.

c. Wiring to door mounted devices shall be suitable for hinge wire application.

d. Bundles of single-core cables shall be routed neatly in the vertical and/or horizontal plane.

e. Individual wires and bundles shall be secured with plastic wire ties, cable lacing or by enclosing in plastic wiring trays.

f. Compartments shall be completely internally wired.

g. All terminal blocks shall be rated 20A (minimum) at 500 V. All terminal blocks shall have a white plastic marking strip over the length of the block.

h. All wiring shall be identified by permanent slip-on plastic sleeves at each terminal point in addition to the marking on the terminal blocks.

i. Panels shall be provided with undrilled, metal gland plates, which shall be grounded to the MDB and CPs earth bus.

j. The internal connections between "motor starter" compartment and this connection compartment shall be executed as internal wiring in the CP.

k. The wires and cables which will be used in the (MDB and CP) should be marked by the following colour-codes:

Cable Type	Color Code
Phases L1, L2, L3	Black, marked with phase-colours (Red, Yellow, Blue)
Neutral conductor N	Light Blue
Potential equalization PE	Green/Yellow
DC main circuits (24 VDC)	Black
AC line control circuits phase (230 V, 50 Hz)	Red
AC line control circuits neutral	Light Blue

Cable Type	Color Code
Measuring circuits	White
DC control circuits positive:	Brown (24 V)
DC control circuits common negative	Gray
Signal lines	Gray (Screened)
Measuring circuits (4-20 mA, - 10, 0 + 10 VDC, PT 100)	Shielded/Gray
Potential Free/External Interface	Orange

Terminals

Each panel shall be provided with appropriate facilities for the independent terminals to connect the LV main cables and the auxiliary cables.

a. The terminals for different voltages shall be effectively separated.

b. The terminals shall be so arranged that all connections can be made safely, even when the assembly is energized.

c. Suitable terminating facilities of adequate dimensions and thermal rating shall be provided for each conductor.

d. Inside the compartment's separate terminals or bolts, one for each cable, are required for earthing purposes.

e. Efficient means to prevent strain on the actual conductors and cable lugs shall be provided.

f. Terminal blocks fitted with tubular type contacts with non-loosening screws shall be provided for termination of cables.

g. Within the panel compartments suitable clamping devices shall be provided for securing of the cables.

h. Terminals in current measuring circuits shall be special purpose with suitable bridging links and measuring facilities.

i. Specified auxiliary contacts for remote circuits shall be wired and connected to an accessible terminal block in the vicinity of the cable entries.

j. Termination compartments for main and control cables shall have adequate dimensions, with ample accommodation for the required number of terminals.

k. Two or more conductor terminations on one terminal are not acceptable unless the terminals are designed for more than one conductor.

l. Cable glands suitable for the cables specified shall be included in the supply of the assembly.

m. Signalling lines and measuring signals are to be put on terminal blocks to guarantee a clearly arranged connection to the PLC. The terminals shall be designed as terminal strips or e.g. as wire wrap technology, according to the number of signals.

n. Over-voltage protection devices, coupling relays and optical couplers are to be included in the terminal level.

Instruments, Relays and Accessories

The following are to be provided on the openable instrument compartment door:

b. Measuring instruments.
c. Control knobs, Position signalling device.
d. The following can be mounted inside the instrument compartment:
e. Auxiliary relays.
f. Pack circuit breakers.
g. Alarm horns.
h. Thermostat and /or humid state for anti-condensation heater.

Each measuring signal is to be transmitted standardized and potential free by 4 to 20 mA. Indicating instruments are mainly analogue indicators. Measuring units must be easily accessible for maintenance and calibration.

All measuring and controlling devices must be tested and they should mainly be built up of a modular structure with easily replaceable groups.

13) Miniature Circuit Breakers (MCBs)

Type:

Thermal magnetic non-adjustable type tested in accordance with the BSEN 60898 Standard. Minimum Short-Circuit Breaking Capacities are to be as follows:

6-32A MCB: 10 kA at 240/415 V A.C.

Construction:

MCBs are to be tropicalized for operation at ambient temperatures up to 70°C within panel board enclosure and humidity up to 95%, and are to be constructed from high quality, high temperature, molded insulating materials. Guaranteed duties and characteristics are to be submitted for temperatures above 40°C. MCBs and combinational devices are to be modular, of unified profile and mounted to a standards DIN rail.